GEOLOGICAL SURVEY

OF

CANADA

ANNUAL REPORT

NEW SERIES

VOL. III

PARTS 1 & 2

1887 - 8

This document was produced by scanning the original publication.

Ce document est le produit d'une numérisation par balayage de la publication originale.

Geological Survey of Canada

GEOLOGIC JRVEY

Annual Report New Series

INVE EYS.

Vol. III

1887-88

Parts 1. & 2.

GEOLOGICAL AND NATURAL HISTORY SURVEY

OF CANADA.

REPORTS AND MAPS

OF

INVESTIGATIONS AND SURVEYS.

THE HONOURABLE EDGAR DEWDNEY, M.P.,
Minister of the Interior.

SIR,—Herewith I have the honor to submit Vol. III, new series, of the Reports of the Geological and Natural History Survey of Canada. It consists of 13 parts or separate reports, with numerous maps and illustrations, relating to the geology, mineralogy and natural history of various sections of the Dominion from British Columbia to Nova Scotia.

The several parts were issued separately at intervals during the past twelve months, and can be purchased at from ten to thirty cents each.

I have the honour to be,
Sir,
Your obedient servant,
ALFRED R. C. SELWYN,
Director.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

ANNUAL REPORT

(NEW SERIES)

VOLUME III.

PART I.

REPORTS A, B, C, E, F.

1887-88.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
WILLIAM FOSTER BROWN & CO.
1889.

TABLE OF CONTENTS.

REPORT A.

SUMMARY REPORTS OF THE OPERATIONS OF THE GEOLOGICAL SURVEY FOR THE YEARS 1887 AND 1888, BY THE DIRECTOR.

	(A.) PAGE
Annual Report for 1887	1
Examinations by the Director	1-3
Explorations and Surveys	
British Columbia and North West Territory	4-13
Manitoba	14-18
Lake of the Woods and Rainy Lake	18-19
James Bay	19-21
Ontario	21-27
Quebec	27-35
New Brunswick	35-38
Nova Scotia	38-39
Mineral statistics	39-42
Chemistry and Mineralogy	42-47
Palæontology and Zoology	47-53
Botany	53-55
Maps	55-56
Library, Museum, Expenditure, etc	56-58
1888.	
Examinations by the Director	58-59
Explorations and Surveys:	
British Columbia	59-69
North West Territory, Yukon and Mackenzie Rivers	69-72
Manitoba	72-75
Ontario	76-80
Hudson Bay—islands and rivers east coast	80-82
Quebec	82-91
New Brunswick	91-96
Nova Scotia	96-100
Mineral statistics	100-101
Chemistry and Mineralogy	101-105
Palæontology and Zoology	105-113
Botany	114-115
Maps	115
Library, Visitors, Staff, Appropriation, etc	116-117

REPORT B.

REPORT ON AN EXPLORATION IN THE YUKON DISTRICT, N.W.T., AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA, BY G. M. DAWSON.

	(B.) PAGE
Introductory	5
Summary of proceedings	7
Main Geographical Results	10
Orography and General Features	11
Sources of the Yukon and nomenclature	14
Navigable waters and Routes of travel	19
Climate, Agriculture, and Flora	21
Fauna	25
Mining and Minerals	26
Fur Trade	28
Economic importance of the region	29
General Geology	31
Occurrence of Jade on the Lewes	38
Glaciation and Surface Deposits	38
Volcanic Ash Deposit	43
The Stikine River	46
General Features	46
Glaciers	51
Geological Notes on the Stikine	53
Climate	58
Discovery and Exploration of the Stikine	61
Published Maps of the Stikine	63
Cassiar Trail	64
Geological Notes on the Cassiar Trail	69
Superficial Deposits and Terraces	73
Route for Waggon-road or Railway	74
Dease Lake	75
Gold Mining in Cassiar District	78
Discovery and Exploration of Cassiar District	82
Dease River	86
Geology of the Dease River	92
Upper Liard River	96
Frances River	102
Frances Lake and Vicinity	108
Country between Frances Lake and Pelly River	114
Upper Pelly River	119
"Pelly Banks" to Hoole Cañon	120
Hoole Cañon to Ross River	122
Ross River to Glenlyon River	123
Glenlyon River to MacMillan River	127
Macmillan River to Lewes River	131

(B.)
PAGE
General Notes on Upper Pelly River 133
Confluence of the Lewes River and Upper Pelly 135
Discovery and Exploration of the Liard and Pelly 136
Lewes River 141
Fort Selkirk to Rink Rapid 144
Rink Rapid to Little Salmon River 147
Little Salmon to Big Salmon River 150
Big Salmon River 151
Big Salmon River to Tes-lin-too 152
Tes-lin-too to Newberry River 154
Tes-lin-too to Lake Labarge 156
Lake Labarge 156
Lake Labarge to Tahk-heena River 160
Tahk-heena River 160
The Cañon 161
Miles Canon to Lake Marsh 162
Lake Marsh 163
Tagish, Bennett and Lindeman Lakes 165
Geology of the Lakes 170
General Notes on Lewes River 173
Chilkoot or Taiga Pass 174
The White Pass 177
Exploration and Prospecting on the Lewes and Gold Mining in the Upper Yukon Basin 178

APPENDIX I.
NOTES ON THE DISTRIBUTION OF TREES AND OF CERTAIN SHRUBS IN THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA 185

APPENDIX II.
NOTES ON THE INDIAN TRIBES OF THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA 191

APPENDIX III.
LIST OF PLANTS COLLECTED IN THE YUKON DISTRICT AND ADJACENT PORTION OF BRITISH COLUMBIA IN 1887 215

APPENDIX IV.
ZOOLOGY 229

APPENDIX V.
NOTES ON THE LITHOLOGICAL CHARACTER OF SOME OF THE ROCKS COLLECTED IN THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA 235

APPENDIX VI.
METEOROLOGICAL OBSERVATIONS 241

APPENDIX VII.
SUMMARY OF ASTRONOMICAL OBSERVATIONS 261

REPORT C.

GEOLOGY OF MINING DISTRICT OF CARIBOO, BY AMOS BOWMAN.

(C)

PAGE

Joint Provincial and Dominion Surveys 5
Limits of field and of the work 6
Survey operations and Geographical results 12
Physical Features of Cariboo District 13
Geology of Cariboo District 15
Recent 16
Post-Tertiary 17
Mesozoic 17
Upper Palæozoic 20
Lower " 22
Mining Geology 26
Dip and Strike of Country-rock 26
Dip and Strike of Veins 28
Distribution of the Placers 29
Quartz Ledges examined 31
Williams Creek 31
Lowhee Creek 34
Island Mountain 34
Mosquito Creek 37
Lightning Creek 38
Sugar Creek 40
Grouse Creek 42
Antler Creek 43
Round Top Mountain and Cunningham Creek 43
Snowshoe Plateau and Snowshoe Creek 44
Harvey Creek 46
Duck Creek 46
North Fork of Quesnel River 47
Spanish Creek 47
South Fork of Quesnel River 48
Between Main Quesnel and Swift Rivers 48
Hixon Creek 48

REPORT E.

NOTES TO ACCOMPANY A PRELIMINARY MAP OF THE DUCK AND RIDING MOUNTAINS IN NORTH-WESTERN MANITOBA, BY J. B. TYRRELL.

	(E.) PAGE
Surveys	5
Extent and General Physical Features of Area	6
Lake Dauphin	7
Old Shore Lines of Lake Agassiz	9
Coast Cliffs and Gravel Beaches	10
Morainic area	13
Lake Assiniboine	14

REPORT F.

ON THE GEOLOGY OF THE RAINY LAKE REGION, BY A. C. LAWSON.

	(F.) PAGE.
Introduction	5
Physical Features	10
The rocky lake country	10
The alluvial plain or river country	20
Archæan Geology—General statement	21
Keewatin Series	22
Limits of area and conditions of contact with lower rocks	22
Stratigraphical relations and structure—Sections	43
Petrography	57
Altered diabase traps	57
Hornblende schists	73
Soft fissile green schists	80
Conglomerates	82
Sericite schists, felsitic schists, altered quartz-porphyries	85
Fragmental rocks—Grauwackes—Volcanic tuffs, &c	91
Peridotites and gabbros	97
Coutchiching Series	99
Relation of series to Keewatin and Laurentian	105
Petrography	107
Laurentian	112
Petrography	120
Hornblende-granite and hornblende-syenite gneiss	120
Mica-syenite gneiss and biotite-granite gneiss poor in quartz	126
Biotite gneiss	127

(F.)

PAGE

Inclusions in Laurentian Gneiss 130
Summary of Archæan Geology 139
The Granites 142
Granites cutting Laurentian 142
Granites cutting Keewatin and Coutchiching 145
Post-Archæan Diabase Trap 147
Glacial Phenomena 163
List of directions of glacial grooves and striæ 164
Post-Glacial Formations 169
Economic Geology 176
Index 183

REPORT H.

MINES AND MINING ON LAKE SUPERIOR.—PART I., BY ELFRIC DREW INGALL.

(H.)

PAGE

Preface 1
Objects and Methods of Investigation 1
A.—*History and General Conditions of the Region* 7
Area dealt with 7
Surface Features 7
General Geological Features 7
Mineral Resources 7
History of Mining in the Region 9
Attention directed to it by the Geological Survey 9
Course of Exploration and Discoveries of different Minerals 9
Natural and Economic Conditions of the Region 15
Communications 15
Early Difficulties 15
Effects of bad Mining Laws 15
Suggestions for the future 15
B.—*Silver Mining* 21
General and Economic Features of the District 21
General Geological Features 21
The Silver-bearing or Animikie Series and its subdivisions 21
The Silver Veins, their contents and grouping 21
The Coast Group 26
Details of the different Veins and of the Work done on them 26
The Coast Section of Rocks 46
The Port Arthur Group 46
Details of the different Veins and of the Work done on them 46
The Rabbit Mountain Group 68
Details of the different Veins and of the Work done on them 68

(H.)
PAGE
The Silver Mountain Group 77
Description of the accompanying Map 77
Geological details of the enclosing rocks of this group 77
Details of the different Veins and of the Work done on them 77
The Whitefish Lake Group 96
General Characteristics of the Veins 96
Geolosical details of the enclosing rocks of this group 96
Details of the Work done on the different Veins 77
General Characteristics of the Silver Veins 104
Strike directions and dips 104
Physical Characteristics 104
Contents: Minerals, Gas and Mineral Waters 104
Characteristics of contained Minerals 104
Relationships and Distribution of the Gangue and Silver Minerals in the Veins 104
Assays 104
Probable Source and Mode of Deposition of the Silver Minerals ... 104
Conclusions 113
Past Experience and Probable Future of the District 113
APPENDIX I.
NOTES ON MICROSCOPICAL EXAMINATION OF ROCKS FROM THE THUNDER BAY SILVER DISTRICT, BY MR. W. S. BAYLEY, OF JOHNS HOPKINS UNIVERSITY, BALTIMORE, U.S.A. 115
APPENDIX II.
LITERATURE OF THE SUBJECT 123
SUPPLEMENT.
RECENT DEVOLOPMENTS AT THE CHIEF SILVER MINES TO 1ST JUNE, 1889 125

REPORT J.

ON EXPLORATIONS IN JAMES BAY AND COUNTRY EAST OF HUDSON BAY DRAINED BY THE BIG, GREAT WHALE AND CLEARWATER RIVERS, BY A. P. LOW.

(J.)
PAGE.
Previous Explorations and Discoveries 6
James Bay 14
Rivers 17
Harbors 20
Islands 24
Big River 37
Route between Big and Bishop Roggan Rivers 40
South Branch of the Bishop Roggan River 43
Upper Big River 45
Route from Big to Great Whale River 48
Great Whale River 50
Route from Richmond Gulf to Clearwater Lake 55
Glaciation and Superficial Deposits 61

(J.)
PAGE

APPENDIX I.
LIST OF PLANTS COLLECTED ON THE RUPERT AND MOOSE RIVERS, ALONG THE SHORES, AND ON THE ISLANDS OF JAMES BAY 63
APPENDIX II.
LIST OF DIURNAL LEPIDOPTERA AND COLEOPTERA 75
APPENDIX III.
NOTES ON THE BREEDING HABITS OF CERTAIN MAMMALS 76
APPENDIX IV.
METEOROLOGICAL OBSERVATIONS 80

REPORT K.

SECOND REPORT ON THE GEOLOGY OF A PORTION OF THE PROVINCE OF QUEBEC, BY R. W. ELLS.

(K.)
PAGE

Bibliography 6
Geology 9
Devonian 9
Silurian 11
Cambro-Silurian 12
Cambro-Silurian and Cambrian (Quebec Group) 25
Cambrian 84
Pre-Cambrian 89
Crystalline and Igneous Rocks 93
Surface Geology 98
Economic Minerals 101
APPENDIX.
SYSTEMATIC LIST OF FOSSILS, WITH LOCALITIES AS REFERRED TO IN THIS REPORT, EXCLUSIVE OF THOSE SPECIES OBTAINED IN THE LIMESTONE CONGLOMERATE BANDS 116

REPORT M.

ON EXPLORATIONS AND SURVEYS IN PORTIONS OF NORTHERN NEW BRUNSWICK AND ADJACENT AREAS IN QUEBEC, AND IN MAINE, U.S., BY L. W. BAILEY AND WM. McINNES.

(M.)
PAGE

Geology 12
Gaspé Peninsula 12
Quatawamkedgwick and Rimouski Rivers 20
Boisbouscache and Tuladi Rivers 26

(M.)
PAGE
Lake Temiscouata 29
Section in vicinity of Siegas River, Victoria Co., N.B. 36
Upper St. John and Aroostook Section. 37
Aroostook County, Maine 39
Comparison of the Silurian System of Southern with that of Northern New Brunswick and Quebec 47
Sequence of Silurian Strata in Southern New Brunswick 48
List of Fossils from Back Bay, Charlotte County, N.B 48
Supposed Sequence of Silurian Strata in Northern New Brunswick, Quebec and Maine 51

REPORT N.

ON THE SURFACE GEOLOGY OF NORTH-EASTERN NEW BRUNSWICK TO ACCOMPANY QUARTER SHEET MAPS, 2 N.E. AND 6 S.W., BY R CHALMERS.

(N.)
PAGE
Area explored 5
Topographic features 6
Rivers and Lakes 8
Classification of the surface deposits 9
Pre-glacial rock Debris, Gravel, &c 10
Glacial Deposits. ....
Boulder clay or Till 12
Stratified boulders in drift 13
Boulders and erratic Blocks 14
Glacial Strix 15
General conclusions respecting Glaciation. Boulder Distribution, &c 16
Stratified Sands, Gravels and Clays 17
Stratified Inland Gravel, sand and clay (fresh water) 17
River Terraces and Kames of River Valleys 18
Leda Clay and Saxicava Sand .....
M 3. Fresh Water Alluviums 22
River Flats, Lacustrine and Fluviatile Marshes 22
Peat Bogs 22
Vegetable Mould 25
M 3. Marine Alluviums 26
Sand Dunes .....
Salt Marshes 27
Estuarine Flats 28
Agricultural Character, Sylva, &c 28
Soils of Carboniferous Rocks 28
Do. of Cambro-Silurian 30
Do. of Pre-Cambrian 31
Indian Encampments 31
Economic Materials 32–33

REPORT R.

THE MINERAL WEALTH OF BRITISH COLUMBIA, BY G. M. DAWSON.

(R.)

PAGE

General Physical Features 6
General Notes on Mineral Deposits 10
Publications Bearing on Geology, etc., of British Columbia 15
The Discovery of Gold 17
Progress of Placer Gold Mining 19
Yield of Gold 22
Gold Mining Districts—Placer 24
Fraser and Thompson Rivers 24
Cariboo District 30
Similkameen, Rock Creek and Okanagan 38
Kootanie and Big Bend 39
Omenica District 41
Cassiar 43
Yukon District 44
Skeena River 44
Vancouver Island 45
General Considerations respecting Placer Gold Mining 45
Connection of Placer-mining and Vein-mining 50
General Remarks on Vein-mining 51
Gold 51
Silver 55
Vein-mining Districts (Precious metals) 56
Cariboo 56
West Kootanie 59
East Kootanie 65
Interior Plateau Region 68
Coast Ranges 72
Omenica 73
Other Localities 73
Table of Assays of Ores containing Gold and Silver 76
Coal 80
History and Annual production of Coal 80
Coal and Lignite-bearing Formations 83
Principal Coal-fields (Cretaceous) 85
Coal and Lignite of the Tertiary 94
Table of Proximate Analyses of Coals and Lignites 98
Iron 99
Copper 101
Lead 103
Zinc 103
Antimony 104
Platinum 104

(R.)
PAGE
Mercury 105
Arsenic 106
Molybdenum 106
Structural Materials 106
Building Stones 106
Ornamental Stones 108
Limes and Cements 109
Precious Stones 110
Miscellaneous Minerals 112
Mineral and Thermal Springs 112
ANNOTATED LIST OF LOCALITIES OF MINES AND OF KNOWN OCCURRENCES OF MINERALS OF ECONOMIC VALUE 115
Gold (placers) 115
Gold (auriferous veins) 143
Silver 144
Coal and Lignite 145
Iron 151
Copper 152
Lead 155
Antimony, Platinum, Mercury 156
Molybdenum 157
Structural Materials 157
Miscellaneous Minerals 161
Mineral and Thermal Springs 162

REPORT S.

STATISTICAL REPORT OF THE PRODUCTION, VALUE, EXPORTS AND IMPORTS OF MINERALS IN CANADA, BY E. COSTE.

(S.)
PAGE
Letter of Transmittal 3
Summary of Production 5
" Exports 6
" Imports 7
Abrasive materials 8
Antimony 10
Arsenic 11
Asbestus 12
Coal 13
Copper 20
Gold 23
Graphite (Plumbago) 28

(S.)

	PAGE
Gypsum	30
Iron	33
Lithographic Stone	43
Manganese	44
Mica	46
Mineral pigments	46
Miscellaneous	48
Petroleum	53
Phosphate and Manufactured fertilizers	59
Iron ores and Phosphate deposits in the Archæan rocks of Canada.	62
Precious stones	65
Pyrites and Sulphuric Acid	81
Pyrites deposits in Canada	83
Salt	86
Silver	88
The most important new developments in the Port Arthur silver district in 1887	89
Structural materials	97

REPORT T.

CHEMICAL CONTRIBUTIONS TO THE GEOLOGY OF CANADA FROM THE LABORATORY OF THE SURVEY, BY G. C. HOFFMANN.

(T.)

	PAGE
Lignites, Analyses of	5–9
Lignite Coal Analyses	10–11
Coal Analyses	11–19
Semi-Anthracite Analyses	20
Natural Waters	21–22
Iron Ores	23–26
Gold and Silver Assays	26–38
Miscellaneous Examinations	55–58

ERRATA.

Page 24 H, Title of Plate, *for* Outline *read* Outlyers.
Page 89 H, line 14 from bottom, *for* p. 72 H *read* p. 88 H.
" 111 H, side note, *for* vein *read* vein minerals.
" 124 H, line 12 from top, *for* per ton (200 lbs.) *read* per ton (2000 lbs.)
" 124 H, line 19 from top, *for* smelting and charges *read* smelting and other charges.
Page 9 J, line 17 from top, *for* Diner's *read* Viner's.
" 9 J, " 3 and 2 from bottom, *for* Gillan *read* Gillam.
" 10 J, " 5 from top, *for* Gillan *read* Gillam.
" 24 J, " 8 from top, *for* Omer's *read* Viner's.
" 28 J, " 17 from top, *for* island *read* inland.
" 33 J, " 19 from bottom, *for* face *read* base.
" 33 J, " 11 from bottom, *for* blackish *read* brackish.
" 34 J, " 7 from bottom, *for* fifty *read* fifteen.
" 35 J, " 9 from bottom, *for* areas *read* terraces.
" 37 J, " 14 from top, *for* Kitchisipis *read* Kitchisipi.
" 43 J, " 14 from bottom, *for* Kotaniwauan *read* Kotaniwanan.
" 44 J, " 21 from top, *for* Kabunskiwas *read* Kabunskiwao.
" 45 J, " 22 from top, *for* Kabunskiwas *read* Kabunskiwao.
" 45 J, " 2 from bottom, *for* Patilawagau *read* Patitanagan.
" 46 J, " 19 from top, *for* Patilawagau *read* Patitanagan.
" 50 J, " 14 from top, *for* Mishiminiwetan *read* Mishimimwetan.
" 50 J, " 8 from bottom, *for* Mishiminiwetan *read* Mishimimwetan.
" 54 J, " 8 from bottom, *for* light green felspar *read* light green hornblende.
" 55 J, " 17 from top, *for* Manitonieck *read* Manitounuck.
" 57 J, " 9 from bottom, *for* Saal *read* Seal.
" 75 J, " 2 from top *for* T. S. Cotter *read* G. S. Cotter.
Page 11 K, line 7 from top, *for gregori read gregoria,*
" 11 K, " 22 " " *for Helsophyllum read Heliophyllum.*
" 11 K, " 23 " " *for seriatula read striatula* (name preoccupied).
" 13 K, " 18 from bottom *for* Roulette *read* Rolette.
" 13 K, " 16 from bottom *for* à *read* de.
" 14 K, " 17 from bottom *for* à *read* de.
" 15 K, " 2 from bottom, *for Orthograptus read Orthograptus.*
" 19 K, " 9 from top *for* Ancient *read* Indian.
" 19 K, " 2 from bottom *for Atrypa hemispherica read Camerella hemiplicata*
" 23 K, " 8 from bottom, *for Hyalostetia read Hyalostelia.*
" 35 K, " 4 from bottom, *for* Belleile *read* Belle Isle.
" 50 K, " 11 from top, *for folium read folium ?*
" 50 K, " 10 from bottom, *for brachiatus read quadribrachiatus.*
" 86 K, " 17 from bottom, *for* Marcelli *read* Marcel.

Page 86 K, " 8 from bottom, *for* de *read* du.
" 92 K, " 14 from top, *for* Les Saintes *read* Saints.
" 101 K, " 13 from bottom, *for* Meul *read* Meule.
" 101 K, " 9 from bottom, *for* Meul *read* Meule.
" 110 K, " 2 from top, *for* compresser *read* compressor.
" 10 M, " 4 from bottom, *for* explored *read* unexplored.
" 10 M, " 6 from bottom, *for* Ardovician *read* Ordovician.
" 10 M, " 12 from bottom, *for* nor *read* or.
" 17 M, " 14 from bottom, *for* 1°-20′′ *read* 10°-20′′.
" 27 M, " 6 from bottom, *insert* M *after* 41.
" 28 M, " 10 from bottom, *for* extentation *read* extention.
" 41 M, " 8 from bottom, *for* Trilobite *read* Crustacea.
" 45 M, " 3 from top, *for* there *read* thin.
" 46 M, " 1 from top, *for* subplanm *read* subplanum.
" 46 M, " 6 from top, *for* like *C. Clintoni*, Hall, *read* sp.

The tabulated list of the fossils, referred to in letter p. 3 M, is omitted.
Page 161 R, line 3 from top, *for* Lytton *read* Lilloet.

PLATES AND MAPS ACCOMPANYING THIS VOLUME.

PLATES.

1. Dease River, above "First Lake," looking west. Part B, Frontispiece.
2. Tahl-tan Valley at Trail Crossing, p. 65 B.
3. View of the Tanzilla River, p. 67 B.
4. Outline Sketch of part of Too-tshoo Range, p. 110 B.
5. Drift Bluff, Upper Pelly River, p. 126 B.
6. Upper Pelly River, p. 128 B.
7. Lake Nares, p. 166 B.
8. Looking towards Coast Range, up west arm of Bennett Lake, p. 167 B.
9. Lake Lindeman, p. 172 B.
10. { Panoramic View from Mt. Agnes, p. 14 C.
    { Panoramic View from Mt. Barker, p. 14 C.
11. Old Indian Houses, near Valley River, p. 12 E.
12. Contact of Laurentian gneiss and Coutchiching schist. Part F. Frontispiece.
13. Diagramatic sections of Keewatin trough, p. 43 F.
14. Angular inclusions of schist in Laurentian gneiss, p. 105 F.
15. Contact of Laurentian gneiss and Coutchiching schist, p. 106 F.
16. Biotite gneiss with included fragment of amphibolite, p. 133 F.
17. Angular and lenticular fragments of Hornblende schist included in Laurentian gneiss, p. 135 F.
18. Fragments of hornblende schist enclosed in Laurentian gneiss, p. 138 F.
19. Diabase dyke cutting Laurentian gneiss, p. 148 F.
20. Sketch of hills looking east from Crown Point Mine, Silver Mtn., p. 22 H.
21. Outliers of the Animikie series north of Whitefish River, p. 24 H.
22. Trap flow on Argillites, Silver Mtn. District, p. 24 H.
23. Plates I. to IX. Plans of Mines.
    Silver Islet, p. 29 H.
    Pie and McKellar's Islands, p. 40 H.
    Spar Island, p. 42 H.
    Jarvis Island, p. 45 H.
    Shuniah Mine, p. 57 H.
    3 A Mine, p. 58 H.
    Porcupine and Rabbit Mt. Mines, p. 68 H.
    Beaver Mine, p. 72 H.
    Silver Mt. and Crown Point Mines, p. 89 H.
24. Rabbit Mountain Mine, View of, p. 70 H.
25. Group of Esquimaux, east coast Hudson Bay, Frontispiece J.
26. South Shore of Richmond Gulf Lake.
27. Clearwater River, 40 miles inland, p. 56 J.

MAPS AND SECTIONS.

1. Index Map of Yukon District. Scale 60 miles to 1 inch. Part B.
2. Yukon District and part of British Columbia, 3 sheets. Scale 8 miles to 1 inch. Part B.
3. Geological Map of Cariboo Mining District. Scale ½ inch to 1 mile. Part C.
4. Island Mountain and Mosquito Creek. Scale 400 ft. to 1 inch. Part C.
5. Hixon Creek quartz locations. Scale 400 ft. to 1 inch. Part C.
6. Veins and "Placers" Hixon Creek. Scale 2112 ft. to 1 inch. Part C.
7. Sketch section from Guy's Mountain to the Cariboo Range. Part C.
8. Topographical Map of Duck and Riding Mountains, Manitoba. Part E.
9. Geological Map of Rainy Lake, sheet 3. Scale 4 miles to 1 inch. Part F.
10. Sketch Map of Thunder Bay Mining Region. Scale 4 miles to 1 inch. Part H.
11. Geological Map of Silver Mountain Mining District. Part H.
12. Quarter Sheet 17 N.E., Edmundston, N.B. Scale 4 miles to 1 inch. Part M.
13. Quarter Sheet 2 N.E., Miramichi, N.B. } Scale 4 miles to 1 inch. Surface
14. Quarter Sheet 6 S.W., Shippegan, N.B. } Geology. Part N.

NOTE.—No. 11 Map is not yet received from the engraver, and will be issued later.

SUMMARY REPORTS

OF THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEARS 1887 AND 1888.

The following Summary Reports are reprinted from Part III. of the Annual Reports of the Department of the Interior, in which the reports and maps presented in this volume are referred to as well as others in course of preparation.

These will be issued during the season of 1889-90, and will together constitute Vol. IV., New Series, of the Reports of the Geological Survey.

1887.

As in previous years, the explorations of the Survey have embraced many parts of the Dominion, and have, during the past season, extended from Vancouver Island and the Alaskan and northern borders of British Columbia, to James' Bay and the Atlantic coast of Nova Scotia, as well as to portions of the provinces of new Brunswick, Quebec, Ontaria and Manitoba.

Much new and valuable geological and geographical information has been acquired, and large and interesting additions have been made to the Museum collection.

The Annual Report for 1886, Vol. II., new series, has recently been issued. This volume of 977 pages, R. 8vo., with numerous maps and illustrations, is composed of thirteen parts, or distinct reports, giving, in detail, the scientific and the practical information, and the conclusions arrived at respecting the various portions of the country explored, or on the other subjects treated of. The parts are also published separately, and are sold at an average price of twenty-five cents each.

My own time, during the early part of the year, after my return from England, at the end of December, 1886, was fully occupied in the preparation of the Annual Departmental report, with the general executive details of the Branch, and in connection with the preparation of of the Annual Report, Vol. II, above referred to.

During the summer, between the 13th June and the 10th of October, I visited and examined varied places, between Gaspé Bay and Cape Rosier in Quebec, and Vancouver Island in British Columbia, where the work of the Survey is in progress, and where some personal observation was required, either for information on points of economic importance, or in connection with the working out of the geological structure of the region. Of these may be mentioned: the occurrence of petroleum at Gaspé; the relations of the graptolite bearing rocks of Cape Rosier, Matane and Bic to those of Point Levis, the Island of Orleans and Quebec; the cupriferous pyrrhotite mines of Sudbury; the silver mines and the iron ores of the vicinity of Port Arthur; the coal mines of Lethbridge and of Banff; the silver-lead mines of Illicillewaet, in the Selkirk Mountains; and the hot springs of Harrison Lake and of Banff.

As regards the Gaspé petroleum, no efforts appear to have been made to develop it since 1863, and beyond the fact of the recent discovery of oozings at a point higher up Silver Brook than where the first boring was made, there is no further information about it now than was given in the Geology of Canada, 1863, pages 402, 521 and 789, and in the report by Dr. T. Sterry Hunt, published in 1865, "On Petroleum, its Geological Relations considered with special reference to its occurrence in Gaspé." Three borings appear to have been made, the sites of which are marked on the geological map, $\frac{1}{4}$ sheet, 6 N. W., but as none of them exceeded 200 feet, a successful result was hardly to be expected. The development of the extraordinarily massive, cupriferous ore bodies in the vicinity of Sudbury was being actively prosecuted by the company. The manager informed me that 2,000 tons of the ore had been shipped to the Messrs. Vivians, of Swansea, Wales, and on their report depends the question whether the Sudbury ores can or can not be profitably worked. This ore-belt has now been definitely traced for eight miles, and outcrops of large bodies of ore have been found at intervals throughout. In view of the immense quantity of ore, the small cost of raising it, and the facilities for shipping it, a very low price per ton would leave a fair margin of profit.

The argentiferous galena of Illicillewaet occurs chiefly in quartz veins, cutting a series of black carbonaceous or graphitic slaty shales, and thin bedded limestones, often much folded, but showing an average dip of from 35° and 40° to E.N.E., and apparently flattening towards the summits of the mountains. Most of the veins are parallel with the stratification, though not infrequently passing from one bed plane to that of another. The openings on Kennedy & Corbyn's claim, No. 2, above the north fork of the Illicillewaet River, and about 5,300 feet above sea level, on a precipitous mountain

side, show a massive quartz vein in an almost vertical attitude, cutting the black slates which are here almost horizontal. The quartz is impregnated throughout with galena and some pyrites, and is said to be very rich in silver. A large pile of ore had been extracted, but as the only present access to this mine is by a steep zig-zag ascent 3,000 feet from the Canadian Pacific Railway, at Illicillewaet, and then by a similar descent of 1,000 feet on the other side of the ridge, ore very much richer than the bulk of this appears to be would be required to enable this mine to be profitably worked. The vein has more the appearance of a gash vein than that of a true fissure or fault vein, the slaty rock on either side of the vein being continuous, and showing no evidence of vertical displacement. Mr. G. B. Wright gave me a number of specimens from some of the other claims, and those that have been analysed by Mr. Hoffmann, have given from 247·92 oz. to 816·67 oz. of silver to the ton. In one only was a trace of gold found.

The great elevation—from 2,000 to 3.000 feet above the railway—at which most of the present openings are situated, must be considered a somewhat serious disadvantage, but there seems no reason why, by careful and intelligent prospecting, the same veins should not be discovered at lower elevations and in close proximity to the railway. No fossils have yet been found in these slates, but they closely resemble the black graptolitic shales described by Mr. McConnell, p. 22 D, Annual Report Geological Survey, 1886, and may be of Cambro-Silurian (Ordovician) age.

Samples were procured from the two hot springs at Harrison Lake, British Columbia, and these are now being analysed. That of Banff has also been analysed by Mr. Hoffmann. It will be interesting to ascertain the difference in the mineral contents of these waters—the one rising from the crystalline rocks of the coast range of British Columbia, and the other from the palæozoic limestones of the Rocky Mountains.

In my last summary report I stated "that the requirements of the Survey in respect to increased museum and office accommodation become each year more pressing." I may now state that, as regards the office accommodation, the steps I recommended are being taken, and in a few weeks, four additional well lighted and commodious office rooms will be available. They are on the top flat of the adjoining building, which has been connected with the present offices, the communication being closed by double iron doors to minimize the risk of fire, a risk unfortunately always great in the present situation of the Museum, and one which, in view of the great and annually increasing value of the collections, and the impossibility of replacing them if destroyed, merits, I would respectfully submit, the serious consideration of the Government, with a view to its speedy removal.

Dr. G. M. Dawson, with Messrs. R. G. McConnell, B.A., and James McEvoy, B. Ap. Sc., as assistants, was engaged during the past season in an exploratory survey of the region of the head waters of the Yukon and its vicinity, including portions of the northern part of British Columbia, but for the most part in the territory to the north of the 60th parallel, which constitutes the provincial boundary. Dr. Dawson was placed in general charge of the expedition, which was carried out conjointly by the Geological Survey and Dominion Lands Branches of the Department of the Interior. He furnishes the following preliminary account of the work of the Geological Survey contingent—Mr. Ogilvie's report on his special work, in connection with the Dominion Lands Branch, appearing elsewhere:—

"The Yukon expedition was undertaken in consequence of the necessity of ascertaining the nature and extent of the developments of placer gold mining, which of late years has attracted an increasing number of miners into the almost unknown district bounded to the south by the northern line of British Columbia, and to the west by the eastern line of Alaska. On account of the remoteness and the isolated character of the region to be examined, and the known difficulties to be encountered in traversing it, much time and attention were devoted to obtaining, by correspondence and otherwise, all available information, and in making such preliminary arrangements as were possible. For assistance in these matters we are especially indebted to Mr. John Grant, M.P.P., of Victoria; to Mr. Robert Campbell, now of Manitoba, the original explorer of a great part of the region; to Mr. J. Wrigley, Commissioner of the Hudson Bay Company, and Mr. J. McDougall, of the same company.

"I must also express my sense of obligation to Mr. W. Ogilvie, D.L.S., in special charge of the instrumental measurement on the Lewis River and to the 141st meridian, for his ready and obliging co-operation, and to Messrs. R. G. McConnell and James McEvoy, of this Survey, for their efficient assistance, to which is due much of the success of the expedition in carrying out the pre-arranged programme of work.

"We left Ottawa on the 22nd of April, travelling by the Canadian Pacific Railway to Victoria, but, in consequence of irregularity in the sailing dates of the Alaskan mail steamers, were unable to reach Wrangell, at the mouth of the Stikine River, where our work may be said to have begun, till the 18th of May. Here Mr. McConnell stayed behind, for the purpose of getting Indians and canoes to enable him to make a micrometer survey of the Stikine from the end of the line measured by Mr. J. Hunter, in 1877, to Telegraph Creek, while I proceeded up the river by the first steamer of the season to Telegraph Creek, the head of navigation. From this place goods are carried by

pack animals to Dease Lake, the centre of the Cassiar mining district; and here again a delay of several days occurred, as the animals had not been brought in from their range or shod for the season's work at the date of our arrival. Finally, on June 5th, we reached the head of Dease Lake, and found the greater part of the lake still covered with ice. It was not till the 9th that we were able to reach the point on the shore near Laketon, at which two men, previously sent on in advance with an Indian packer, were sawing lumber for boats. Seven days were here busily employed in this work and in constructing three boats for the purposes of the expedition. On the evening of the 16th, a strong wind having broken up the remaining barrier of ice, we reached Laketon with our boats; Mr. McConnell, with a crew of five coast Indians intended for my work on the Upper Liard, having meanwhile joined us. On the 18th, having completed our supplies and outfit at Laketon, we left that place, and on the 23rd reached 'Sylvester's lower post' at the confluence of the Dease and Liard Rivers. Here Mr. McConnell, with one boat and two men was to separate from us for the purpose of surveying and geologically examining the Lower Liard. In consequence of the delays experienced I thought it advisable to instruct Mr. McConnell to make arrangements, if possible, to winter at Fort Simpson, on the Mackenzie, as this would allow him to spend at least an an additional month in exploration in the autumn, besides enabling him to begin work to great advantage next spring, by descending the Mackenzie and crossing by the Rat and Porcupine Rivers to Yukon, thus obtaining a much more complete knowledge of the geology of the basin of the Upper Yukon than would otherwise be possible. This action on my part, I am happy to say, has since met with your approval, and advices have been received from Mr. McConnell since my return, to the effect that he had successfully accomplished the work on the Liard and had made arrangements to make his headquarters for the winter at Fort Providence.

"On leaving the confluence of the Dease and Liard, my own party included, besides myself, Mr. McEvoy, Messrs. L. Lewis and D. Johnson, engaged at Victoria, two Tshimsian and three Stikine Indians, all good boatmen. Two local Indians, hired as guides, and to help on the long portage, deserted a day or two after engaging, and from the lower post, to near the confluence of the Pelly and Lewis, for an interval of more than six weeks, we met with neither whites nor Indians.

"The ascent of the Liard and Frances Rivers to Frances Lake proved unexpectedly difficult and tedious, the water being swift throughout and three bad cañons having to be passed through. Frances Lake was reached on the 8th of July, and after spending a few days in examining and mapping the lake, making the observations necessary to fix its

position, and in the endeavor to find some Indian trail by which we might travel across to the Pelly, we began the work of portaging on the 17th.

"As we had been unable to discover any route now in use by the Indians, and no trace whatever remained of the trail employed by the Hudson Bay Company in former years, and as no local Indians could be found to act as guides or to assist in carrying our stuff, it was evident that the crossing of this portage (which had been estimated by Mr. Campbell at about 70 miles in length) would be a difficult matter, and that we might indeed find it impossible to carry over a sufficient supply of provisions for further work on the Pelly. We, therefore, constructed a strong log *câche* on the shore of Frances Lake, and left there to be taken back to Laketon by the Indians when they returned, everything we could possibly dispense with. Had we been unable to effect the portage, there was in our *câche* an ample supply of provisions to enable the whole party to return to the mouth of the Dease River. After a very toilsome journey, we were, however, so fortunate as to reach the bank of the Pelly on the 29th of July, with still nearly a month's provisions for four persons, the necessary instruments, and a small camping outfit, a canvas cover from which a canoe might be constructed, and the tools and nails for building a wooden boat, should that prove to be necessary. Our Indians, who had for a long time been very uneasy because of their distance from the coast and the unknown character of the country into which they had been taken, were here paid off, and to their great delight allowed to turn back.

"As a dangerous rapid was reported to exist on the upper part of the Pelly, it was decided to construct a canvas canoe in preference to building a boat, which it might prove impossible to portage past the rapid. Having completed the canoe, we descended the Pelly, making a portage of half a mile past Hoole's Rapid or Cañon, and reached the confluence of the Lewis branch of the Pelly (or Yukon) on the 11th of August. We had now reached the line of route which is used by the miners, and expected to find, at the mouth of the Lewis, a memorandum from Mr. Ogilvie, from whom we had separated in May. As we could not find any such memorandum, and as Mr. Lewis had not been seen on the lower river by a party of miners whom we met here on their way up the Lewis, we were forced to conclude that he had not yet reached this point. The same party informed us that few miners were during the summer on the Stewart River, where most of the work had been carried on in 1886, but that in consequence of the discovery of "coarse" gold on Forty Mile Creek, about 120 miles further down the river, all had gone there, and that Harper's trading post, where I had hoped to be able to get an additional supply of provisions should we fail to con-

nect with Mr. Ogilvie, had also been moved from the mouth of the Stewart to Forty Mile Creek. From the place where we now were we still had a journey of over 400 miles to the coast, with the swift waters of the Lewis to contend against for most of the distance. If, therefore, it should have become necessary to go down stream 220 miles to Forty-Mile Creek for provisions, so much would have been added to our up-stream journey that it would become doubtful whether we should be able to afford time for geological work on the Lewis and reach the coast before the smaller lakes near the mountains were frozen over. I therefore decided to set about the building of another boat, suitable for the ascent of the Lewis, and on the second day after we had begun work, Mr. Ogilvie very opportunely appeared. After having completed our boat and obtained Mr. Ogilvie's preliminary report and survey sheets, together with the necessary provisions, we began the ascent of the Lewis, from the head waters of which we crossed the mountains by the Chilkoot Pass and reached the coast at the head of Lynn Canal on 20th September. I am happy to be able to add that the entire expedition was carried out without any serious accident or loss, notwithstanding the difficult nature of the country, and that, though circumstantial reports were heard in the spring of trouble between the miners and Indians on the Yukon, these proved to be entirely groundless.

"The geographical, geological and general results of the work are now in process of elaboration and will be made the subject of a detailed report at an early date. Mr. Ogilvie's instrumental survey, now doubtless completed to the intersection of the river with the 141st meridian, will form a sufficiently accurate base line for future exploration in the region. In addition to this, the geographical results include the completion of an instrumental survey of the Stikine to Telegraph Creek by Mr. McConnell, which is connected with Dease Lake by a carefully paced traverse by Mr. McEvoy. Thence, a detailed running survey was carried by the route previously outlined, following the Dease, Liard and Pelly rivers and connecting with Mr. Ogilvie's line at the mouth of the Lewis River, a total distance of about nine hundred miles. Taken in connection with Mr. Ogilvie's measured line, these surveys include an area of over 60,000 square miles, the interior of which is still, with the exception of reports received from a few prospectors and from Indians, a *terra incognita*. The same remark, with little qualification, may be applied to the whole surrounding region outside the surveyed circuit, but much general information has been obtained respecting the entire district which will facilitate further explorations. The whole region is more or less mountainous, though intersected by wide areas of flat or rolling country. The north-eastern margin of the belt of coast mountains may be said to be at Telegraph

Creek on the Stikine. A second important mountain range runs in a general north-west by south-east course to the east of Dease Lake and is cut through by the Dease River. To the east of this no high or well-defined range was met with till the vicinity of Frances Lake was reached. Here a range, which may be accepted as the western part of the Rocky Mountains proper, is found with a similar trend to the east, and in this the streams feeding Frances Lake and the Pelly River rise. On the lower Pelly and Lewis Rivers the mountains are less considerable and assume a direction approximating more nearly to east and west.

"The following heights, deduced from a series of observations at a few main points will serve to indicate the general elevation of the country —

	Feet.
Telegraph Creek, Stikine River (water level).....	540
Dease Lake	2,661
Confluence of Dease and Liard Rivers.....	2,100
Frances Lake.....	2,577
Pelly River at "Pelly Banks" (water level).....	2,965
Old Fort Selkirk, mouth of Lewis River (water level).	1,555
Lake Lindeman, head of Lewis River	2,165

"Till the observations made in the field have been laid down on the map it will be impossible to give with precision any account of the geological features of the region. The rocks in general are closely analogous to those met with in the corresponding region in British Columbia to the south. The coast mountains where crossed by the Stikine and by the Chilkoot Pass consist for the most part of granitoid rocks, with some included crystalline schists precisely similar to those found to the south in the same mountain belt, some details in connection with which are given in my last report on Vancouver Island. *

"To the east of the coast mountains, on the Stikine and Lewis Rivers, there are Palæozoic rocks resembling those provisionally classed in the southern interior parts of British Columbia as the Câche Creek series. They include limestones, quartzites, slates and schists, with a notable proportion of agglomerates and other materials of volcanic origin. In the vicinity of Dease Lake, and nearly on the same line of strike on the Pelly, important beds of serpentine occur, and the associated rocks in these and many other places are preponderantly schistose and slaty, running through numerous varieties, but closely resembling the rocks of the Cariboo and other goldbearing districts to the south.

* Part B, Annual Report Geol. Surv. 1886, V. II.

"These Palæozoic rocks are by far the most widely spread in the entire region so far as exploration has yet gone, but are interrupted by areas of granitic rocks which generally form ridges or mountain ranges, and these in some places are flanked by more or less important developments of crystalline schists which are probably, at least in part, altered portions of the Palæozoic. The most important granitic range met with in the inland region is that previously mentioned as crossing the Dease River.

"Fossils are by no means abundant in the Palæozoic rocks, but a small collection of graptolites, of Cambro-Silurian age, were obtained on the Dease River, and Carboniferous forms were observed in connection with the limestones in several places. It is quite probable, however, that rocks ranging from the Cambrian to the summit of the Palæozoic, and possibly extending also to the Triassic, may be included in this great series, of which the schistose and slaty members constitute the gold-bearing rocks of the country.

"Rocks which are probably of Cretaceous age occur in limited basins on the Stikine immediately east of the coast mountains, and beds holding Middle or Lower Cretaceous marine fossils have a considerable development on the Lewis River, where there are also plant-bearing beds referable to the horizon of the Laramie and probably of the same age as the so-called Miocene of the Alascan coast and Mackenzie River. A few fossil plants which are probably Cretaceous in age were also found at one place on the Pelly River.

"The Miocene proper is represented in the Upper Liard valley by soft stratified rocks, associated with basalts, and basaltic overflows, probably of the same age, occur on the Pelly, near the mouth of the Lewis, on the latter river at the Cañon, and in the Stikine valley east of the coast mountains. In the last mentioned locality are some remarkable examples of superposed columnar flows overlying coarse gravel deposits There is not, however, in the entire region examined, any wide basaltic plateau.

"Some features of special scientific interest occur in connection with superficial deposits and the evidences of glacial action, but these cannot be detailed here. It may, however, be stated that in both the Lewis and Pelly valleys traces of heavy glacier-ice moving in northward and north-westward directions, are often apparent. The grooving and furrowing is found equally well marked at the water level, and at the summits of hills several hundred feet in height, and appears to indicate the northward movement of a confluent glacier, in conformity with the general slope of the country. Terraces are of general occurrence and well developed, and often appear at considerable heights on the mountain sides. In connection with the distribution of placer

gold, the direction of ice movement in the glacial period is of special importance.

"As the main object of the expedition was the exploration of the Yukon basin, but passing notice could be taken of the Cassiar mining district. The rich placer mines in the vicinity of Dease Lake were discovered in 1872, and reached their maximum productiveness in 1874, in which year they are reported to have yielded about $1,000,000. The yield in succeeding years has gradually declined, but about 150 men are still annually employed in the district. Much prospecting still remains to be accomplished before the possibility of the discovery of new rich creeks is exhausted. Promising deposits of quartz are known to occur, though nothing has yet been done towards their investigation and development. These seem to be worthy of special attention in consequenee of the comparative accessibility of the district by means of the Stikine. It would be easy to construct a waggon road from the head of navigation on the river to Dease Lake, and a railway may eventually be expected to follow this route into the interior.

"Gold mining in the Yukon district may be said to have been initiated in 1880, though little was done in that year, except a certain amount of prospecting by twenty-five or thirty miners who entered by way of the Chilkoot Pass. Since then a yearly increasing number of miners have entered the country by the same route, and river bars have been worked with good results on different parts of the Lewis and its tributary the Teslin-too (Newberry of Schwatka, Hootalinqua of the miners), and on the Pelly and Stewart rivers. In 1886 most of the work was done on the Stewart, but in consequence of the discovery of 'heavy' or 'coarse' gold on Forty-mile Creek, as previously mentioned, nearly all the miners went to that place last summer. This is the first discovery of 'coarse' gold in the district, but it may safely be predicted that many more will follow. Prospecting has so far been confined almost exclusively to the larger rivers, and the mining to river-bar mining, but the fact has been developed that gold occurs in greater or less quantity on all the streams, and the extent of the gold-bearing river bars already known is, in the aggregate, almost unprecedented. The number of men engaged in mining on the upper Yukon last summer was about 250, of which about 100 are wintering in the country. The number likely to be employed next season can only be guessed at, as so much depends on the demand for labor on the west coast generally. It is not impossible, however, that at least 500 men will be at work.

"In comparison with the region now known as an auriferous one on the upper Yukon, the productive portions of the Cassiar mining dis-

trict are small, as profitable work there was practically confined to a few creeks, yet in 1876 the transit trade at Wrangell, in connection with the mining in Cassiar amounted in value to about a million dollars. This may serve as an index of the probable commercial results of a similar development of placer mining alone in any portion of the Yukon territory.

"The prospective value of the Yukon district and northern part of British Columbia as a mining region I believe to be great. This region includes—measured from the vicinity of Dease Lake to the intersection of the Pelly (Yukon) with the 141st meridian—a length of over 500 miles of the Cordillera belt of the west, which, wherever it has been examined, has been found rich in minerals and particularly in deposits of the precious metals. The width of this particular part of the Cordillera belt is also great, as it appears, so far as our explorations have gone, to extend from the coast to the eastern ranges of the Rocky Mountains in the vicinity of the Mackenzie River. This portion of the Cordillera region, together with that of the more southern part of British Columbia, gives an aggregate length of between 1,200 and 1,300 miles, almost exactly equal to the length of the same metalliferous belt contained by the United States, and in all probability susceptible of an eventual mining development equally great.

"The general climatic features of the region explored and their relation to its orography cannot be entered into in this preliminary note. It must suffice to say that the very humid conditions of the coast do not extend to the interior, which includes some tracts of very dry country, and in the mountains of which glaciers occur rarely, if at all. Wheat, barley and patatoes are grown, on a limited scale, at Telegraph Creek and in its vicinity on the Stikine, though irrigation is necessary. Farther north, summer frosts are probably almost everywhere too frequent to admit of the growth of wheat, but I feel satisfied that barley and rye, with other hardy crops may be grown as far north as the 63rd parallel in the Yukon basin. The country, though generally mountainous in character, includes large tracts of flat or slightly broken land, and is, in fact, one which may eventually support a population as large as that found in corresponding latitudes in Europe (as, for instance, in the province of Vologda in Russia). It is for the most part wooded, and produces much timber of very fair quality, while open hill sides and terraces with bunch grass and aspen thickets occur along the river valleys. Large quantities of fine furs are yearly exported from the Yukon district, reaching the coast by the Chilkat and Chilkoot Passes, Taku and Stikine Rivers, or crossing to the Mackenzie by the Porcupine and Rat Rivers.

"One of the most important features of the Yukon district is the facility which the various large rivers, converging to form the main stream, offer for travel and inter-communication. These afford means for prospecting and exploring the country, and the distances to which they may respectively be ascended by boat or canoe has not yet, in most cases, been determined. It may be stated, however, that the rivers navigable for sternwheel steamers in Canadian territory have an aggregate length (measured without reference to minor flexures) of considerably over 1,000 miles, in which but one serious break of about three miles occurs on the Lewis. This length will be added to when the upper reaches of the larger streams are examined beyond the rapids or cañons, which are, in the above estimate, considered as defining the head of navigation in each case.

"Over 120 photographs were taken along the route followed, representing the character of the country, and I am happy to say that nearly the whole of these have proved satisfactory on development. Meteorological observations were kept up as regularly as possible, and numerous observations for latitude and longitude were made. Such geological and botanical specimens as appeared to be of interest were brought back, but in consequence of the difficulties of transport the weight of these had to be kept down as much as possible."

Cost of season's exploration of both parties, $4,832.46.

Mr. R. G. McConnell intended to send out a preliminary report on his examination of the lower part of the Liard River, above referred to, by the Hudson Bay winter packet, from Mackenzie River, but as this has failed to arrive in time to be included in this report, the following extracts from letters addressed to Dr. G. M. Dawson may serve to give an outline of his work.

In the first, sent back to the Pacific coast with his men, and dated Liard River, July 27, he writes:—

"I have now got down nearly to the mouth of the Nelson, and have just met some Hudson Bay men ascending the river. I am sending my two men back with them as the river is good from here, and I can drift down to Fort Liard, even if I cannot find an Indian to go down. I send them back from here because there is no chance of getting supplies either at Fort Liard or Nelson House, and if I took them on to Fort Simpson they could not get back this autumn, as the river is still booming and shows no sign of going down, and we have just about enough food left to last them to their *câche* at the Devil's Portage. I shot two moose on the way down and that kept our supply up. We had a bad time getting down, as the river is a regular cascade for over a hundred miles. Between the Little Cañon and forty miles below the Devil's Portage it falls over 1,000 feet, and as forty miles of this

is good water you may imagine the state of the rest. It would be bad enough if it had room to flow, but it is penned in by cañons, often less than 150 feet wide, every few miles, and then whirls and boils in an incredible manner. We worked our way by sheer muscle, carrying both boat and stuff through forests and over high hills. My men turned out well and worked without a grumble. As for myself, I have hardly a stitch of clothes left, as they were torn to pieces and left hanging on the brambles and roots along the many portages. I hope that you have worked your way through your many difficulties, and have got out to the coast again. But you have a tremendous task before you, which I can appreciate now better than in the spring."

In the next letter, from Fort Smith, Slave River, under date August 23rd, Mr. McConnell writes:—

"After leaving the men, I floated down alone as far as Fort Liard, and there got an Indian to take me down in a bark canoe to Fort Simpson. At Fort Simpson I found the steamer, and came up as far as this place in her. This is rather a hard country to winter in without sending in supplies beforehand, as the deer have deserted it, and the people have been on short commons since last March. I am making arrangements to stay at Fort Providence, as it is a good locality for fish, and one will always have something to fall back upon. It is, besides, below Slave Lake, the ice on which is the great impediment to getting down the Mackenzie early. * * I am going down Slave River in a canoe, and on the way I will go up Salt River to the ridge in which it heads. From the mouth of Slave River I purpose going up Hay River to the falls, about 100 miles. I may also go up Buffalo River if I have time. During the winter I will try to visit Horn Hills, and see the country about Fort Rae. I believe Sir John Richardson is right about the Palæozoic age of the shales between Fort Simpson and this place."

A box of fossils, sent out at the same time with the letter from which the above extracts are taken, has since arrived. The fossils show the presence of Devonian, Triassic and Cretaceous rocks on the Liard River.

Mr. Amos Bowman was occupied the whole season in preparing and in supervising the lithography of the maps of his field work in British Columbia during the seasons of 1885 and 1886, chiefly in the Cariboo district, the survey of which, as stated in my report last year, was undertaken in connection with the Provincial Government. It was then, December, 1886, anticipated that the work of reducing the measurements and preparing the maps for publication would have been completed early in 1887. It has, however, together with the preparation of the report on the district, occupied till the close of the year. Both maps and report will be published at an early date.

In Manitoba, Mr. J. B. Tyrrell commenced a geographical and topographical examination and survey of the Riding and Duck Mountain region. He was assisted during the season by Mr. D. B. Dowling. We had very little precise knowledge respecting this district, but were aware of the occurrence in it of salt springs, gypsum deposits and strong indications of petroleum. It was also thought possible that workable seams of coal or lignite and natural gas might be found there, and in view of its proximity to navigable waters and to railways, it was considered important that it should be thoroughly explored. Mr. Tyrrell reports as follows: "We left Ottawa on the 5th July and reached Brandon on the 14th, where the horses used last year on the Calgary and Edmonton survey had previously been brought by rail. Men and supplies having been obtained, the party left Brandon on the 15th of July, following the trail northwards to Strathclair, situated in range 21, township 17. Thence an odometer survey was made up the Little Saskatchewan River, across the Riding Mountains and down the Vermilion River to Lake Dauphin. From the trails, paced surveys were made of ths beds of Ochre River and Edward's Creek, the banks of these streams being either too swampy or too much obstructed by fallen timber to admit of following them, except on foot.

An odometer survey was then made northward across Wilson River to Valley River, a track survey being at the same time made of the Wilson River and its vicinity. North of Valley River, one of the rounded gravel ridges, known to the Indians as "pitching ridges," was followed first with a buckboard and odometer and afterwards on horseback as far as Fork River, a fairly accurate sketch-map being at the same time made of the eastern face of Duck Mountain. Finding that progress would be very slow north of Fork River, we returned to Valley River and made an odometer survey of the cart trail leading westward along this stream, passing through the gap that separates the Duck from the Riding Mountains in a wide glacial valley leading down into the Shell River, from which the trail was followed and surveyed over the high ground southward to the village of Russell, a terminus of one of the branches of the Manitoba and North-Western Railway. From Russell, a similar survey was conducted across Silver, Bird Tail and Arrow Creeks to Shoal Lake, and thence to Little Saskatchewan River, returning by a more northern route to the point of starting. From Russell we proceeded northward with buckboard and carts to Asessippi, on the Shell River, from which point the vehicles were sent round to meet me higher up the river, while with saddle and pack horses I examined the lower part of the valley, and rejoined the carts about the south line of township 26. We then continued up Shell River, to within three miles of the confluence of the north and

east branches, generally in the bottom of the wide deep valley, but sometimes we were obliged to climb to the top of the bank where it was impossible, without great delay, to ford the stream. On the way, however, we left Shell River for a time and turned westward on an Indian cart trail to Angling Lakes, where Coté's band of Indians have several houses in which they spend the winter, being here in the centre of their hunting grounds. From this village, then quite deserted, a track survey was made of the stream that flows northward into the largest and most eastern of the Angling Lakes till it flowed out of the valley that separates the Duck and Riding Mountains. It was found to be the main branch of Valley River. Two pack trails leading northward from the Indian village were also examined, one being found to lead up the west branch of Valley River to its source, and the other to "The Lake that does not freeze," and the latter of which belongs to the drianage area of Shell River.

Returning to this latter river, we were obliged to leave the carts at a point three miles below the confluence of the north and west branches and to use pack horses in continuing the survey towards the sources of some of the small streams tributary to the main river. Returning to the carts, we followed and surveyed an Indian cart trail northward across Big Boggy and Little Boggy Creeks, till it joined the old Pelly cart trail at the Indian village on Coté's Reserve. We then followed and located the latter trail northward to Fort Pelly, where we arrived on the 22nd of September. Having here obtained sufficient supplies to last till the end of the season, we followed a cart trail to the north-east, keeping north of Swan River for about forty miles, or till we reached the "Square Plain," making an odometer survey throughout the distance. I, however, branched off from this trail, and with pack horses followed a trail up Rolling River, till the stream became very small, and was flowing in a shallow valley through a country that appeared to be one interminable swamp. As the country was impassable for horses, I returned and made a paced survey down the bed of the stream to a short distance below the crossing of the old location of the Canadian Pacific Railway, where the river again flows in a defined but winding channel through a marshy, level tract of country.

Returning to Square Plain, Swan River was crossed and followed on its northern bank down to the mouth of Oak Creek, where the carts were again left, and with pack and saddle horses a track survey was made around the north end of Duck Mountain, following, during part of the distance, conspicuous gravel ridges that extend along the eastern face of the escarpment, at least so far north as the Valley of Swan River. In returning, the north-east point of the Duck Mountain was crossed, and also the head-waters of North and South Duck

Rivers and Pine River. Then passing around the north end of Big Lake, in which Rolling River takes its rise, the head of Favell River was reached. This river was then followed on a northward course to near its junction with Rolling River, returning thence to the carts at the mouth of Oak Creek.

While I was engaged as above described, Mr. Dowling was making pace and track surveys of Swan River and of the country lying north of it in the vicinity of the camp.

Below Oak Creek an odometer survey was made of the trail down to Swan Lake, and the river was followed on foot in many places, where there was any possibility of exposures of the underlying rocks being met with. From Swan Lake, the party returned to Fort Pelly by the old Hudson Bay Company's cart trail on the north side of Swan River, at the same time making an examination of the southern face of Thunder Hill.

The village of Russell was reached and the season's work completed on the 7th of November. Arrangements were made for the care of the horses and outfit for the winter before leaving for Ottawa, which we reached on the 14th November.

The surveys, which were checked throughout by latitudes taken with an eight inch sextant, will be plotted at once, and material will thus be furnished for an approximately correct map of a part of the country that, up to the present, has been almost entirely unknown.

Readings were taken regularly three times a day from a mercurial barometer, and numerous intermediate readings were taken from two aneroids, and as these will be compared with readings taken from a standard mercurial at Minnedosa, the height of which is known, it is hoped that the altitude of all important points can be determined with sufficient exactness to show the general slope of the country and the height of most of the important elevations.

The geological structure of these so-called mountains, as far as seen, is very simple. They are composed of practically horizontal dark-grey clay-shale, interbedded with bands of chalky limestones and bands and nodules of hard sandstone. These beds contain fossils characteristic of the Niobrara and Benton sub-divisions of the Cretaceous of Meek and Hayden's Nebraska section, and it is not improbable that some of the lower beds, which on Swan River were found to be sandstones and clays, represent their lowest, or Dakota Group, but no fossils were found to corroborate this, and no break or unconformity of any kind was found between any of the beds.

In some places, as on Vermilion and Ochre Rivers, the dark shales were found to contain a small quantity of mineral oil, and it is quite possible that borings may reveal reservoirs holding this oil in consider-

able quantities. No coal seams of any value, though carefully sought for, were found.

This subject and the geological structure of the district will be treated of in a detailed report to be prepared during the winter, after the observations and collections have been studied and the measurements plotted. About 1200 lineal miles of survey were made, and the observations covered an area of 3200 square miles of territory within the province of Manitoba.

The surface of the country is almost everywhere underlain by an irregular deposit of till, varying from a very thin crust to a massive bed several hundred feet in thickness. East of Duck Mountain its surface on the lower lands is generally level or slightly sloping, to the west it is generally more or less undulating, while on the summit of the mountain, and on the upper parts of its eastern slope there are many areas covered by moranic ridges, consisting of high drift knolls, thickly overstrewn with gneissoid boulders, between which are deep, rounded hollows, often holding small lakes of beautifully clear water.

Most of this latter country is practically valueless for agriculture, but considerable areas of it are covered with valuable forests, which by careful cutting could be made to yield a continuous supply of timber; but much of this rough land, especially that towards the north, is so thickly covered with boulders that it appears unable to bear more than a few scattered and stunted scrub pines. The undulating land to the south and west of the Duck and Riding Mountains is at present partly covered with groves of poplar, between which are more or less extensive areas of grassy prairie. This country is admirably suited for agriculture, since the soil is rich and well drained, and wheat can be raised with very little danger from early frost, certainly as far north as Big Boggy Creek, and perhaps as far as Fort Pelly. But perhaps the most fertile part of the whole district is that which lies between Dauphin Lake and the foot of Riding Mountain, where the underlying till is covered with rich layers of alluvial sand and clay. The land slopes gently towards the lake and is drained by several clear streams that flow from the face of the mountains. The area is partly wooded, the surface being covered with a rank growth of grass, weeds and rose-bushes, and dotted with groves of willow and poplar. Towards the north it is continuous with the swampy country lying between the gravel ridges east of Duck Mountain, though even here there are many rich meadows. Still further north, in the Swan River valley, meadow land again forms the greater portion of the surface, bearing a close growth of tall fine grass.

Near the headwaters of the Shell and Valley Rivers, between Rolling and Favell rivers, on the northern face of Duck Mountain, as well a

on some of the streams flowing from its eastern slope, there are some large areas covered with excellent white spruce averaging from 10 to 20 inches in diameter. Much of that on Shell River can be floated down into the Assiniboine River, where it can be sawn and distributed, but the rest must be floated into Lake Winnipegoosis. From there it must be conveyed to Lake Manitoba before it can reach a market, but this will be a very easy matter when communication is once opened through the narrow neck of land in the vicinity of Meadow Portage. Of late years fires have been doing very great damage to the forests of this region, and it certainly seems advisable that some more stringent measures should be adopted to prevent the occurrence of the conflagrations that periodically sweep over such large areas throughout northern Manitoba.

Fossils were collected from the Cretaceous shales and limetones, and also a small but interesting collection was obtained from beds of pre-glacial or en-glacial age, near the summit of Duck Mountain. Numerous specimens of recent mammals, birds and insects were also collected.

Sixty-six photographs were taken during the season illustrative of the geology and general surface of features of the country examined.

Cost of exploration, $1,741.16.

In April, correspondence was entered into with Major Powell, director of the United States Geological Survey, with a view to joint action in carrying out the survey and delineation of the glacial Lake Agassiz in its continuation into Manitoba. The terms of this joint action were agreed upon, and on the 6th May, Major Powell wrote expressing his "gratification at this inauguration of international work."

On the 11th September, Mr. Warren Upham, to whom the work was entrusted by Major Powell, wrote as follows:—"I have the honor to report the successful completion of the examination of the glacial Lake Agassiz in its continuation north of the international boundary in Manitoba, done under the auspices of your survey jointly for a detailed report to be made by me to you during the coming winter, and for my monograph on the subject for the United States Geological Survey. The cost of this exploration was $344.88."

Mr. Upham's report will form part of the next Annual Report.

Mr. A. Lawson left Ottawa for the field accompanied by Mr. Smith as assistant on the 27th of May, to continue the exploration and survey of the country between the Lake of the Woods, Rainy Lake and Lake Superior.

The work was commenced in the vicinity of Rainy Lake, and during the months of June, July and August, Messrs. Lawson and Smith

were occupied in making the surveys and investigations necessary to complete the maps of the Rainy Lake and the Rainy River districts. These maps cover an area of 5,182 square miles. They will be similar to that of the Lake of the Woods, published with Part CC of the Annual Report, 1885, though on the smaller scale of four miles to one inch. The information for these maps is now in course of compilation in the office, and the maps will be prepared for publication, together with a detailed report, during the winter.

After completing the field work, and before commencing the survey of the intervening country east of Rainy Lake, it was deemed desirable to make a further general reconnaisance of the geological features of the Thunder Bay district and the vicinity of Port Arthur, where latterly mining interests have been rapidly developing. The remainder of the season was accordingly devoted to this work and to a visit to the Vermilion Lake and Gogebic iron ore districts in Minnesota, for the purpose of comparing the geological conditions which obtain there in connection with these deposits, with those of the Thunder Bay district, in many parts of which there are geological indications inducing the belief that valuable deposits of iron ore exist there like those above referred to. While Mr. Lawson was thus engaged, Mr. Smith continued the topographical work on the north side of Hunter's Island, in the vicinity of the international boundary.

Mr. Lawson's party was in the field four and a half months. Average strength five men. About 700 miles were measured by micrometer, log survey and compass triangulation.

Cost of exploration, $1,608.97

Mr. A. P. Low, accompanied by J. M. Macoun as assistant, was engaged during the summer in making an exploration of the islands of James' Bay. No suitable craft for the work could be obtained at Moose Factory. A Lake Huron fishing boat was therefore purchased at Collingwood and sent to Missinabie station, on the Canadian Pacific Railway, situated on Dog Lake, at the head of the Michipocoten River. From here the boat was taken across the height of land and down the Missinabie branch of the Moose River to James' Bay, Moose Factory being reached 27th June. Leaving Moose 2nd July, the first island visited, called Charlton, lies near the southern end of the bay and about one-third of the distance across from the eastern shore. This island was found to be wholly made up of sand, clay and boulders, without any rock in place, and further investigation on the other islands visited showed that they were all of the same origin. Charlton Island is the second island in James' Bay in regard to size, being in shape an irregular oblique parallelogram, the diagonals being 18 miles from N.E. to S.W., and 12 miles from N.W. to S.E.

On the south side the shores are low and swampy, covered with a dense growth of black spruce and tamarac of small size; on the other sides the shores are high, and inland the island is a rolling plateau, with a light sandy soil, supporting a larger growth of white spruce and poplar. While on Charlton Island, a paced survey was made on the shore of Danby Island, which lies about one mile to the eastward. It was found to be roughly triangular in shape, each side being about two miles long. The whole island is low and flat, and covered with small black spruce and tamarac. On 11th July the party crossed to the Strattons, two small islands lying N. 65° E. from the north-east point of Charlton and ten miles distant. The western or larger is five miles long from E. to W. by about one mile and a half broad; the smaller is nearly round, with a diameter of one mile and half. The interior of the larger island has an elevation of seventy-five feet above sea level.

Little Charlton Island was next visited, distant eighteen miles from the Strattons in a N. N. W. direction.

From Little Charlton a northerly course was taken through the Tiders, several small low islands, the larger covered with low bushes, the smaller being merely sand and boulder shoals, stopping at Watson Island, which lies N. 33 E. from Little Charlton in latitude 52° 31·07″.

This island in form resembles a thin crescent, the greatest length being eight miles from north to south. With the exception of a few stunted white spruce, no trees grow on the island, its sand and boulder surface being covered with small arctic flowering plants, grasses and sedges. Continuing northward, Solomon's Temples, a number of low, sandy shoals, were passed, and the Twins, two large islands lying north and south, and separated by a channel five miles wide, were reached. These islands have the same barren character as Watson. After the Twins, Walter and Spencer, small islands lying to the eastward, were examined, and the mouth of the Big River reached 19th July. Here the party divided, Mr. Low going up the river, while Mr. Macoun explored the Lead and Bear Islands to the northward. The Big River was ascended fifty miles in an easterly direction. This is the largest river flowing into the east side of Hudson Bay, and is navigable with large boats for twenty miles from its mouth. It flows in a valley from one-third to one mile wide between cut banks from thirty to one hundred feet high.

The surrounding country is covered with a dense growth of trees in the following order as regards quantity: black and white spruce, tamarac, balsam and aspen poplar, balsam spruce and banksian pine; there are numerous outcrops of rock along the shores, the most common being a dark grey hornblende-gneiss.

Leaving Fort George, 2nd August, the bay was crossed by way of the Twins, and the island of Agoomski reached.

This is the largest island in James' Bay, being about seventy miles long from N. W. to S. E. by an average of ten miles broad.

Unlike the other islands, its coast line and interior are low and swampy and the interior is covered with small spruce and tamarac. From Agoomski the party returned to Moose Factory and thence by the Missinabie River reached the Canadian Pacific Railway 7th September.

The coast line and islands, as laid down on the Admiralty chart, do not agree with the Hudson Bay Company's chart, especially on the east coast, and further, neither the size, shape nor position of the islands visited by Mr. Low agrees closely with that given on either of the charts.

Mr. Macoun made several interesting additions to the collections of plants and insects.

Total cost of the exploration, $3,179.00.

In December last Mr. E. D. Ingall visited the salt districts of Ontario for the purpose of investigating the present condition of that industry, and to gather statistics and other information relating to it. This work was continued by means of correspondence, after his return to Ottawa on the 5th of January. He was then engaged completing a report on the subject, and also one on the silver production of Canada, both of which are published in the Statistical Report on mineral production in Canada, Part S of the annual volume for 1886.

The preparation of the latter report, examinations for which were commenced in 1885, was much delayed last year by the preliminary work with Mr. Coste in connection with the arrangements for the collection of the mining and mineral statistics.

After the completion of this work, Mr. Ingall commenced the preparation of the maps and other illustrations to accompany his report on the silver mining district west of Port Arthur, and on the geological features connected with the very rich silver-bearing veins of that district. At the same time arrangements were being made to commence an exhaustive investigation and survey, during the approaching summer, of the apatite mining districts in Ottawa county, province of Quebec, with a view to the preparation of a monograph on the apatite deposits and their developments.

In pursuance of this plan it was decided to make an accurate delineation of the rocks associated with these deposits over an area of about 200 square miles, so outlined as to embrace the most important mines of the district, thus including parts of the townships of Portland, Der-

ry, Buckingham, and Templeton. Mr. Ingall was assisted by Mr. J. White, who on the 22nd June commenced the preliminary topographical measurements requisite for the construction of a map, on which to lay down the geological features and the position of the worked and the unworked apatite deposits. At the same time Mr. Ingall made a tour of inspection of the principal mines, and then returned to Ottawa to continue work in connection with his report on the silver bearing district above referred to, leaving Mr. White to continue the work in the field. This was unfortunately brought to a close on the 11th of August by a serious accident, in which Mr. White had his leg broken and was otherwise so seriously injured as to incapacitate him for any work during the rest of the season. Under these circumstances, Mr. Ingall disbanded the party, and has since devoted his time to the completion of his monograph of the Thunder Bay, Lake Superior silver mines, of which the publication is now in progress.

Cost of the work in the field, $860.24.

Dr. R. Bell was engaged during the summer in an exploration of a portion of the large tract of but little known country on the confines of the provinces of Quebec and Ontario, including Lakes Temiscaming and Abbittibbi, the Montreal River and the upper waters of the Ottawa. The chief objects of the exploration were to ascertain more precisely the northern extension and the distribution of the great mineral bearing belt of Huronian rocks which commences on the Georgian Bay of Lake Huron and crosses the Canadian Pacific Railway at and in the vicinity of Sudbury, also to investigate the question of the northern limit of the apatite or phosphate and mica bearing belts of Ottawa county, and likewise to make such additions as might be possible to the existing very imperfect geographical knowledge of the region to be traversed.

Dr. Bell was assisted in the field during the summer by Messrs. A. E. Barlow and A. S. Cochrane; by the former from the 16th July to the 1st October, and by the latter from 8th September to the 28th of October. The exploration extended from the 11th July to the 18th of October, when Dr. Bell returned to Ottawa.

Dr. Bell furnishes the following summary of the season's operations:—

"Although the watershed to Hudson Bay was crossed both in the eastern and in the western extension of the exploration, the country examined may be described as the Upper Ottawa country, as the waters used as the bases of our operations, both east and west of Lake Temiscaming, fall into the Ottawa River.

"Fort Temiscaming was selected as headquarters for the summer."

The examination of the rocks of Lake Temiscaming was in continuation of the work of Sir W. E. Logan, in 1845, the result of which is summarized in chapters IV and XII of the Geology of Canada, 1863, and where also the succession of the Laurentian and the Huronian rocks on Lake Temiscaming is described. In the report for 1845 the rocks are more fully described, but they were not then known as Laurentian and Huronian.

Dr. Bell now states :—"This lake is surrounded by Huronian rocks and these were re-examined in the light of the knowledge of the Huronian system which has been gained since the time of Sir W. Logan's visit in 1845. The Silurian limestones, &c., of the islands and of the northern part of the lake were also examined and a considerable collection of their fossils was made. It is believed that the limits of the Silurian area at the north end of the lake can now be defined with tolerable accuracy.

"The course of the main Montreal River is singularly straight; its upward bearing is about north-west, and the distance from the mouth to the Great Bend, near which it divides into two branches flowing from the south, is 85 miles in a straight line. In 1875 I examined both these branches and the country thence to Lake Mattagami, in connection with a geological exploration, extending from the Wanapitai and Sturgeon Rivers, but the main Montreal River, below the Bend, had not hitherto been examined geologically. The rocks along it were found to belong to the Huronian system, except in two parts, namely at Bass Creek, two miles above the head of Elk Lake and just below the extremity of Sinclair's Line, or four miles below the junction of the East Branch, where Laurentian gneiss was met with.

"From the Great Bend of the Montreal River I crossed the height of land northward and descended the Frederick House River, a branch of the Abbittibbi, to Paish-ko-tchagami Lake. All the rocks seen on this route also belong to the Huronian.

"On returning from this exploration I descended the Montreal River to its junction with the northern outlet of Temagami Lake, and made a track-survey and geological examination of the lakes through which it flows. The rocks on this route were found to consist principally of clay-slates, argillites and quartzites, At the time of my visit to Temagami Lake, Mr. Barlow was engaged in making a micrometer and compass survey of it, having begun this work on the 23rd July, and he completed it about the end of September, after which he made a similar survey of the route from Temagami Lake *via* Rabbit Lake to the foot of Lake Temiscaming. Temagami Lake was found to measure about thirty miles in its greatest extent, or from north to south, and nearly the same from east to west, but much of its general area is

occupied by peninsulas and islands. It is remarkable for having two outlets which discharge its waters, the one into the St. Lawrence and the other into the Ottawa. The southern outlet is a branch of the Sturgeon River, which flows into Lake Nipissing and thence by the French River into Lake Huron; while the northern outlet, as already mentioned, falls into the Montreal River and thence into the Ottawa. The rocks around Temagami Lake embrace felsites holding pebbles of syenite (which are the most abundant), quartzites, clay-slates, massive diorites and crystalline schists.

"After having made a geological reconnaissance of Temagami Lake, I returned to Fort Temiscaming by way of Rabbit Lake and the Mattabatchawan River, and found the rocks along this route to consist principally of felsites and clay-slates.

"The Rivière Blanche and the travelled canoe route from Lake Temiscaming to Abbittibbi Lake were explored geologically by the late Mr. Walter McOuat in 1872, * and during the present year Mr. E. B. Borron, on behalf of the Government of Ontario, made an exploration of the region lying to the southward of the latter lake and he has kindly promised to furnish me with notes of his geological observations. We are indebted to Mr. Edward Haycock and to Mr. David Beatty, P.L.S., for additional information on the rocks of the Rivière Blanche and neighborhood.

"The next division of the season's operations consisted of the exploration of the region between Lake Temiscaming and the source of the Ottawa. Accompanied by Mr. Cochrane I proceeded from this lake by way of Kippewa, Birch, Sasiganaga, Wolf and Grassy Lakes to the Grand Lac du Moine, and thence to Grand or Victoria Lake of the Ottawa. Laurentian gneiss was the only rock observed on this route all the way from the foot of Lake Temiscaming.

"From Grand Lake Mr. Cochrane was sent northward to ascertain whether or not the Huronian belt, which crosses the canoe-route between the height-of-land and Lake Abbittibbi, extends eastwardly to that longitude. In connection with this exploration he made a track-survey of the northern arm of Grand Lake, which has a length of about twenty miles, and thence across the watershed, and down the chain of lakes and streams which leads in the same direction to Shabogamog Lake. A track-survey and a geological examination were made of this lake, which proved to be over thirty miles long. Mr. Cochrane next descended the river flowing from this Shabogamog Lake for a distance of over ten miles, northwordly, where a series of rapids begins. It proved to be a large stream, fully equal to the Ottawa just below Grand Lake, and is apparently the head of the un-named river

* Report of Progress, Geol. Surv., 1872-73, pp. 112-135.

flowing into Hannah Bay, at the southern extremity of James' Bay. The height of land passes close to the northern extremity of Grand Lake, and soon after crossing it Mr. Cochrane found crystalline schists of the Huronian system, and further on they were met with here and there, alternating with Laurentian-like gneiss, as far as the outlet of Shabomagog Lake, beyond which the schists were continuous as far as he descended the river. There is little doubt these rocks form part of the Huronian belt, extending eastward from Abbittibbi Lake.

"On returning to Grand Lake, Mr. Cochrane, according to instructions, descended the Ottawa to Lake Temiscaming. The section of the river lying between Grand Lake and Lac des Quinze had been surveyed with the micrometer by Mr. Lindsay Russell, and it only remained for Mr. Cochrane to note the geological formations. The rocks along this division of the Ottawa proved to consist entirely of Laurentian gneiss. The Huronian schists, between Lac des Quinze and Lake Temiscaming were examined and reported on by the late Mr. McOuat, in 1872.

"Leaving Mr. Cochrane at Grand Lake to continue the explorations which have just been described, I proceeded up stream towards the source of the Ottawa. Grand Lake, the Ottawa River and the lakes upon its course as far as Barrier Lake, had been explored by Mr. Henry C. Symmes, P.L.S., in 1866, so that I only required to examine this section geologically, and throughout its whole extent the only rocks seen were gneiss.

"Above Barrier Lake, both a geological examination and a track-survey of the Ottawa were made to its source, which was found to be in a small lake at the head of the north-western and longest of the two branches into which it ultimately divides. This sheet of water, which is only about two miles long, had no name, and I called it Ottawa Lake, as an appropriate designation, and as following the almost universal rule which obtains in these regions by which the lake at the source of a river bears the same name as the river flowing from it. Laurentian gneiss continued to be the only rock observed all the way from Barrier Lake to Ottawa Lake.

"From Ottawa Lake I crossed the water-shed to Echaume Lake, one of the sources of the Gatineau River, and then descended that stream, which is constantly augmented by tributaries from either side as far as the river Désert, continuing to make both a track-survey and a geological examination the whole way. No rock but gneiss was met with in descending the Gatineau until reaching a portage about thirty miles below the Zigonse or principal north-east tributary of the river, where a white weathering coarsely crystalline light grey limestone made its appearance, and was afterwards traced, almost continuously,

down the river nearly to its mouth. This well characterized belt of limestone has evidently a great thickness. Thinner bands of a somewhat similar crystalline limestone were observed interstratifying gneisses, &c., in the lower part of the valley of the Désert. From this point I brought my canoe-men by stage to Ottawa, and thence sent them back to Lake Temiscaming *viâ* Mattawa."

The limestone above referred to by Dr. Bell was first noticed by Mr. J. Richardson in 1870, and is pretty fully described by him in the Report of Progress, Geol. Survey 1870-71, in which, on page 289, he says: "Without further examination it would be impossible to say whether these limestone which are so largely displayed along this portion of the Gatineau River form one or more bands. The thickness of this limestone in some parts cannot be short of five or six hundred feet and below the Big Eddy Portage may reach a thousand feet."

Dr. Bell further reports that while endeavoring to ascertain the nature, structure and geographical distribution of the rocks in the districts examined during the season, special attention was directed to the discovery of economic minerals.

"In this connection it may be mentioned that some days were devoted to an enquiry and examination into the alleged discovery of auriferous quartz veins in several places in the vicinity of Mattawa. The various openings where the discoveries were said to have been made were visited, and a number of specimens were collected. These have since been assayed by Mr. Hoffman, but without finding gold or silver in any of them.

"The glaciation of the fundamental rocks and other phenomena of the drift were studied, and many interesting facts noted, but these will be more appropriately recorded in the detailed report to be prepared. Numerous observations for latitude were made, which will be used to give greater accuracy to the maps of our track surveys. Notes were constantly kept in reference to commercial timber and to the distribution and the northern limits of the trees in the region visited. Considerable information was gathered on the natural history of the districts, especially with reference to food fishes; and collections of Coleoptera and Lepidoptera were made. The temperature of Lake Temagami and of other lakes was recorded three times a day by Mr. J. Fraser, a member of the party.

"Forty photographic views were taken to illustrate the various characteristic features of the scenery, points of geological interest and the general aspect of the country.

"As on all previous occasions, the Survey is again indebted to the officers of the Hudson Bay Company for their kind hospitality and assistance in promoting the work, and in this connection I may be

allowed to mention more particularly Chief Factor Colin Rankin, Mr. C. C. Farr, J. P., Mr. J. Mann, Mr. L. Christopherson and Mr. J. Turner.

Cost of season's exploration, $2,036.87.

Mr. F. D. Adams left Ottawa on the 13th July, and spent the following three months and a-half in exploring and mapping in detail those portions of the counties of Montcalm and Joliette, which are included in the north-west quarter sheet of the map known as the map of the Eastern Townships.

The area examined by Mr. Adams has an extent of about 1,200 square miles, and lies immediately to the north of that explored by him in 1885. He now states that:

"The great mass of anorthosite underlying Morin, Abercrombie, Wexford and several other townships in Montcalm and in the adjacent counties, and the southern and western boundaries of which have already been determined, was still further examined, and its southern and eastern boundaries carefully traced. In doing so the unexpected fact was ascertained that the so-called massive and stratified varieties of this rock are in reality only different portions of one and the same mass. A number of small outliers of anorthosite were found in the gneiss to the east of this main area, resembling those found before on its western and southern sides. Four bands of crystalline limestone were also found east of the Lac Ouarreau band and on the eastern side of the principal anorthosite area, some of which undoubtedly correspond to those found by Sir William Logan on its western side. As a result of this summer's work, I think it may be safely concluded that the rocks comprising the principal area of anorthosite above referred to, as well as most, if not all, of the smaller areas, are of eruptive origin.

"All localities, where minerals of economic importance were reported to occur, were visited and examined. These were for the most part deposits supposed to contain either gold or iron ore, many of which are associated with bands of pyritous rock near the contact of the anorthosite and gneiss. Several of them, now abandoned, had at one time been more or less extensively worked for gold. Specimens of these ores were collected, and it is proposed to assay them, in order to ascertain whether they really contain a sufficient amount of gold to warrant further efforts being made for their development. A large number of other specimens were also collected, some of which, it is hoped, may prove of economic importance, as well as of scientific interest.

"There still remains a large area to be examined within the limits of the map referred to, and until this is effected and the map can be

completed for publication, it is deemed desirable to defer the preparation of a detailed report on the geological structure of the district. A short report will, however, be prepared during this winter, dealing chiefly with the economic resources of those portions already examined, and which seem to be of more immediate practical importance.

Cost of season's exploration, $563.00.

Dr. R. W. Ells, with Mr. N. J. Giroux as assistant, was occupied during the past season in continuing to the north-east the final examination and mapping of the geological formations on the south side of the St. Lawrence, in a part of the area comprising the north-east quarter sheet of the map of the Eastern Townships, extending from the county of Megantic north-eastward to the county of L'Islet. This work was, as stated, a continuation of that of the previous season to the south, which is described in the summary report for 1886, and in greater detail in part J of the annual report recently issued. The first two months were devoted principally to an examination of the gold-bearing rocks of the Chaudière district, and later the rocks along the southern side of the St. Lawrence were re-examined from St. Nicholas towards Rivière du Loup, together with some of the islands below the Island of Orleans. The object of this was to ascertain, and to map more accurately than has been hitherto effected, the distribution and the relative positions of the Levis formation and of the so-called Lauzon and Sillery formations along the borders of the St. Lawrence, where the rocks, over considerable areas, were in 1869 assigned to the horizon of the Potsdam sandstone, while other large areas of precisely similar rocks were still included in one or other of the sub-divisions of the so-called Quebec group. The reconnaissance examination which I have, from time to time, carried out in all parts of the region since 1874, had made it evident that an entire revision of the work of 1869 and previous years was now required, and this was commenced by Dr. Ells in 1885, and has since been ably prosecuted by him. The observations of the past season must now be carefully studied, and another season's work in the area will be required before the actual distribution of the formations can be fully ascertained and finally mapped, and the geological structure reported on, as there is still a very large area, probably not less than 1,250 square miles, in the counties of Bellechasse, Montmagny and L'Islet, that has been but little, if at all, explored. Much of it is thickly wooded and difficult of access; but as it is on the line of strike of the mineral-bearing belt to the south-west, it is not impossible that in some parts of it there may be a recurrence either of the asbestos, the iron ore, or the cupriferous deposits of that belt. In any case it is very desirable that the whole area should now be fully

and exhaustively explored, and its geological structure worked out before the map of it is published. This, is hoped, may be accomplished next year. A number of outcrops of serpentine, which are confined to the area south-west of the Etchemin River, were examined, with a view to finding workable deposits of asbestos, but though at several of these small veins of asbestos were observed, the mineral does not appear to occur in sufficient quantity to be of economic importance, and the altered igneous rocks with which it is associated to the south-west, chiefly in what has been called the volcanic belt, seem to disappear after the valleys of the Chaudière and Etchemin rivers are crossed.

On mining in the district, Dr. Ells reports :—

"The output of asbestos at the mines of Coleraine and Thetford has largely increased during the past season, and preparations were being made to continue working during the winter. Several new mines have been opened at Thetford and near the Coleraine station which promise well.

"The Broughton Mine, situated on lot 14, range 7, Broughton, about half a mile west of the Quebec Central railway, is still being worked, though its present output is not very considerable. The asbestos at at this mine occurs in an irregular vein along the contact between the serpentine and the black Cambrian slates, and differs from that obtained at the other mines of this mineral in character of fibre, and in its being associated with soapstone. It is, in so far as yet ascertained, confined to but one vein of any importance. Three shafts have been sunk in the line of outcrop, and some very excellent asbestos has been extracted, more especially from the upper portion of the vein. Very good indications of asbestos were also observed on lots 27, 28 and 29, range A, Coleraine, near the Poudrier road, the property of Dr. James Reed. Though but little work had been done, a number of veins of asbestos were exposed at the surface, varying in thickness from half an inch to an inch and a half.

"The gold mines of the Chaudière have not yet been developed on a scale commensurate with their importance. During the past season three companies have been engaged in mining operations, viz., the St. Onge Co., on Slate Creek, at St. George, Beauce; Messrs. Coupal & McArthur, on Mill Creek, near St. Francis village, and Capt. Richards on the Cumberland Stream, a branch of the Famine River. On the DesPlantes River also, Mr. Horace Sewell has been engaged in prospecting, with the object of finding the old channel of that stream, and claims to have been successful in locating it, though no work has yet been done to test it as a source of gold. At St. Francis, Mr. Coupal states that he has found considerable 'coarse' gold.

"During the past summer the old copper mine at Harvey Hill has

again been opened up, under the management of Mr. Chas. Lionais, but at the time of my visit the operations were confined principally to repairing the shafts and buildings. This mine has already been fully described in the Geology of Canada, 1863, pp. 724, 728, and no further information need here be given concerning it.

"Work has again been resumed at the South Ham antimony mine. This property is mentioned in the Geology of Canada, 1863, p. 876, and later in the Report of Progress Geo. Survey 1881-82, p. 399. It has lately changed hands, and is now owned by Dr. James Reed, who, within the present year, 1887, has driven a tunnel from the lower part of the hill in which the mine is situated, a distance of 304 feet, which has struck the vein at the bottom of the 100 foot shaft, with which also the other workings of the mine are connected. The mineral bearing lode, cut by the tunnel, is reported by Dr. Reed to be seventy feet in width, all of which he says will pay for extraction. The object of the tunnel driven by Dr. Reed is to drain the workings and to facilitate the extraction of the ore. Dr. Reed has already taken out about twenty tons of ore, and intends carrying on the work during the winter. The great difficulty in the way at present is the lack of a market, a difficulty likewise experienced at the antimony mines of Nova Scotia and New Brunswick. According to the 'Mineral Resources of the United States, 1885,' the price of 50 per cent. ore was at that date $10 per ton, the amount of crude antimony and regulus imported into the United States for that year being 2,668,302 lbs., valued at $223,741, and of antimony ore 243,635 lbs., valued at $8,783.

"Attention has again been directed to the iron ore deposits of Leeds. These ores, referred to in the Geology of Canada, 1863, p. 677, were subsequently examined by the late Mr. Chas. Robb, M.E., and are also referred to in "Iron Ores of Canada, p. 205, Rep. Geol. Sur., 1873-74," by Dr. Harrington, who says: 'The strata have been exposed by stripping for a distance of forty yards in the direction of the strike, and sixteen yards across it. In the latter distance three tolerably regular beds of ore were seen, respectively six, four and three feet thick, and all dipping to the north-west at an angle of °50. The beds are separated by bands of chloritic slate, containing quartz and felspar. The ore is a fine-grained magnetite, more or less mixed with micaceous iron ore, and some specimens exhibit polarity in a marked manner.' Similar ores occur in the adjoining township of Inverness. The analysis of the Leeds ore, by Dr. Harrington, gave: metallic iron, 67.079; phos., ·206; sulphur, ·038. These ores are distant from the Quebec Central railway, at Robinson station, about ten miles, and from the Grand Trunk railway, at Bécancour station, from sixteen to eighteen miles.

"The field work was commenced on the 4th of June, and terminated on the 19th October—cost $1,449.33."

Professor Laflamme, who was engaged for a short time during the summer in re-examining the country, and in continuing the revision of the geological boundaries on the north side of the St. Lawrence above Quebec, furnishes the following report :—

" A detailed examination was made of the country between the St. Maurice and the Batiscan Rivers, especially that portion of it which lies to the north of the boundary of the Cambro-Silurian rocks. The rocks observed here, as everywhere else in this region, belong to the Laurentian gneiss, which occurs in all its varieties. I, however, observed also three important bands of crystalline limestone in the parish of St. Tite. One commences at the southern extremity of Lake Roberge and runs westward to Lake Claire where it terminates. It is a coarse-grained limestone and encloses many fragments of gneiss, occurring as angular blocks regularly distributed through the limestone. The exposure is abont five or six hundred feet wide, and about half a mile in length. The stone could, probably, only be utilized for burning intc lime.

" The second band occurs about six miles to the south-east of the first. It is a fine-grained rose-colored limestone, susceptible of taking a fine polish, and consequently of being used as an ornamental marble. At the junction of the limestone and gneiss, there is a distinct appearance of bedding or alternating bands of limestone and of gneiss dipping south-easterly 75°. The exposure is about two acres in extent.

" The third band occurs about a mile to the south of the second, and the limestone closely resembles that of the Lake Roberge band, the crystals perhaps even larger. It likewise encloses many angular fragments of the surrounding rock. It could not be utilized as a marble.

All this northern country closely resembles the Saguenay district in the manner in which the deposits of clay "glaise," occur. These deposits are very irregular, and show much false bedding in most of the section made by the railway. There is no trace of quarternary fossils like those of the country in the vicinity of Quebec, and it seems that these deposits are all the result of the submergence of this part of the country by the fresh waters of the melting ice and snow of the glacial epoch. The country is generally fertile, but there is a larger number of extensive projections of Laurentian rocks, which interrupt the continuity of the clay deposits.

" East of Batiscan River the Laurentian rocks present the same general characters, as do also the arable lands. The general strike is north-east and south-west, and there is no trace of limestone bands in this region.

"I also made a further geological examination on the St. Anne River, but have nothing to add to what was stated last year.

"The Trenton limestones are very regular, with a scarcely discernable dip to south-southeast. About two miles above St. Anne's church they are covered by the Utica and Hudson River formations.

"In conclusion, I desire to draw attention to the work now being done in this part of the country in connection with the occurrence of natural gas.

"Already a number of wells have been bored, and though the result has not been what was at first anticipated, yet there is no reason why judiciously conducted researches should not some day be crowned with success. The discovery of natural gas in available quantity in the province of Quebec would be extremely valuable. We have no coal to work our minerals. Natural gas might replace it and give a fresh impulse to all our industries. Abundant sources of natural gas have been found in Ohio in the same formations, adding a certain degree of probability to the presence of gas in our Trenton and Utica formations.

"Cost of explorations, $400."

From the above it might, perhaps, be inferred that natural gas had not been discovered in these formations, and, therefore, it may be well to quote the following passage from chapter xvii, p. 527 of the Geology of Canada, 1863, from which it will be seen that both gas and petroleum have long been known to occur over wide areas in Canada from the vicinity of Quebec to the Manitoulin Islands, and it has also long been known to occur in the Gaspé Peninsula:—

"The light carburetted hydrogen or marsh gas, which is so often a product of the transformation of organic matter at ordinary temperatures, is abundant in the palæozoic rocks of Canada and issues from many mineral springs. Those of Caledonia, Varennes and Caxton, in the Lower Silurian series, give off great volumes of this gas, which keep the waters in constant agitation. Many other less important instances of the same kind might be mentioned, while in the higher strata of western Canada this gas is still more abundant, as at the well known burning spring near Niagara Falls and in the region of the oil wells. In boring these, reservoirs of it are frequently penetrated from which the gas is liberated with explosive violence. In nearly all the oil wells there is a greater or less disengagement of inflammable gas; so that it would appear that the strata almost everywhere in that region hold, in a condensed state, portions of light carburetted hydrogen, which is discharged wherever a natural fissure or an artificial boring furnishes a vent.

"It was further stated *Op. cit.* p. 788: 'The possibility of its occur-

rence in available quantities in some parts of the Trenton formation should not be lost sight of.'

"During the past three or four years, attention has again been directed to this question, chiefly through the great developments that have during that period been made in Pennsylvania, Ohio and other states, and several wells have been sunk in the province of Quebec with a view to develop the indications of petroleum and natural gas, which, as already stated, were long ago pointed by the Geological Survey. The most important of these trials was made in the summer of 1885, and it seems desirable to quote here the detailed description of it by Mr. Obalski, as published, pp. 116-117, Report of the Commissioner of Crown Lands, Quebec, 1885."

Gas Well near St. Grégoire, County of Nicolet.

"These borings were effected on Mr. Hilaire Trudel's land (No. 501 of the Cadastre) at the south-east end of the concession of Bonsejour (Seigniory Roquetaillade). The following table gives the depths reached and the nature of the rock encountered :—

	On the surface, 31st July, 1885, 1 foot of earth, good cultivatable soil, flow of odorless gas.
From 1 to 48 feet.	47 feet of blue loam, with thin layers of sand.
From 48 to 53 feet.	5 feet of white sand, with abundant emanations of odorless gas.
From 53 to 68 feet.	15 feet of heavy gravel, composed of pebbles of granite, sandstone, calcareous rock, &c., with abundant emanations of odorless gas and water.
From 68 to 75 feet.	7 feet of black sand, very dense, hard to penetrate; water, but no gas.
From 75 to 155 feet.	80 feet of solid rock, sandstone, somewhat calcareous, soft enough to be cut with a knife; oily oozings.
From 155 to 215 feet.	60 feet of same rock, but harder and of a finer grain.
From 215 to 290 feet.	70 feet of red shale, wrongly called by the miners "soapstone."
From 290 to 300 feet.	10 feet of same rock, lighter color.
From 300 to 316 feet.	16 feet of same rock, nearly black.
From 316 to 370 feet.	54 feet of blackish brown schist, not hard; abundant and sudden flow of gas, having a strong smell of kerosene.
From 370 to 475 feet.	105 feet of red shale; more abundant emanation of gas.
From 475 to 525 feet.	50 feet of red schist, somewhat greyish.
From 525 to 580 feet.	55 feet of red schist, softer.
From 580 to 640 feet.	60 feet, another flow of gas, more violent, throwing mud and stones from the bottom to a height of 60 feet in the air, and preventing work. This gas affects the sight and the lungs of the workmen; continuation of red shale.

From 640 to 660 feet. 20 feet of impure calcareous rock, apparently containing magnesia. Another vein of gas of the same nature.
From 660 to 720 feet. 60 feet of calcareous rock.
From 720 to 820 feet. 100 feet of oily calcareous rock.
From 820 to 860 feet. 40 feet of black schist, soft to the touch. New vein of the same gas.
From 860 to 1,115 ft. 225 feet of compact black schist.
1,115 feet. Work suspended. The gas continues to flow with such force that it is impossible to close the orifice, so two pipes of ½-inch diameter are fitted to the main one.

"This boring has evidently passed through the Medina shales and sandstones which appear to be here 565 feet thick* and the remainder of the boring, 540 feet. seems to be in the Hudson River rocks. Below these the Utica, and the Trenton would be found, and as it is at the junction of the latter that the main gas and petroleum occurs in north-western Ohio it seems very desirable that the St. Grégoire boring should be continued till it reaches the Trenton limestone. The Ohio section shows the Medina only 80 feet thick with 305 feet of Clinton and Niagara on top, and at the base of the Medina there is a heavy flow of gas, as is the case at 640 feet deep, the base of the Medina, at St. Grégoire. Below this in Ohio are 430 feet of Hudson River strata and 275 feet of Utica shale, at the base of which, or a few feet lower in the Trenton limestone are, as above stated, the great petroleum and gas reservoirs.

"An all-important consideration in connection with the probable occurrence of these reservoirs is that of the geological structure of the district, and while for reasons in connection with this I have never had any faith in their occurrence on the north side of the St. Lawrence, I consider that the probability of such reservoirs existing on the south side, in the country between Lake St. Peter and St. Hyacinthe, is very great, especially along, or in proximity to, the central part of the line indicated by Sir W. E. Logan as the course of the Deschambault anticlinal.—Geol. of Canada, 1863, pp. 152, 205 and 272.

"At St. Grégoire, 550 feet of Hudson River strata have been penetrated. Between the Island of Orleans and the north shore of the St. Lawrence, Sir W. E. Logan estimated the thickness of the Hudson and Utica at 2,000 and 300 feet respectively. Supposing them to be equally thick at St. Grégoire the boring would have to be continued 1,700 feet before reaching the Trenton limestone. A little north of St. Hillaire, on the Grand Trunk railway, however, the Trenton limestone would probably be reached at a much less depth, as the axis of the anticlinal gradually rises in that direction, and the upper measures of the Hudson River and the Medina are absent.

* The thickness of the Medina formation at the west end of Lake Ontario is (Geol. of Canada, 1863, p. 312) as 614 feet.

"In any case the question may certainly be regarded as one of great importance in comparison with the small amount of money which would be required to thoroughly test it.

"As regards the question of manufacturing industries in connection with natural gas as a fuel, however, I may quote the following remarks by Professor Lesley. †

"The facts in reference to natural gas wells, briefly given above, point to the conclusion that gas wells have their regular life, and that the quantity of gas is a limited amount. If a single well is down and yielding gas, the pressure will remain constant and the supply regular for many years, but as soon as new wells go down in the immediate vicinity the total gas supply is sooner or later exhausted and all the wells cease yielding gas.

"The necessary result of this would be that natural gas as a fuel for iron puddling and other uses must be confined to the position of an economical adjunct to other fuels. That is, for works in all other respects well situated for successful iron working, with a cheap coal supply, immediately available upon a temporary or permanent ceasing of the gas supply, this natural gas can be brought in as a fuel and used with heavy saving of cost. But it is highly improbable that it could ever pay to locate works on a gas supply in a position where without the gas the works could not be successfully run. It is therefore as an economical adjunct, and not as a main source of supply that this gas must be regarded."

In New Bruswick, work was continued during the past summer by Professor Bailey and Mr. McInnes, assisted by Mr. J. W. Bailey. Professor Bailey's attention was first directed to the examination of the country on the upper waters of the St. John River, with a view to determine the limits of the Silurian System in that direction and its relations to the so-called Quebec group supposed to underlie and flank it on the northern side. With this object in view, an attempt was made to ascend the valley of the St. John to the north-west branch, where only a short interval separates the St. John waters from those of the Etchemin River flowing to the St. Lawrence: owing, however, to the dry season and the consequent low state of the water, it was found impossible to ascend further than the Seven Islands, and even this point was reached with difficulty, while the ascent of the Big Black and Little Black Rivers had to be abandoned.

Having obtained as much information as possible regarding the Silurian rocks in northern New Brunswick and in the adjacent portions of the province of Quebec and the State of Maine, it was considered advisable as a preliminary to the examination of the older rocks,

† Report L. 2nd, Geol. Survey of Pennsylvania, p. 171.

hitherto known as the Quebec group, to obtain somewhat greater intimacy with the latter in the localities where they were first observed and where their typical features can be best studied.

For this purpose Professor Bailey visited Rimouski and Bic, and then carried his examination inland, till, at the village of St. Blondin, he not only found the western edge of the Silurian rocks, but that there, and in the adjacent Bois Brulé Mountains, the beds were highly fossiliferous, and from them considerable collections were made. He then visited Quebec, where Dr. Ells was engaged in similar work, and with him made a boat trip down the St. Lawrence, thus acquiring a familiarity with the rocks of the so-called Quebec group which would not otherwise have been possible, and which will greatly facilitate his further study of the similar formations in New Brunswick.

During the latter part of the season, the cuttings recently made in constructing the Témiscouata railway were carefully examined, as was also the country in the vicinity of Témiscouata Lake. In the latter examination Professor Bailey was accompanied by Mr. Ami, who made a thorough exploration of the fossiliferous strata of Mount Wissick, Point aux Trembles and Lake Tuladie, and secured a number of interesting fossils, which must be critically examined before any precise correlation of the strata in which they occur can be made. The district was examined in 1849 by Sir W. E. Logan, and is described in the Geology of Canada, 1863, Chap. XVI, pp. 420-423, under the heading "Gaspé Series."

The attention of Mr. McInnes was devoted chiefly to making measurements and securing other data required for the completion of the quarter-sheet map, 17 N.E. of the New Brunswick series, on a scale of four miles to one inch. His observations extended also into the area, which will be included in the adjoining quarter sheet, to the north. A micrometer survey was made of the north side of the St. John River from Edmundston to the mouth of the St. Francis, and of the St. Francis River and lakes, in all about 100 miles. The region to the east of the inter-provincial boundary, in Restigouche county, was examined by ascending the Green River and crossing by a portage of about seven miles to the Quatawamkedgewick, and thence by the Restigouche and Grand Rivers to the St. John. The whole of this region was found to be occupied by strata of Silurian age. Large areas of good land are yet available for settlement in the valleys of these streams, along which there are many fine alluvial flats, with good soil on the uplands. About 250 miles of roads and streams, of which surveys were available, were traversed and examined during the season.

Mr. McInnes further reports that game, owing to the protection afforded it by law, is still fairly abundant in this region; that moose

and cariboo are numerous, and that red deer have latterly been coming in in considerable numbers from the adjoining state of Maine.

During the first part of the season Mr. J. W. Bailey was occupied in making an examination of the St. Francis River and its tributaries from their sources along the line of the Temiscouata Portage road to the junction of the same stream with the St. John. He also made a detailed examination of Temiscouata, Boundary, and other lakes as to depth, physical peculiarities, &c. Subsequently he accompanied and assisted Professor Bailey during the remainder of the season.

Mr. McInnes left Ottawa for field work on the 5th of July, and returned on the 11th October. Professor Bailey was in the field from 12th July to the 21st September.

Cost of season's explorations $1,024.60.

The geological features of this region will form the subject of a detailed report and map, which will be prepared when the observations have been studied, the fossils determined and the measurements plotted. Another season's work in the field will, however, probably be desirable before the report and map referred to are published.

Mr. R. Chalmers left Ottawa on the 12th of May for New Brunswick to continue the examination and mapping of the surface deposits within the area embraced in the quarter-sheet maps Nos. 1 S.E. and 1 S.W., bordering the Bay of Fundy. In 1885 the area embraced in the quarter sheet maps 3 S.E. and 3 S.W. was surveyed and the report and accompanying maps are published as Part M. of the Annual Report, 18-6. During the season of 1886 Mr. Chalmers made a detailed examination of the surface deposits in north-eastern New Brunswick, in the area covered by the quarter-sheet maps 2 N.W. and 6 S.E. These latter, with the report referring to them, are now waiting to be printed. Each of these quarter-sheet maps covers an area of 3,456 square miles. Mr. Chalmers has, therefore, now examined, making allowance for water areas, about 20,000 square miles.

During the past season the work in the field was continued to the 14th December. The cost being $749.42.

Mr. Chalmers states "that the mapping of the different superficial formations was carried out in greater detail this season than had hitherto been attempted, the more settled condition of the country affording better facilities for doing so. All the important mountains and hill features, as well as the forest covered tracts, will be delineated on the map as accurately as time and circumstances permit. The representations of the hills and ridges in western Charlotte seemed to be absolutely necessary to exhibit the character of the surface deposits. In the vicinity of St. Stephen and eastward these ridges were found

to be capped with boulder-clay, while the valleys between them contain stratified materials.

"Observations with the aneroid barometer were regularly taken, based upon those of the meteorological stations at St. John and St. Andrew's, so that the heights in nearly every part of the area can be shown.

"The general character of the soil within the area under consideration is unfavorable to the successful prosecution of agriculture. Nevertheless, along the river valleys, and more especially in western Charlotte, there are excellent, well-cultivated farms. The land is good enough anywhere when once cleared of boulders; but owing to their abundance, the labor attending this is simply immense. At St. Andrew's there is a fine tract of land upon the Lower Carboniferous sandstones."

The maps and a full report will be prepared during the winter.

The explorations and surveys in Nova Scotia were conducted during the past summer, as heretofore, under the supervision of Mr. H. Fletcher, who left Ottawa for the field with his associates, Mr. E. R. Faribault, Mr. J. A. Robert and Mr. McMillan, on the 5th July. Mr. Fletcher's attention was devoted to the survey and examination, in which he was assisted by Mr. Robert, of that portion of Pictou county which lies between West River and the country that is described in Part B of the Annual Report for 1886, recently published. Mr. Fletcher reports having secured the services of Mr. Donald Fraser, of Springville, to trace the outcrops of the iron ores of the East River, and to describe the various workings on them.

Besides coal and iron ore, there are, within the area examined by Mr. Fletcher, workable deposits of gypsum, limestone, freestone, sand, brick clay and fire-clay. There is also a small deposit of bog-manganese in a brook at Glengarry.

The coal mines were not re-examined, but Mr. Fletcher states that "some alterations and some additions are now required in the map made by Sir W. E. Logan and Mr. Hartley, and published with the Report of Progress, Geological Survey, 1866-69.

"The iron ores of Pictou county, though not yet developed, must be regarded as next to the coal in economic importance. They are found at West River, Glengarry, Gairloch, Lorne, Bridgeville, Blanchard, Sutherland's and French Rivers, within a radius of seven miles and a half, and consist of limonite, red hematite, specular, spathic and bog ore, in such abundance, variety and purity as to astonish all visitors. The ores of the East River and Blanchard were worked sixty years ago, in a small way, by the General Mining Association. Since then

much money has been expended to develop the mineral resources of the district. It presents greater facilities for manufacturing iron profitably than are to be found in any other part of the Dominion, and it offers a field in which the investment of capital, by a company having enterprise and skill, would almost certainly result in the establishment of extensive and remunerative mining and smelting works, for the production of nearly all the grades of iron that are now imported. Pictou county is as favorably situated as are the best ore producing districts of Pennsylvania. There is a large market in the Dominion, as is shown by the value—nearly fifteen million dollars in 1886—of the iron and steel in various forms annually imported, much of which might be made in the country, labor being plentiful and cheap.

"The iron ores are in veins and in beds, varying in thickness from mere threads to one hundred feet. They crop out on hills and in bluffs, and the mines could be worked and drained by an adit to a depth, in most cases, of 200 to 300 feet, so that for some time to come neither pumping nor hoisting machinery would be required.

"The limonite, which yields 65 per cent. of metallic iron, is associated with manganese in quantity, thus strongly resembling the limonites that are brought to England from Spain to be used in the manufacture of spiegeleisen, manganeisen and steel. The percentage of iron in the other ores is variable, but all are of workable richness. The Pictou coal is free from sulphur and yields a firm, excellent coke. Limestone for flux is in close proximity and can be quarried cheaply in any required quantity."

A short and easily constructed branch railway would connect all the mines and the works with the Intercolonial main line, which now passes the coal mines, to an excellent shipping port on Pictou Harbor.

Cost of season's exploration $1,500.

Mineral Statistics.

Mr. Coste, Minining Engineer to the Geological Survey, has been engaged during the past year in collecting the material for, and in preparing a statistical report on the exports and imports and on the production of minerals in Canada in 1886, and, when the information was available, for some previous years also. This report, covering 85 pages, forms Part S of the Annual Report of the Geological Survey, Vol. II, new series 1886. It is also published separately and sold for twenty-five cents.

The articles relating to salt and silver were prepared by Mr. E. D. Ingall, Mining Geologist of this Branch.

Mr. Coste was ably assisted throughout by Mr. H. P. Brumell. He was further greatly aided, and the work was much lightened and expedited by the readiness evinced in all quarters to send in returns and answer enquiries, while but for the information afforded by the Department of Mines in British Columbia and by Mr. Gilpin, Chief Inspector of Mines in Nova Scotia, it would have been impossible to have completed the returns for those provinces.

Mr. Coste states that "about 2,000 forms and 400 letters were sent and 665 forms and 185 letters were returned. Plans of twenty different mines were secured and copied."

With a view to prepare for 1887 a more detailed and complete report on the mining resources and industries of the country than that now presented, the following places were visited during the summer by Mr. Coste in order to make personal examinations and enquiries:—

Port Arthur, Sudbury, Bristol Mine and places on the Kingston and Pembroke railway, Perth, Capelton and Montreal.

During these visits Mr. Coste observed "that in several districts the mining operations were being pushed with more vigor and success than during the previous year, especially in the Port Arthur silver district, along the Kingston and Pembroke railway line, at the Bristol iron mine, in the phosphate districts and at the Capelton copper mines. A wonderfully rich ore body was discovered in March of this year at the Beaver silver mine and in July was exposed in four different levels. Ninety to 100 tons of selected ore had been secured, which gave an average of $1,500 to the ton; 1,400 tons of rock, averaging by assay $40 per ton, had been treated in the mill, and had been reduced to about fifty tons of concentrates, averaging by assay $1,000 per ton. On one day in July assays of the mill rock gave $85 and the concentrates $2,300 per ton.

In the district along the Kingston and Pembroke railway and at the Bristol iron Mines, Mr. Coste observed a marked "renewal of activity in the working of the iron mines by two strong companies."

"Some of the Canadian ores, it is true, contain a high percentage of sulphur, but so do the similar iron ores of New Jersey, in some instances as much as $\frac{3}{4}$ per cent., and yet these ores are mined in large quantity. In 1880, there were 112 mines being worked in New Jersey, which produced 739,369 tons of ore. An analysis of the average ore of the Sulphur Hill mine gave 2·527 per cent. of sulphur. This ore was used in the company's furnace at Chester, N. J., but was first roasted in Taylor's patent gas kilns, and it is stated that in a sample taken from 100 tons of the roasted ore only 0·786 per cent. of sulphur could be detected. *

* Tenth Census of the United States. Vol. XV, pp. 145-147.

These facts are given by Mr. Coste to show that there is no apparent reason why the same treatment could not be successfully applied to the sulphurous Canadian ores, and he states that the experiment is now being tried by the enterprising Ottawa capitalists who are working the Bristol mine, and who last summer erected two large Taylor-Langdon gas kilns to roast their ore before shipment. Should this prove successful it will probably lead to the further development of a number of large deposits of iron ore that have hitherto been neglected.

At the Capelton copper and sulphur mines some extensive new works were in progress both at the mines and near the railway station. At the latter, large new sulphuric acid works, nearly completed, and fitted with the best improvements, were being built by the present owners of the Albert, Hartford and Capel mines, Messrs. G. H. Nichols & Co., of New York. At the mine, also, extensive preparations for working on a larger scale were being made. These included the erection of a large crushing and concentrating plant, two new boilers, a pumping station three-quarters of a mile from the mine, a powerful hoisting engine, two air compressors and two shaft houses with corresponding well constructed skip roads. The old Albert, or present No. 1 shaft will also be repaired. It is now about 810 feet deep, and the vein is, on the whole, stronger in depth than it was nearer the surface. This is also the case in the Crown mine, which is further west on the same vein, and continues in active operation, the shaft having now reached a depth of more than 1,500 feet. Nearly 44,000 tons of ore were exported from these two mines (Albert and Crown) to the United States in 1886. The ore is an argentiferous iron and copper pyrites, very similar to, but holding a larger percentage of both copper and silver than that of the celebrated Huelva district in Spain, whence 550,000 tons were exported ta England in 1886, valued at a little more than one million sterling. *

The cupriferous pyrites of the Eastern Townships contains as much sulphur as the Spanish pyrites and is, as stated, richer in copper and silver. If it could be introduced into England at the same price, about ten dollars per ton, there seems no reason why it might not compete successfully with the Spanish ores, and thus lead to the development of other valuable mines in the Eastern Townships.

In the phosphate mining industry Mr. Coste states "there is a renewal of activity in the Ontario district, where two promising properties are being worked by Capt. Boyd Smith, and by the Anglo-Canadian Company. In Quebec, Ottawa county, the mines continue to be actively worked and the production this year will probably be greater than in 1886." The introduction of Canadian phosphate in the

* Mining Statistics of the United Kingdom, 1886.

United States is likely to become an important feature of the industry, and to afford a large and profitable market.

Some hesitation and distrust is still noticed among many of the phosphate miners. This arises from the often irregular nature of the deposits, and from an idea, at one time somewhat prevalent, that most of the deposits were mere surface pockets. In this respect, however, there is no reason for supposing that the deposits of phosphate differ from those of iron ore or of any of the other associated minerals, and thus, while some of the deposits may be quickly exhausted, others will be permanent to the greatest depth to which mining operations can be profitably carried.

During the summer Mr. Brumell was requested by Mr. Coste to visit localities in the counties of Esssex, Lambton and Brant, in Ontario. He also spent five weeks in New Brunswick, in King's, Queen's, Westmoreland, Charlotte, York, Sunbury and Northumberland counties.

Early in October he was sent to examine into a reported discovery of coal at Campbellford in Ontario. The report, as was well known it must, turned out to be unfounded, the country there being all occupied by the Trenton limestone formation.

On the 13th of October Mr. Brumell went to Lake Temiscaming, but owing to the steamer on the lake being disabled was unable to effect anything or to visit the mines.

Field expenses of Messrs Coste & Brumell $1,088.40.

Chemistry and Mineralogy.

The report furnished by Mr. Hoffmann on the work carried out in the chemical laboratory includes that in connection with the mineralogical section of the museum, to the arrangement of which much time and care has been devoted by Mr. Hoffmann, and, as a number of new specimens has been added to the collections, considerable extension and re-arrangement of the cases has been necessary.

Mr. Hoffmann reports as follows :—

"The work carried out in the chemical laboratory during the past year may be said to have an almost exclusive economic character. It included :—

"I.—Analyses of numerous specimens of lignites, lignitic coals and coals from the North-West Territory and British Columbia. Of the coals examined from the last named province, three were from seams of considerable thickness, and proved to be of very superior quality.

"II.—Analyses of iron and copper ores.

"III.—Analyses of mineral waters.

"IV.—Gold and silver assays. The number of these assays made in the laboratory during the period above specified amounted to one hundred and forty-eight, and exceeds that of any previous year.

"V.—Miscellaneous examinations, embracing chromic iron ore, clay, &c., &c.

"In the last summary report of this section mention was omitted of the following additions to the list of minerals previously known to occur in Canada, viz., cookeite, uraninite, monazite and smaltite. They have, however, been fully referred to in Part T, Annual Report, 1886. The second mentioned, uraninite or pitch-blende, constitutes the principal ore of uranium, and is of economic importance, being employed in chemical operations, for painting on porcelain, and glass staining.

"The number of mineral specimens received for examination amounted to six hundred and ninety-eight, as compared with five hundred and forty-six for 1886, and three hundred and thirty-nine for 1885. A large proportion of these were brought by visitors desirous of obtaining information in regard to their economic value, and this was in most instances communicated in the course of a personal interview. In many cases, however, a more than cursory examination was called for, and the results were subsequently communicated by letter. Notwithstanding that correspondence has been, as far as possible, limited to the writing of only such letters as were absolutely necessary for the conveying of information in regard to the results of examination, analysis, assay, or economic value of mineral specimens, it shows a marked increase over that of preceding years. Altogether the time devoted to visitors and correspondence has been very considerable. The number of letters written amount to two hundred and seventy-seven, as compared with one hundred and seventy in 1885.

"The mineral specimens collected by Dr. G. M. Dawson in the Upper Yukon district are under examination, and the two mineral waters from Harrison Springs, B.C., collected by yourself will now shortly be submitted to analysis.

"Mr. F. D. Adams has, (with the exception of about three months and a half during the summer, when he was engaged in field work in the counties of Montcalm and Joliette, in continuation of work commenced in the season of 1885) in the capacity of assistant chemist, rendered excellent service, amongst other work conducted by him being that of the analysis of the water of one of the principal thermal springs at Banff.

"Mr. E. B. Kenrick worked faithfully and diligently as junior assistant chemist up to the end of August, when he left to accept a professorship at St. John's College, Winnipeg. The position occupied by him has since been filled by Mr. R. A. A. Johnston, an earnest worker.

"In the mineralogical section of the museum some of the specimens have been replaced by better ones of the same kind, and one hundred and twenty-six new ones have been added. These include the following presentations:

Allan, W. A., Ottawa:—
Crystal of apatite from the Emerald mine, township of Buckingham, Ottawa county, Q. This crystal weighs five hundred and fifty pounds, and has a circumference of seventy-two and a half inches. It is supposed to be the largest crystal ever found in any country.
Muscovite, with inclusions of garnet, from the Villeneuve mica mine, Villeneuve, Ottawa county, Q.
Native silver from mining location R. 238, north of Atik Lake, west of White Fish Lake, Thunder Bay, Lake Superior, Ont.

Chisholm, Duncan, Salt Springs, N. S.:—
Brick-clay and bricks from Salt Springs, Antigonish county, N. S.

Copeland, J. S., Merigonish, N. S.:—
Infusorial earth from Merigonish, Pictou county, N. S.

Daly, Thomas:
Phlogopite, from the township of Portland, Ottawa county, Q.

Egan, H. L., Ottawa:—
Magnetite, from the township of Litchfield, Pontiac county, Que.

Haycock, E. B., Ottawa:—
Uraninite, from the township of Villeneuve, Ottawa county, Que.
Monazite, from the township of Villeneuve, Ottawa county, Que.

Hanks, Prof. H. G., 543 Clay street, San Francisco, Cal. U.S.
A fine specimen of the new anhydrous sulpho-carbonate of sodium, "hanksite"; also well-crystallized specimens of glauberite.

Keefer, T. A., Port Arthur, Ont.:—
Zinc blende, from the Zenith zinc mine, north shore of Lake Superior, Ont.

Lemieux, Joseph, Ottawa:—
Hematite, from Iron Island, Lake Nipissing, Ont.

McCool, James, Mattawa, District of Nipissing, Ont.:
Apatite, from the township of Ferries, district of Nipissing, Ont.

McDonald, R., & Sons, Arnprior, Ont.:
Polished column and base of Arnprior marble, the stone having

been taken from their quarry in the township of McNab, Renfrew county, Ont.

Mackenzie, Alexander, Montreal, Que.
Gold-bearing rock, from the Crow's Nest mine, Guysborough county, N.S.

McLaurin, J. Templeton, Ottawa county, Que.:—
Phlogopite, from the township of Templeton, Ottawa county, Que.

McNeely, J. L. Carleton Place, Ont.:—
Hematite, from the township of Beckwith, Lanark county, Ont.
Copper pyrites, from the township of Beckwith, Lanark county, Ont.

Moore, Isaac, Ottawa:—
Copper pyrites, from the south-east side of Straight Lake, district of Algoma, Ont.

Murphy, W. H., Ottawa:—
Zinc-blende, from the township of Calumet, Pontiac county, Que

Poole, H. S., Stellarton, N.S.:—
Carboniferous conglomerate carrying native gold, from Gay's River, Colchester, N.S.
Altered bitumen, from the *falls measures* immediately overlying the Acadia seam at Westville, Pictou county, N.S.
Anglesite, from the Big Dome mine, Arizona.

Shea, Dennis, Bryson, Pontiac county, Que.:—
Zinc-blende, from the township of Calumet, Pontiac county, Que.

Toronto Stone Company, Toronto:—
A dressed cube of the dolomite, from Pelée Island, Lake Erie, Ont.

Van Horne, W. C., V. P. Canadian Pacific Railway. Montreal:—
Copper pyrites, from Sudbury, district of Nipissing, Ont.

Wild, General E. A.. Port Arthur, Ont.:—
Silver glance, from the Rabbit Mountain mine, Thunder Bay, Lake Superior, Ont.

Wright, G. B., Victoria, B.C.:—
Silver ore from four different claims, Illicillewaet, Selkirk Range, B.C.

"Mr. R. L. Broadbent was, for the space of eight months, engaged in the prosecution of the work of permanent labelling of specimens in the mineral collection, re-adjusting the contents of some of the cases, and the maintaining of the same in an orderly condition. During the remaining months he was occupied in writing labels, under the direction of Mr. Whiteaves, for the biological section of the museum.

Mr. C. W. Willimott has labelled and catalogued a large number of the specimens which are exhibited in the yard of the museum. These specimens consist, in part, of such as cannot, by reason of their size or nature, be accommodated in the museum, and of others, such as building stones, &c., upon which it is desired to ascertain the action of atmospheric influences. He has also been occupied in making up mineral and rock collections for various educational institutions, &c.

"Collections of this description have been forwarded to:—

	Specimens.
Depart. de Olras Publicas Republica Argentina, for exchange	119
James Edmunds, London, England	42
St. Joseph Philosophical and Theological Seminary	105
Halifax Teachers Class and Halifax Academy	105
Professor J. G. Bonney, London, England	41
Captain Douglas	4
Canadian Pacific Railway (for exhibition at the Liverpool Exhibition)	75
Professor H. A. Ward, of Rochester, N.Y. (in exchange for specimens required for the museum)	81
	533

"Collections for the following will be ready in a few days:—

	Specimens.
J. C. Tremblay, Chicoutimi	115
High School Board, Aylmer	115
University of St. Joseph, Memramcook, N.B	115
Christian Brothers training school, Clonmel, Ireland	115
St. John's College, Winnipeg	115
Canadian Institute, Toronto	115
	1,223

"Collections for the following have yet to be made up:—

W. Smith, Land and Works Department, B.C.
Royal Military College, Kingston, Ont.
College Bourget, Rigaud, P.Q.

"In the course of the summer, Mr. Willimott visited the townships of North Burgess, Ramsay, Darling and Ross in Ontario, and Oxford, Chatham, Grenville, Villeneuve, Wakefield, and Hull, in the Province of Quebec, for the purpose of procuring certain mineral specimens required for the making up of collections for educational purposes. Whilst so engaged, he collected many specimens superior to those already in the museum collection, which they will replace, and in addition some other highly interesting ones, such as tourmaline in various stages of alteration, a mineral which may prove to be lepidolite, as also specimens of the monazite and uraninite, of which mention was made at the commencement of this report."

PALÆONTOLOGY AND ZOOLOGY.

In this division Mr. Whiteaves reports as follows:—"The illustrated synopsis of the fossils of the Hamilton Formation of Ontario, with descriptions of some new species, to which reference was made in the Summary Report of last year, has been published and distributed. The fossils, collected by Dr. G. M. Dawson in 1885 from the Mesozoic rocks of the northern part of Vancouver Island and adjacent coasts, have been studied, and a critical list of the species, with descriptions of such as are believed to be new, has been prepared and published as an appendix to Dr. Dawson's report on the geology of that district. An interesting series of fossils, collected by Mr. J. B. Tyrrell in 1885 and 1886 from the Cretaceous and Larimie deposits of the valleys of the Saskatchewan and its tributaries, has also been studied, and a similar list of species, with descriptions of several new forms, has been printed as an appendix to Mr. Tyrrell's report on Northern Alberta. A paper, descriptive of the whole of the fossils at present in the Museum of the Survey from the Triassic rocks of British Columbia, has been written during the year, but its publication has been deferred in consequence of the recent receipt from Mr. McConnell of some additional species collected by him, during the summer from deposits on the Liard River. These are evidently of Triassic age, a description of these species being deemed essential to the completeness of this presentation of the subject. The generic and specific affinities of these fossils from the Liard River, however, have been for the most part ascertained, as have those also of a small but remarkable assemblage of species recently collected by Dr. Dawson from the Cretaceous rocks of the Lewis River, a tributary of the Yukon. A preliminary examination has been made of a series of Cretaceous and other fossils obtained during the year by Mr. Tyrrell from the Duck and Riding Mountains in northern Manitoba.

"Considerable alterations and improvements have been made in the upper flat of the museum. The more important of these consist of the construction of six large and new upright wall cases, three for the reception of fossils, two for recent shells, and one for birds. One of these new wall cases is now filled with the remains of vertebrata from the Post Tertiary and Tertiary deposits of Canada, which have been skillfully re arranged by Mr. T. C. Weston. To this series an important addition has been made during the year in the shape of a lower jaw, with several vertebræ, ribs and limb bones of a *Mastodon*, which was discovered some years ago in a peat bog near Woodstock, Ont. In two of the other new wall cases the larger fossils of the Carboniferous and Permo-Carboniferous rocks of the Lower Provinces are now displayed to much better advantage than heretofore, these specimens also having been judiciously re-arranged by Mr. Weston. Two others have been devoted to the exhibition of a number of recent shells, of large and comparatively large size, many of which have been recently acquired by exchange. The whole of the shells in these new cases, and in another of similar size, have been neatly labelled by Mr. R. Broadbent, under Mr. Whiteaves' directions, the number of labels required for this purpose being 377. Mr. Broadbent, who has worked in this department for four months, has also labelled each specimen in the extensive series of recent mollusca from the Pacific coast of Canada now in the museum, so that the duplicates can be more readily distributed to educational institutions, and has placed upon exhibition in the cases a number of additional specimens. The last of the five new cases now contains 112 specimens of Canadian birds belonging to the family Oscinæ, very few of which had previously been exhibited.

"On the 31st of December, 1886, there were 44 mounted specimens of Canadian mammals and 142 of Canadian birds on exhibition in the museum. On the 23rd of December, 1887, the number of mounted specimens on exhibition was, mammals, 82 (including a fine example of a puma, shot in August last near Victoria, Vancouver Island); and birds, 352; many of which have been set up by Mr. Herring during the year. To most of these specimens a provisional label has been attached.

"The number of letters written is a little over 200; and for rather more than three months, in the absence of the Director on field work, the duties of Acting Director, as on several former occasions, have devolved on Mr. Whiteaves.

Mr. Weston reports that since the 30th of December, 1886, he has spent about three months in arranging, cataloguing and labelling several hundred ethnological specimens. He has also prepared about 150 microscopic sections of rocks from various formations. Between 13th June and 17th September, 56 days were devoted by him to field

work and to the examination of many fossil localities between Cape Rosier and Point Levis. In this exploration Mr. Weston was assisted by Mr. L. M. Lambe. A few days were subsequently spent in collecting fossils at Grimsby, Ont. Through the kindness of Mr. R. Thompson, of Grimsby, an unusually fine example of *Arthrophycus* (or *Harlania*) *Harlani* was secured for the museum. The rest of Mr. Weston's time has been occupied in museum work in the palæontological department.

Mr. H. M. Ami reports that during the earlier portion of the past year he was engaged in determining, classifying and labelling the large series of Silurian fossils collected by Mr. Weston in 1886, at various localities on the Arisaig shore, at Cape George and at Lochaber Lake, and in Antigonish county, N.S., from rocks which range in age from the Medina to the Lower Helderberg. He has also determined the Graptolites collected by Dr. Selwyn at Matane, and has helped Mr. Whiteaves in the examination of some Devonian fossils from Western Ontario. He has prepared systematic lists of labels, which have since been printed, for the fossils of the Hamilton Formation of Ontario enumerated in Mr. Whiteaves' "Contributions to Canadian Palæontology," Vol. 1, part 2, and for the graptolites of the Lévis Formation. Collections from the duplicates in the museum have been selected and labelled by him and sent to the following institutions or persons:—(1) To Laval University, Quebec, fossils; (2) to Mr. W. B. Clark, of Johns Hopkins University, Baltimore, fossils, in exchange for other specimens; and (3) to the Rev. Hector Currie, of Thedford, Ont., recent shells in exchange for Devonian fossils. Small collections, for special purposes, have also been forwarded for examination to Messrs. G. F. Matthew, E. O. Ulrich and C. D. Walcott. During the month of September and part of October, Mr. Ami was engaged in assisting Dr. Ells and Professor Bailey in their field explorations of various parts of the Province of Quebec, by collecting fossils with a view to ascertain the exact geological horizon of the rocks from which they were obtained. Since his return from the field he has examined the somewhat extensive collections of Natural History specimens of various kinds, which Mr. D. N. St. Cyr brought to Ottawa for identification, on behalf of the Quebec Government. These collections are intended to form the nucleus of a museum in connection with the Department of Instruction at Quebec, and consist of a large series of Canadian fossils, mostly from the Province of Quebec, and numerous species of marine, land and fresh water shells, with other invertebrata, from the gulf or valley of the St. Lawrence, exotic shells and the like. These collections have since been named, labelled and catalogued by Mr. Ami, under the supervision of Mr. Whiteaves, and duly forwarded to Quebec.

As in previous years, the whole of the drawings required for the illustration of palæontological reports have been carefully and skillfully prepared by Mr. L. M. Lambe.

The following collections have been received during the year from members of the staff or from gentlemen engaged in the work of the Survey:—

Dr. A. R. C. Selwyn:—

About 60 specimens of graptolites from the shales of the Lévis formation at Matane, Que.

Dr. R. Bell:—

About 250 specimens of fossils from the Silurian rocks of Lake Temiscaming.

One skin of a black hare from Paish ko-tchagami Lake.

About 120 specimens of coleoptera and fifty of lepidoptera from the Upper Ottawa region, extending from Temagami Lake and the Montreal River to the source of the Ottawa River, due north of Ottawa.

One Star-nosed Mole (*Condylura cristata*) from Ottawa.

One Jumping Mouse (*Zapus Hudsonicus*) from the Albany River.

Dr. G. M. Dawson:—

One Field Mouse (*Arvicola riparia*) from Finlayson Lake, Liard River, N.W.T.

One Red Squirel (*Sciurus Hudsonicus*) from the Yukon River at the confluence of the Lucas and Pelly.

One Northern Flying Squirrel (*Sciuropterus volucella*, var. *Hudsonicus*) from Chilkoot Inlet.

One Spotted Sandpiper (*Actitis macularia*) from the Cassair district, B.C.

One Northern Pacific Kittiwake (*Rissa tridactyla*, *pollicaris*) from Frances Lake, N.W.T.

A small series of fresh water shells, including some remarkable varieties of *Limnæa ampla*, from Frances and Finlayson lakes and the Lewis River.

Several specimens of graptolites from the presumably Cambro-Silurian shales of the Dease River, and thirty-five specimens of fossils from the Cretaceous rocks of the Lewis River.

Dr. R. W. Ells:—

A series of about 50 specimens of fossils from the Lévis Formation at various localities in the province of Quebec.

Dr. R. W. Ells and H. M. Ami :—

Forty specimens of fossils from the Chaudière River, Q., near the railway bridge.

Twenty specimens of fossils from the Hudson River formation, near St. Nicholas, Q.

About twenty specimens of fossils from Point Lévis and South Quebec.

Several fossils from Champlain Street, and foot of Citadel Hill, Quebec.

About twenty fossils from the Montmorency River, and the same number from Bois Brûlé and St. Blondin, Q.

Prof. John Macoun :—

Fifty-six species of birds, represented by 90 skins, and two mammals, from Vancouver Island; also a large number of marine shells and other invertebrata, and of land and fresh water shells, from the same locality.

R. G. McConnell :—

An interesting series of fossils from the Triassic and Cretaceous rocks of the Liard River.

J. B. Tyrrell and D. B. Dowling :—

450 specimens of Cretaceous fossils, twenty-four of butterflies and three of mammals from Duck and Riding Mountains, in northern Manitoba.

Prof. L. W. Bailey :—

Fossils from the Beccaguimic River, N.B., from various places around Lake Temiscouata, Q., and from Bois Brûlé and St. Blondin, Q.

T. C. Weston :—

About 1,000 specimens of fossils collected at various localities between Cape Rosier and Point Lévis, Q., and about 300 specimens of forty species of Niagara fossils from Grimsby, Ont.

H. M. Ami :—

Collections of fossils from Pointe aux Trembles, Mount Wissick, Tuladi River, Tuladi Lake and other places near Lake Temiscouata.

W. McInnes :—

Silurian fossils from rocks south of Rimouski, Q.

H. P. Brumell :—
Five specimens of fossiliferous Trenton limestone from Campbellford, Ont.

The additions to these departments of the museum, by presentation and purchase, are as follows :—

By Presentation :—

Charles E. Fish, St. John, N. B. :—
Specimen of *Lepidodendron Sternbergii*, from the Millstone-grit of Newcastle, N. B.

J. W. Tyrrell, Weston, Ont. :—
One female "Blue" Fox, *Vulpes lāgopus*, var. *fuliginosus* (trapped January 12th, 1886); one Arctic Fox, *Vulpes lagopus*, in winter coat; one Ringed Seal, *Phoca fœtida* (something under a week old); two Hudson's Bay Lemmings, *Cuniculus torquatus;* one Polar Hare, *Lepus timidus*, var. *arcticus*, in winter coat; all from Ashe Inlet, Hudson's Strait.

G. Seifert, Fabrique St., Quebec :—
Three specimens of the Fresh-water Pearl mussel (*Margaritana margaritifera*) with a number of pearls from the same species.

W. F. Whitcher, Ottawa :—
Skin of Kit Fox (*Vulpes velox*) from Antelope Lake, Assiniboia.

Prof. E. Hull, Director Geological Survey of Ireland, Dublin :—
Two specimens of *Oldhamia antiqua* from Carrick Mountain, Wicklow, and two of *Oldhamia radiata* from Bray Head, Wicklow.

H. Bartlett, Ottawa :—
Specimen of an Osprey (*Pandion haliœtus Carolinensis*) shot on the Rideau River near Ottawa.

W. P. Lett, Ottawa :—
One Sora Rail (*Porzana Carolina*) also shot on the Rideau River near Ottawa.

Sir William Dawson, C.M.G., &c. :—
Specimen of *Flustra serrulata*, Busk, from Murray Bay.

T. G. White, Ottawa :—
Four specimens of Wilson's Meadow Mouse (*Arvicola riparia*) from near Ottawa.

W. J. Bayley, New Edinburgh :—
One adult female of the Marsh Harrier (*Circus Hudsonicus*) shot at Britannia Bay, near Ottawa.

D. N. St. Cyr, Department of Public Instruction, Quebec ;—
One young Harp Seal (*Phoca Groenlandica*) apparently about five or six weeks old.
Specimen of *Hippopus maculatus*.

H. L. Poole, Manager Acadia Coal Mines, Stellarton, N. B. :—
Fine specimen of *Lepidodendron personatum* from the coal measures at Westville, Pictou Co., N.S.

Percy Woodworth, Kentville, N.S. :—
Six specimens of insects and two fœtal mice, from Digges Island, Hudson's Bay.

W. F. MacKay, Fort Albany, James' Bay :—
Three specimens of birds from the Albany district.

By Purchase :—
Head of adult Bull-walrus (*Odobœnus rosmarus*) and skin of a White Wolf (*Canis lupus*, var.), both from Ashe's Inlet, Hudson's Strait. The walrus was shot on the 10th of April, 1886, was eleven feet long and weighed about 2,500 lbs. The white wolf was shot by an Eskimo in the winter of 1885-86, about 30 miles north of Ashe Inlet, or in Lat. 63° N., and Long. 71° 30 W.
Underjaw (with two teeth in place) vertebræ, ribs and limb-bones of *Mastodon* found in 1871 in a peat bog near Woodstock, Ont.
Specimen of an adult female Puma (*Felis concolor*) shot in August, 1887, near Victoria, V. I.
One Red Fox (*Vulpes vulgaris*).
One Kit Fox (*Vulpes velox*) from near Calgary, N.W.T.
One young Whooping Crane (*Grus Americana*) and one adult Franklin's Gull (*Larus Franklini*) both from Manitoba.
Remarkable colour variety of the Rough-legged Buzzard (*Archibuteo lagopus*) shot near Ottawa.

Botany.

On the work in this section during the year, Professor Macoun reports as follows :—" In January, February and March, I was occupied with correspondence and in examining and classifying a very large quantity of miscellaneous cryptogamic matter.

" My results have since been submitted to specialists, and their partial reports are now in my hands.

" The collection of Canadian Fungi, upwards of 600 species, now in the Museum, has been named by Mr. J. B. Ellis, of Newfield, N.J.

" Dr. Nils Conrad Kindberg, of Lusköping, Sweden, has examined the mosses, and has confirmed, or corrected my determination, and the list of Canadian mosses has been increased to nearly 600 species, many of them new, not only to Canada, but to science. The Hepaticæ or Liverworts are difficult to determine, but good progress is being made in this work. More than 100 species are now in the hands of Mr. Pearson, of Manchester, who is the highest authority in England on this class of plants.

" On the 8th of April, I left Ottawa for Vancouver Island, arriving there on the 15th. From that time to the end of August, I was occupied in collecting specimens of the flora of the island and in determining the distribution of its forest trees and the character of its soil as indicated by the vegetation.

" My researches extended from Victoria to Connox on the east coast, with frequent excursions to points in the interior. Crossing from Qualicum to Alberni I went in a canoe to Cape Beall on the outer coast. The islands in Barclay Sound were examined, and in prosecuting the examination of the country inland the following mountains were ascended :—

	Feet.
Mt. Erskine on Salt Spring Island	1,275
Mt. Finlayson near Goldstream, Vancouver Island	1,350
Mt. Benson at Nanaimo	3,363
Mt. Prevost at Somenos	2,700
Mt. Arrowsmith near Qualicum	5,976
Mt. Mark at Horne Lake	3,080

Fifteen hundred species of plants were collected.

Since my return in September, I have been fully occupied sorting and determining the specimens collected during the summer, and in writing the fourth part of the Catalogue of Canadian Plants, a portion of which is now passing through the press.

During the year 1886-87 there were placed in the Herbarium 4,305 sheets of specimens, as follows :—

Canadian,	752
American	1,807
European	750
Cryptogams	996
	4,304

From the herbarium 5,905 sheets of duplicate specimens were distributed either to individuals in exchange for specimens received, or to scientific institutions. Among the latter were the British Museum, McGill and Queen's Colleges in Canada, and the Harvard University herbarium in the United States.

Dr. Dawson has brought back from his last summer's field of labor on the Upper Yukon a valuable and interesting collection of plants and although but a cursory examination has been made of them, they show conclusively that the summer climate there is neither cold nor wet

Mr. J. M. Macoun acts as botanical assistant during the winter and takes care of the herbarium, while during the summer he accompanies one or other of the exploring parties in the field, taking every opportunity to make botanical and zoological observations and collections. Besides the botanical work here recorded, Professor Macoun made valuable zoological collections during the summer which are referred to in the report on that section by Mr. Whiteaves.

MAPS.

British Columbia.—The map of the western part of Vancouver Island and adjacent coast, scale eight miles to one inch, has been published with Part B of the Annual Report, 1886.

Mr. Bowman during the year has completed the following maps and plans:—

	Area in Square Miles.
1. Revised map of the southern interior of British Columbia, scale 8 miles to 1 inch	28,914
2. Map of Cariboo district, scale 2 miles to 1 inch, about	2,720
3. Plans of eleven creeks showing placer mines and quartz ledges and embracing together about 249½ square miles, as follows:—	
(1.) Little Snowshoe and Keithley Creeks, scale 2½ inches to 1 mile.....	54
(2.) Sugar, Hardscrabble and Slough Creeks, 3 inches to 1 mile	49
(3.) Antler Creek, scale (about) 26 chains to 1 inch.	38
(4.) Cunningham Creek do 27½ do do .	34
(5.) Lightning Creek do 400 feet do .	17
(6.) Grouse Creek, scale do 25 chains do .	14
(7.) Island Mountain and Mosquito Creek, scale (about) 480 feet to 1 inch.....	3½
(8.) Harvey Creek, scale (about) 19 chains to 1 inch.....	3⅛
(9.) Williams Creek, scale (about) 400 feet to 1 inch.	12
(10.) Hixon Creek, scale 2½ inches to 1 mile.....	24
(11.) do do about 10 chains to 1 inch..	¾

North West Territory.—Mr. J. B. Tyrrell's map of the country between the Upper Bow and the North Saskatchewan Rivers is engraved, and accompanies Part J., Annual Report, 1886; scale 8 miles to 1 inch; area 45,000 square miles.

Manitoba and Western Ontario.—The map of the Lake of the Woods to illustrate Mr. Lawson's report on that region was published early in the year; scale 2 miles to 1 inch; area 3,456 square miles.

Mr. E. D. Ingall's map of Silver Mountain and vicinity is engraved; scale 20 chains to 1 inch; area 45 square miles. Also sketch map of Thunder Bay mining region; scale 4 miles to 1 inch; area 3,000 square miles.

Mr. Cochrane has continued the revision of sheet 115 in the field from 17th July to the 2nd September, having examined and corrected about 250 square miles. Copies were made of about 55 miles of the plans of the Wellington, Grey and Bruce railway: scale 200 feet to 1 inch.

Mr. Coste has a plan of the townships of Madoc and Marmora, county of Hastings, ready for publication. Scale 2 miles to 1 inch.

For two weeks during the summer Mr. Barlow was engaged surveying roads, range lines, &c., to aid in the compilation of the map of Carleton county. Scale 4 miles to 1 inch.

Quebec.—The south-east $\frac{1}{4}$ of the Eastern Townships map is completed and will accompany Part J Annual Report, 1886. Scale 4 miles to 1 inch. Area 4,500 square miles.

Professor Bailey and Mr. McInnes are working on $\frac{1}{4}$ sheets, 17 N. E. and 18 S. E.

The map of Ottawa and Pontiac counties remains as last reported.

New Brunswick.—$\frac{1}{4}$ sheet, No. 2, N. W., has been published. Scale 4 miles to 1 inch. Area 1,512 square miles.

Nova Scotia—$\frac{1}{4}$ sheets, No. 4 N. E. and 4 S. E. are being drawn.

LIBRARY.

Dr. Thorburn reports that 5,075 copies of the various publications of the Survey were distributed during the year, including Annual Reports, special reports and maps. Of these 3,980 were distributed in Canada, the remainder were sent as exchanges to scientific and literary institutions and individuals in the United States, South America, Europe, India, China, Japan, Australia, &c.

The number of reports in French sent out was 563.

There were received as exchange during the past year 1,027 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets, and maps.

There were added to the Library during the year 82 publications by purchase, besides 37 scientific magazines and periodicals on geological, mineralogical and natural history subjects subscribed for.

The number of volumes bound was 281.

The letters received in connection with matters relating to the Library and the distribution of the geological publications were 1,211, whereas those sent out during the same period were 1,315.

VISITORS.

The number of visitors to the Museum during the year from the 1st of January to the 31st of December was 17,575 or three thousand more than in any previous year.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is 53, viz., professional, 36, ordinary, 17.

During the calendar year the following appointments were made to the permanent staff:—

Mr. Eugène Coste, Mining Engineer.
Mr. Amos Bowman, Field Geologist.
Mr. A. C. Lawson, do

The amount available for the fiscal year ended 30th June, 1887, was:—

Civil-list salaries, appropriation	$40,650 00
General purposes, do	56,995 32
	$97,645 32

The expenditure may be summarized under the divisions named as follows:—

Civil-list salaries	$38,450 00
Wages, temporary employés	19,765 00
Exploration and survey	19,144 58
Indian and Colonial Exhibition	5,700 83
Printing and lithography	11,389 02
Purchase of specimens	865 05

Purchase and binding of books, and purchase of instruments	525 83
Laboratory apparatus and chemicals	89 06
Stationery, mapping material and Queen's Printer	1,087 21
Incidental and other expenses	2,286 47
	$99,303 93
Less paid in 1886	8,837 48
	$90,466 45
Advance to field explorers and others on account 1887-88	3,930 4
Unexpended balance civil-list appropriation	2,200 00
Unexpended balance of contingency appropriation	1,048 43
	$97,645 32

The correspondence of the branch shows a total of 8,489 letters sent, and 5,505 received, from 1st January to 31st December, 1887.

ALFRED R. C. SELWYN,
Director.

1888.

During the summer, between the middle of July and October, I visited and examined certain places for the purpose of investigating questions in connection with the work of the Survey, and the discovery and development of valuable economic minerals. Among them may be mentioned the apatite and iron ore deposits near the village of Carp, in the townships of Huntley and Fitzroy, the borings for gas and petroleum at St. Grégoire and Maison-Neuve in Quebec, at and to the west of Collingwood in Ontario, and near Lake Dauphin in Manitoba. The whole of the month of August was devoted to the study of the great mineral bearing belt which occupies the shores of the north channel of the Georgian Bay of Lake Huron and extends from Sault St. Marie to Sudbury. Within this belt are situated not only the newly discovered nickel-copper and gold-bearing deposits in the vicinity of Sudbury, but also the old and now abandoned Bruce and Wallace mines, and a number of other promising deposits of copper ore, argentiferous galena and iron ore, which seem only to require energy and enterprise to convert them into profitable mines. The Vermilion or Tough gold mine near Whitefish station on the Sault St. Marie branch of the Canadian Pacific Railway was visited. Some of the rock obtained from the vein is mar-

vellously rich in visible free gold, but it is not easy to predict what the future of these mines will be. At the date of my visit, only one shaft, which strangers were not permitted to examine, had been sunk on the deposit, apparently a bed of quartz two to three feet thick running with the stratification, or about E.N.E and W.S.W., in a vertical attitude. Fine grained diorite, and altered greenish sandstone and schists of the usual Huronian type constitute the country rock, and on the summit of a ridge of this diorite, a few hundred yards to the south, a pit about 20 feet deep had been sunk in a fragmentary ferruginous mass which shows both free gold and films of native copper, while pyrrhotite, and yellow and purple sulphurets of copper occur impregnating the diorite as they do in the Stobie, Copper Cliff and Evans mines at Sudbury. The general geological features of this region appear to correspond very closely with those observed around the Lake of the Woods where also a number of gold-bearing quartz veins have been discovered, one of which, opened during the past year about seven miles S.E. from Rat Portage, opposite Quarry Island, has afforded a large number of specimens, even richer in free gold than those from the Vermilion Mines. The vein is a somewhat ferruginous quartz traversing a dioritic or hornblendic schist near its contact with the granite mass of Quarry Island, and if the material can be got in quantity the owners have here an exceptionally rich mine. It is known as the Sultana mine, but does not appear to be the same vein as that described by Mr. Coste, p. 17 K, Geological Survey Report 1882-84, as the Sultana Lead, and of which he says, "I do not think it is auriferous."

The subject of natural gas in Canada was referred to in my last summary report. Since then I have informed quite a number of enquirers that almost in any part of the Ontario peninsula, more especially south and west of the outcrop of the Trenton limestone which extends from Port Hope to Collingwood, the chances of striking natural gas and petroleum are as good as they are in Ohio. I am informed that several borings are now in progress to test the question, and steps have been taken to secure an accurate record, and samples for examination, of the strata passed through in these borings.

Cost of season's work was $852.60.

Dr. G. M. Dawson, assisted by Mr. J. McEvoy, was occupied during the past summer in carrying out a somewhat detailed geological examination of part of the southern interior of British Columbia. This region had been subjected to a general geological reconnaissance by Dr. Dawson in 1877, and a preliminary geological map and report were published as the result of the work. Since the completion of the

Canadian Pacific Railway, however, the importance of this particular portion of British Columbia has much increased, and Mr. A. Bowman was in consequence instructed to carry on work there in 1882 and 1883. Much of his time was devoted to topographical measurement and delineation, as the physical features of the region are very complicated and in some places hold a close relation to the geological structure. A map embodying the result of Mr. Bowman's geographical work was prepared and published last winter, and is a great advance on anything previously existing for the region covered by it, which is practically identical with that of Dr. Dawson's reconnaissance map of 1877. This map was regarded as the basis for a more detailed geological map, but from the complicated geological structure which Dr. Dawson's close examination during the past summer has revealed in some parts of the district, it may perhaps eventually be found desirable to complete the geological map on a larger scale. Dr. Dawson furnishes the following outline of his work, in connection with which he left Ottawa on the 14th of June, returning on the 30th of October :—

"On beginning the work of the past season, I thought it probable that with the information already in hand it might be possible to revise the geology of the arena covered by the map of 1877 and 1887, and to re-examine the various doubtful points within the area in the course of the summer. Before field work was begun, however, I arranged to meet Mr. Bowman, and on discussing the matter with him found that more than I had supposed remained to be done, and later, as the work progressed, unexpected complications of structure presented themselves, rendering necessary a close re-examination of certain parts of the district. There were also considerable gaps in the geographical outlines and topography of the map which we were obliged to fill, and it soon became evident that it would be better to go over a portion of the region in a somewhat detailed manner than to make disconnected observations over the entire area of the sheet. The operations were, therefore, practically confined to a district having an extreme length of about 130 miles with an extreme breadth of about 70 miles, which occupies the central portion of the map sheet above referred to.

"The geographical and topographical part of the work was chiefly performed by Mr. McEvoy.

"The geological observations have cleared up several points previously in doubt and have resulted in the definite outlining of the principal formations in the area covered, but much yet remains to be done before the present observations can be presented in a connected and satisfactory form, in combination with the facts ascertained by Mr. Bowman, as a supplement to those of 1877. I shall, therefore, here confine my remarks to notes on certain points which appear to have an immediate economic interest.

"The discovery of coal in the vicinity of Kamloops, which occurred last winter, has attracted some attention to the coal question in this interior part of the province, and was one, among other reasons, for the present re-examination of the district. The coals found in this region occur at the base of the Tertiary formation, in beds of ordinary sedimentary origin, while the upper portion of that formation is composed of volcanic rocks, largely basalts. Unlike most Tertiary fuels, however, these were found, in some places, to assume the character of bituminous coals. This is the case with one of the seams known for many years near the junction of the Nicola and Coldwater Rivers, and also with that of the Indian Reserve on the North Thompson. These localities, with others in which lignites occur, are described in the Report of Progress for 1877-78. The coal near Kamloops is also a bituminous coal, and though the seams so far found are quite thin, the locality appears to be worthy of examination on account of its nearness to the railway. The rocks in which the coal occurs form a local extension of the Tertiary basin which is somewhat wide-spread in the vicinity of Kamloops Lake, and even should no really workable bed be found at this spot, the mere occurrence of coal here points to the probability of the existence of thicker seams elsewhere in the basin. Excellent lignite, in seams of good thickness, has lately been found near Vermilion Forks on the Similkameen, but from the isolation of this locality can at present be of local use only. The lignite reported near Quilchana on Nicola Lake is of inferior quality and scarcely suitable even for local use.

"The work of the past summer has proved that the sandstones, shales, &c., with which the coal is associated really underlie but limited portions of the whole area covered by the Tertiary rocks, and appear to have been deposited in isolated basins, a fact scarcely realized before. This renders the thorough examination, by boring or otherwise, of the localities where either coal or lignite occurs very desirable. A further study of the region near the confluence of the Nicola and Coldwater Rivers indicates that this is one of the most promising places for coal mining which has yet been discovered in the region.

"While speaking of the Tertiary formation, it may be noted that important beds of trachyte occur in a number of places among its volcanic materials, and that in one of these, a few miles to the north-west of the head of Stump Lake, opaline silica and hyalite were found to be developed in small vesicular cavities. While nothing which can be classed as precious opal was actually observed, the locality would appear to be worthy of close examination, as the matrix is identical in character with that yielding precious opal in Hungary and elsewhere.

"The working of placer gold deposits has been in progress for many

years in a number of places scattered over this region, and though no extremely rich deposits like those of Cariboo have been discovered, a large amount of gold has been obtained in the aggregate, even without including that got along the Fraser and Thompson Rivers. Tranquille River, Cherry Creek, Mission Creek and the Similkameen River have been almost or quite continuously worked since their first discovery, either by whites or Chinese, and still continue to yield remunerative quantities of gold. The discovery of Granite Creek, a tributary of the North Similkameen or Tulameen, in 1885, with the late renewal of placer mining on a considerable scale on the Tulameen itself, seems to show that paying auriferous creeks may still remain to be found even in this comparatively well known part of the country. The area of good ground on Granite Creek was found eventually to be less considerable than at first supposed, and comparatively few claims are now being worked there, but several of the streams in this vicinity have since been worked with success. Of these Boulder Creek, a small stream running into Otter River, is at present the most important.

"The most interesting feature which has been developed in connection with mining on the upper part of the Similkameen and Tulameen and their tributaries is the occurrence everywhere of platinum in association with the gold. This association is mentioned in my report of 1877, in connection with the placers of Whipsaw Creek, where, however, both the gold and platinum are found only in fine scales. On the discovery of Granite Creek it was found that with the "coarse" or "heavy" gold obtained there, platinum of a similar character was also associated. In all about 1,400 ounces of platinum was sent out from this region in 1887. The close and constant association of the platinum with the gold renders it nearly certain that both are derived from a common source, to be found in the rocks of the immediate vicinity.

"Some attention has lately been paid to the search for lodes in the vicinity of the Tulameen, and a number of locations have been taken up, but nothing except a limited amount of preparatory work has yet been done toward their development. I may state, however, that the district appears to be worthy of attention by the prospector, as it presents very favorable indications, and the rocks often show evidence of solfataric action, being highly silicified and holding much pyrites in certain belts.

A specimen of ore collected by myself at the "Bonanza Queen" location has since been found by Mr. Hoffmann to contain 1·3 ounces of gold, and 5·1 ounces of silver, to the ton of 2,000 pounds.

"A remarkable indication of the existence somewhere in the Tulameen Basin of extremely rich ores is found in the discovery in sluice-boxes

on the river, about thirteen miles above Granite Creek, of small rolled pellets of pure silver-glance strung through with filamentous gold.

"In the vicinity of Stump Lake the principal mining developments are comprised within an area about five miles in length, with a variable breadth, running nearly north and south on the east side of the lake. A large number of mining claims have been taken up in this vicinity, and numerous prospect holes and small trial shafts have been sunk. The greatest amount of work has so far been accomplished on the property of the Nicola Mining Company, under the superintendence of Mr. W. Craib, and on the adjoining property of the Star Mining Company, under Mr. G. Henderson. A considerable amount of work has also been done on the Hepburn group of claims on the opposite side of the valley and further south than those first mentioned. Operations were temporarily suspended on the last mentioned claims at the time of my visit, but some of the richest ore, of which very satisfactory trial shipments have been made, has been obtained at this place.

"The metalliferous veins which have been found within the limited district above defined are very numerous. They vary from about ten inches to five or six feet in width and some of them have been traced for a length of several hundred feet. Though it is probable from the great number of veins which exist that no single one will be found to be continuous for a very great distance, a large supply of ore is already assured. Most of the veins run with very considerable uniformity in bearings a few degrees west of true north, or from N. 10° W. to N. 30° W. magnetic. There are, however, a few which diverge widely from this direction, and two or three which run nearly at right angles to it. The gangue is generally white quartz, and the principal metalliferous minerals present include iron and copper-pyrites, galena, blende and tetrahedrite. Assays made by Mr. Hoffmann, in the laboratory of the Survey, run from 15 to 406·5 ounces of silver, with 0 to 6 ounces of gold per ton of 2,000 lbs., according to the relative amounts of the various mineral constituents. The country-rock consists of altered volcanic materials, probably of Palæozoic age, and may be generally characterized as a diabase-porphyrite, the most characteristic material in this place being a rock of green and green-grey colour with coarse porphyritic crystals of plagioclase and pyroxene.

"On the whole, the prospects for the immediate development of an important mining district are here most encouraging. The occurrence of these ores in the green, altered volcanic rocks, which, under slightly varying forms, occupy so large an area of the southern interior of British Columbia, is a feature of peculiar interest, inasmuch as it leads to the belief that these wide-spread rocks become a metalliferous series where the other conditions are favorable. What these precise condi-

tions are, beyond the existence of fissures in which the segregation of metallic minerals has occurred, we are yet unprepared to say. Massive granite rocks occur a few miles to the west of the mineral belt of Stump Lake, and while a similar rock may underlie its surface at no great depth in the mineral belt, there is nothing to indicate that the ores partake of the nature of contact deposits.

"Another metalliferous locality to which some attention has been drawn, and which was visited during the summer, is situated near the lower part of Jamieson Creek, fifteen miles up the North Thompson. Very little work has yet been done here, though a number of claims have been recorded. The veins occur in a mass of greyish granite, which breaks through certain black micaceous schists or argillites, which form an important intercalation in the Palæozoic rocks, generally of volcanic origin, of this part of the province. The granite is highly siliceous in the vicinity of the veins, and these appear to have been produced contemporaneously with the intrusion of its granite. The gangue is quartz and it shows pyrites with a little galena, blende and tetrahedrite. Assays made by Mr. Hoffmann show from $\frac{7}{10}$ to 1 ounce of gold and $2\frac{1}{2}$ to 34 ounces of silver to the ton. Little can as yet be proved respecting the continuity of the veins in this district, and the area within which claims have been recorded is comparatively small.

The surface display of quartz is, however, considerable, and this, with the rich character of the ores, would appear to warrant some expenditure of a tentative character. The widest vein seen is from five to six feet. It may further be mentioned in this connection that fragments from similar veins were seen by us near the headwaters of Jamieson Creek.

"It is here only possible to mention some of the principal localities visited without entering into detail respecting them, and space cannot be accorded even to include mention of the numerous isolated "prospects" which have, of late, been brought to light. The mines of Cayoosh Creek and those of Rock Creek, though comprised within the area of the map first referred to, were not visited though encouraging reports have been received from both, and assays of specimens yield well in gold. At Cherry Creek also, a new company has undertaken a thorough examination of the very rich silver ore found there, but of which some difficulty has been found in following the vein. Some account is given by Dr. Selwyn, in the last summary report, of the deposits of argentiferous galena in the Selkirks, particularly near Illicillewaet. The exploration of some of these has been quietly but persistently carried on during the past summer. Work has also been in progress on the Monarch and Cornucopia claims at Mount Stephen, and prospecting operations in a number of localities on the eastern slope of the Selkirks.

"The Toad Mountain and Kootanie Lake districts have attracted much notice during the summer, and a large number of prospectors and miners have been at work there, with most encouraging results. Though I have not myself visited these localities, it appears certain that they require only to be brought within the reach of the railway to ensure a large output of argentiferous galena, some of which is of high grade. Some trial shipments have already been made, of which one of 22 tons, from the Silver King claim, sent with considerable difficulty to Butte, Montana, realized a gross amount of $6,463, chiefly in silver.

"Amongst other items bearing on mining enteprise in the province in general, may be mentioned the establishment, which is in progress under the government of British Columbia, of a test mill in Cariboo, and the erction of a smelter, with a capacity of 50 tons per diem, by the British Columbia Smelting Company (Limited) at Vancouver.

"Of the various enterprises on the coast it is impossible to give particulars here, though it may be noted that Mr. Dunsmuir has commenced work on the opening up of a portion of the Comox coal field, while renewed efforts were in progress with a view of making a thorough test of the anthracite of the Queen Charlotte Islands.

"Notwithstanding the great activity in placer gold mining in British Columbia in the years following its discovery in 1857, and particularly after the finding of the phenomenally rich placers in Cariboo, in 1860, the subsequent development of metalliferous mining in its more permanent forms has been slow. This circumstance has been due to several causes, which need not here be discussed, but one of the chief drawbacks has always been the want of proper means of transport for heavy machinery and for ores. It is therefore extremely gratifying to find that, as an immediate consequence of the building of the Canadian Pacific Railway, that part of the country in its vicinity is rapidly beginning to evince its character as a rich metalliferous district, and to justify the confidence which those best informed on the subject have always felt as to its ultimate great value. The general knowledge which we now have of the geology of the province as a whole, is such as to show that, when similar means of travel and transport shall be extended to what are still the more inaccessible districts, these also will prove to be equally rich in minerals, and particularly in the precious metals, gold and silver.

"It is true that we have even in the southern part of the province to chronicle as yet merely the inception of "quartz mining," but so much has (even already) become known, and the deposits discovered in many cases carry ores of such high grade, that I feel no hesitation in stating my belief that the district is now on the verge of an era of

mining activity of great importance. The establishment of mining centres in different parts of the country, will react on all other industries, and in particular will supply just that local demand for produce which is required by the somewhat scattered character of the agricultural lands.

"I must also add that in comparing the degree of settlement, cultivation and progress of the ranching industry in the portion of British Columbia here particularly referred to, with that of these industries at the time of my previous work in the same district eleven years since, evidence is everywhere apparent of substantial progress. I was particularly struck with the fact that, even in the higher and more secluded valleys, settlers are now taking up land, and finding that crops may be successfully grown and stock raised, where in the more easy-going early years of the province no one would have attempted either. With this particular fact of evidence, it is worth calling renewed attention to the circumstance that in the further northern parts of British Columbia, particularly in the basin of the Nechacco and its vicinity, there exist relatively extensive tracts of low cultivable land. It would appeared that the time has now almost arrived when the settlement of these may be undertaken with advantage."

Cost of season's work was about $1,950.

On the seaboard of British Columbia, Mr. Amos Bowman commenced field work in New Westminster District on the 1st of April, continuing to the end of August. The area delineated comprises a rectangle of a degree of latitude lying north of the 49th parallel, and three degrees of longitude lying eastward from the Gulf of Georgia to the cañon of the Fraser. In this region are situated the cities of Westminster and Vancouver. It includes the delta of the Fraser, and also the much larger pleistocene delta of that stream. A considerable expanse of lignite-bearing Tertiary, and also of bituminous coal bearing rocks of Cretaceous age, occur in this region, the two series presenting a system of outliers and ranges flanking the higher coast mountains of granite.

In May and June the limits of the Tertiary were traced, first south of the Fraser, commencing at Mud Bay (Semihamoo) and thence eastward to the Chilliwack River Mountains. The same rocks were then delineated (and incidentally others) on the north side of the Fraser, especially in the vicinity of Westminster and Vancouver.

Workable beds of lignite and coal, in the older as well as in the newer series of rocks, are believed to exist, and will be developed when prospecting for them by boring, or drifting to depths beyond atmos-

pheric influence, is undertaken. In the adjacent United States territory the same rocks have been more extensively prospected, and in several places, where exploited, show every indication of the prevalence and continuance of favorable coal making conditions along the whole eastern or mainland side of the Puget Sound and Fuca Strait, from the southern extremity of the former as far northward as the valley of the Fraser—in other words, on the Westminster side of the trough as well as on the opposing Vancouver Island side. The older or Cretaceous series of rocks are extensively developed in Canadian territory in the Harrison Lake district, and in the south-eastern portions of the field described.

The quantity of Tertiary coal or lignite, which may be developed by means of judicious boring operations in the vicinity of Westminster and Vancouver, can only be conjectured by the experience at Bellingham Bay, which furnished one of the earliest examples of profitable coal mining on the Pacific Coast; the basin there and its rocks being continuous, it may be fairly inferred that the coal seams are so also.

Although coal has been found in very many localities north of the international boundary-line in the Tertiary delta of the Fraser, in only two instances have attempts been made, by sinking or boring, to ascertain the thickness of the seams at depths where they would be uninfluenced by atmospheric weathering, and in both instances without adequate capital—at Coal Harbour (Vancouver) by a boring, and at Sumas Mountain by an incline. The results, so far as they go, are by no means discouraging.

The quality of this Tertiary coal is somewhat superior to that of Mount Diable in California, which has there served a most useful purpose.

The conditions now existing, which justify prospecting by boring operations, and mining lignite for local use, are its cheapness, and a local market greatly extended beyond that heretofore existing; which would enable it now to successfully compete for many purposes with coal transported from Vancouver Island.

Proximity to croppings of seams known and considered to be more or less promising, so as to test these at a distance from the surface, would be the first consideration in selecting sites suitable for boring operations. Otherwise located, a bore hole might be put down very widely astray, and might succeed only in testing a theory; but thus guided the bore could not fail to test the ground in association with the seam or seams in question to the depths explored.

The thickness of the measures desirable to be tested in the same connection will of course govern the depth of the bore in any given locality. The entire series exposed in the vicinity of Burrard Inlet is

not far from 3,000 feet in thickness. But all these beds, except some unknown, possibly underlying ones, come to the surface; those exposed nearest to the Inlet being at the bottom and those nearest to Fraser River at the top of the series. A bore near Port Moody, say at the terminus of the "North Road," would test the lower series; but could reveal nothing respecting the next overlying strata, which at that place have been removed by denudation. To test these it would be necessary to go as far up the coal ravine of the "Gravel Pit" (nearly opposite the north arm of Burrard Inlet, known also as camp No. 2, and the "Italian Camp," on the railway) as it would be possible to haul the boring machinery. The same rocks would be far below the surface at Burnaby Lake, and probably several thousand feet beneath the city of Westminster.

A very short incline, shaft or tunnel, might test the ground satisfactorily in one place, while a bore of several hundred feet might suffice at another; the choice being determined by the contract price. Sinking by shaft, necessitating pumping of water, would be undertaken only after the ground has been tested, and proved to justify that expense.

Boring for water, a question of present public interest, is quite another problem, if the water be looked for in the porous gravelly or sandy strata overlying the coal, as at Westminster. In a bore there, for an artesian well, a depth of from one to two thousand feet would have to be attained before any coal yet found could enter into consideration at all, and at such depth, even if found in that vicinity, it could not be profitably worked.

Cretaceous coal measures already referred to, lie probably too deep in the littoral district under consideration to be reached by boring, except possibly in certain localities along the south shore of Burrard Inlet, where a bore would probably go through some shore edges of the Cretaceous before reaching the underlying granite; such as opposite the valleys of the North Arm and of Pitt River, both of which may represent arms of the Cretaceous sea.

Any point between the smelting works and the terminus of the "North Road," would be suitable for a bore to search for the deep lying Cretaceous coal measures in this vicinity. That of the coal croppings on Hastings town site, half a mile west of Hastings, is as favorable as any other; and presents, in addition, the inducement of connected and interesting developments in the Tertiary series.

At Sumas Mountain, and at the Warnock-Kanaka Creek Mountain, the Tertiary coal, so far as known, lies near the botton of the series. Kanaka Creeks presents a favorable locality for test by boring in the line of the ancient valley of the Lillooet River.

Two series of coal seams come to the surface on opposite sides of the city of Vancouver. The coal measures occupy the whole of Stanley Park, and also immediately underlie the city. By means of a bore of over 400 feet put down near Granville Hotel, Vancouver, nearly twenty years ago, some lower beds of the series coming to the surface in Stanley Park have been proved to be either noncontinuous or barren. But the seams which have given Coal Harbor its name more probably escaped the investigation of the prospectors altogether, from the circumstance that the locality selected appears to have presented only strata overlying the coal. The upper coal croppings of Brewery Creek, and other localities on the south side of False Creek, do not anywhere extend to the northward of False Creek. They could be conveniently intersected by a bore on the line of the False Creek trail to Fraser River, which could be so located as to reach the coal at any desired depth below the surface.

Cost of season's exploration was $1,216.05.

Mr. R. G. McConnell, who left Ottawa on the 22nd April, 1887, and crossed from the Yukon to the Mackenzie River, where he passed the winter, as mentioned in the summary report for 1887, returned to Ottawa on the 15th of October last, and now furnishes the following statement respecting this exploration :—

" I separated from Dr. G. M. Dawson at the mouth of Dease River, on the 25th June, 1887, and commenced the descent of the Liard the next day, accompanied by two white men, John McLeod and Louis Trépanier, and a couple of Indians who had agreed to go as far as the Devil's Portage, but became frightened at the first rifle and could not be induced to go farther.

" The evil reputation of this river has not been exaggerated, and it requires careful steering and hard work to navigate it with safety. It is constantly interrupted with rapids and hemmed in by narrow cañons which render frequent portages necessary. The most dangerous part of the river is included between the Little Cañon and Hell Gate. In this distance of about one hundred miles it has a fall of over a thousand feet, and in high water is simply one long cascade.

" The two longest portages are the Portage Brulé, two miles, and the Devil's Portage, which is four miles long and passes over a steep wooded hill 1,000 feet high. At the latter portage we were obliged to abandon our wooden boat owing to its weight and the impossibility of getting it across the portage, and rig up a small sixteen feet canvas boat with which we shot the remainder of the rapids. Escaping through Hell Gate the rapids are left behind, and from that on to near its mouth the river is free from any obstacles to navigation.

"Two days after reaching smooth water I met some Hudson Bay voyageurs going to Dease River, and I took advantage of the opportunity thus afforded of sending my men back to the coast, while there was still time for them to get out the same season. After the separation I drifted down alone to Fort Liard, and obtaining there, after a short delay, a bark canoe and an Indian boatman, proceeded to Fort Simpson where I arrived on the 5th August.

"At Fort Simpson I met Mr. Cummings who had charge of the Mackenzie River district in the absence of Mr. Camsell, the chief factor, and made arrangements with him for wintering at Fort Providence, a fur trading post belonging to the Hudson Bay Company, situated on the Mackenzie River, about forty miles below Great Slave Lake. From Fort Simpson I took passage on board the Hudson Bay Company's steamer "Wrigley" to Fort Smith on Slave River, and embarking there in a bark canoe with a couple of Indians I spent the remainder of the season on Slave River, Salt River, and Hay River, and in coasting round part of the north side of Great Slave Lake, reaching Fort Providence again about the 1st October, where I was hospitably received and treated during the winter by Mr. John Reid, the officer in charge.

"Exploratory work was necessarily suspended during the greater part of the winter, but rough traverses were made at intervals to Lake Bis-tsho, Fort Rae and other places in the vicinity of Fort Providence, and while staying at the post, the work of the preceding summer was plotted, and a complete set of meteorological observations recorded.

"I left Fort Providence on the 1st of May, travelling on the ice with dogs, and reached Fort Simpson on the 6th, where I remained until the river became sufficiently free from ice to allow travelling by boat.

"The river broke up on the 13th of May, but continued full of drift ice all the month. On the 28th of May, having had a boat built at Fort Simpson in the meantime, I left that post accompanied by two Indians, and spent about a month descending and examining the valley of the Mackenzie as far as the mouth of the Peel, and in ascending the latter river to Fort McPherson. Here a delay of a few days was caused by the non-arrival at the appointed time of the Mackenzie River boat, on which I depended for some supplies. The delay was, however, utilized in making a short trip up Rat River to the mountains, and being informed that neither boats nor canoes were to be had west of the mountains, but that the one I had used on the Mackenzie might be portaged across by taking it up Rat River and down a branch of Bell River on the other side, I sent five Indians to try and take it across.

"On the 12th of July, the Mackenzie boat not having arrived, and not knowing how long it would be delayed, I decided not to lose any more time waiting for it, and started across the mountains by the summer portage, reaching Lapierre's House on the 15th. This portage is about sixty miles long, and at the summit of the range attains an elevation of 2,500 feet. The walking is difficult and wide reaches covered with *Têtes des Femmes*, alternating with soft moss-covered muskegs, are met with all the way across. It is crossed by Indians carrying a load of forty pounds, besides supplies for the trip, in four days.

"Leaving Lapierre's House on the 16th July, with an ex-employé of the Hudson's Bay Company, whom I engaged to go to the coast with me, we reached Rampart House on the 20th and Fort Yukon, at the mouth of the Porcupine, on the 24th. From this point the coast and outside communication can be reached, either by descending the river to St. Michael's, or ascending it to the head of the Lewes, nearly 1,000 miles, and crossing the coast range by the Chilkoot Pass. The former is by far the easier route, as the lower Yukon possesses a strong steady current and is free from dangerous rapids, but as it lay altogether outside of Canadian territory, I decided if possible to try and ascend the stream. To do this in a short square-sterned boat, proved, however, to be a matter of no ordinary difficulty. In many places neither tracking nor poling was possible, and progression was only attainable by clinging to the overhanging branches and pulling ourselves up foot by foot. Fortunately the men worked well and we arrived at Forty-mile Creek after a laborious trip of fifteen days. At this place, which is the head-quarters of the miners on the Yukon, I had a suitable boat built, and the ascent of the upper part of the river was made without difficulty. We left Forty-mile Creek on the 14th August, and arrived at Chilkoot Pass on the 15th September, Juneau on the 21st, and Victoria on the 1st October. The total distance travelled from the time I left the coast at Fort Wrangell until I rejoined it again at the head of Lynn Canal, was 4,200 miles, 3,200 miles by water and 1,000 miles on foot.

"The general results of the exploration have not been worked up yet, but will be given in the next report of the survey. In the meantime it may be stated that the geographical results obtained include traverses of the Liard from Dease River to the Mackenzie, of the lower part of Hay River, and of Bell River and the Porcupine from Lapierre's House to Fort Yukon, and that, over the whole route travelled, in addition to the geological work, notes were taken on soils, trees, &c., and on the general capabilities of the country with regard to agriculture.

"During the past summer from two to three hundred men were engaged in working placer deposits on the Yukon and its tributaries,

but owing to continued high water these proved much less remunerative than in the preceding years and the total yield of the district would probably not exceed $20,000. Mining and prospecting on the Yukon has heretofore been confined entirely to river diggings, and no attention has been paid to the extensive system of quartz veins and ledges, which are found all along the river from the boundary, up to White River, a distance of 150 miles, and which afford the greatest promise for the future. In the Mackenzie River valley the petroleum bearing beds were found to have a much wider distribution than expected, and although the distance from a market prevents the utilization of these at present, they will become exceedingly valuable in the future, when the supply of oil from more accessible regions is diminished or exhausted."

The total amount paid during 1887 and 1888, on account of the exploration in the Yukon and Mackenzie districts, was $7,714.08, of which sum Dr. Dawson paid in 1887, in connection with his own and Mr. McConnell's explorations, $4,426.25, the balance, $3,287.83, being Mr. McConnell's expenditure for 1887 and '88.

Mr. J. B. Tyrrell, assisted by Mr. D. B. Dowling, was engaged during the winter of 1888 in plotting and compiling the surveys of the valleys of the Assiniboine and its tributaries, and of the Duck and Riding Mountains, for the purpose of making a map of that hitherto almost unknown district. A profile map on a scale of eight miles to an inch, with 100 feet contour lines has been made, and is now in the hands of the engraver, and will be published during the present winter. It will eventually form part of a larger map of north-western Manitoba, the publication of which must now be delayed for a year on account of Mr. Tyrrell's illness during the past season.

During the season of 1887, a number of enterprising gentlemen of Manitoba sank an eight-inch bore hole on the banks of Vermilion River to a depth of 300 feet in the hope of obtaining a supply of petroleum. Mr. Tyrrell was then consulted, and they were told that they would have to bore through Cretaceous shales to at least 420 feet below the surface, below which they would in all probability shortly strike the Devonian limestones. If petroleum was to be found, as far as there was any evidence to show, it would be in the beds immediately overlying this limestone. During the past summer the bore was sunk to a depth of 743 feet, the Devonian limestone having been struck at a depth of 422 feet, two feet below the depth stated by Mr. Tyrrell. Flows of salt water are reported from the well, but no petroleum or gas.

During the summer Mr. Tyrrell was engaged in continuing the work begun in 1887 in north-western Manitoba. The shores of Lakes Manitoba, Winnipegosis and small surrounding lakes were to be examined and as much of this work as possible was accomplished. The travelling in connection with the work in the west has, up to the present, been largely accomplished with the aid of horses and carts, but this summer most of the horses having been sold, two nineteen feet Peterboro' canoes were purchased and shipped to Westbourne, where they were awaiting the party on its arrival. Mr. Tyrrell reports as follows :—

"We left Ottawa on the 7th of June and proceeded at once to Winnipeg. Here a short time was spent in obtaining necessary supplies, which were at once shipped to Westbourne, whither Mr. Dowling had gone a day or two before to have all the camping outfit got ready for the summer, and if possible to obtain men. For this latter purpose, however, it was necessary to cross the lake to St. Laurent, where two canoemen were obtained.

"On the 13th June I left Winnipeg for Portage Laprairie, where Mr. W. R. Baker, General Superintendent of the Manitoba and North-Western Railway, kindly ordered a railway velocipede to be placed at my disposal. Proceeding by train westward to Minnedosa, I there obtained the velocipede and a man, and thus accompanied examined all the cuttings on the railway between Minnedosa and Langenburg, and the material thrown out of the wells at and between the different stations.

"On this trip much useful information was collected, referring in the first place to the character, structure and mode of accumulation of the superficial deposits. The numerous small cuttings show that the surface is in part underlain by glacial till, in part by the sediment laid down in ancient lakes, and along the rivers, in places, by flood-plain deposits. In the next place the cuttings along the sides of the wide valleys of the little Saskatchewan, Bird Tail and Assiniboine Rivers show excellent sections of the underlying Cretaceous (Pierre) shales.

"On the banks of the latter river, near Millwood, these shales, which are of a dark blue-grey color, contain many, both large and small, nodules of limestone or calcareous ironstone. Some of these, when broken, are found to contain fossils, and from them an interesting collection of about twelve or fourteen different species was obtained.

"Returning to Minnedosa, I was requested by a number of gentlemen to go with them up the valley of the river, for a short distance, and examine a property, where a drift had been run into the side of the bank in the hope of finding coal. After making an examination of the bank, which consisted of dark grey Cretaceous shale, I was obliged to state that there was no indication of the presence of coal.

"Returning from Minnedosa to Westbourne, where Mr. Dowling was camped on the bank of White Mud River, we started in canoes down the stream to Totogan. From there we coasted along the west side of Lake Manitoba to Manitoba House, the shore being generally low throughout, and everywhere composed of alluvial sand and gravel.

"At Manitoba House we obtained another canoe, with an Indian, and proceeded to make an examination of the shores of the northern part of Lake Manitoba. Following the eastern side of the lake as far as the head of Fairford River, we descended this stream to St. Martin Lake.

"Sending Mr. Dowling with a patent floating log to make a survey of this lake, I set out on foot with some Indians, and travelled back from the lake to examine a deposit of gypsum which had been reported to exist in that locality. It was found to be a thick deposit of white, or in places crystalline and transparent gypsum, and to extend, apparently, in lenticular masses and bands, over very large areas. As this deposit is readily accessible it will be of great economic value in the near future, being destined to furnish Manitoba and the surrounding territories with land plaster and plaster of Paris, both of which must now be brought from Michigan, Iowa, Ontario, or more distant places. It can be quarried without difficulty, and can be readily removed by water; or if the proposed Hudson's Bay railway should be built on the east side of Lake Manitoba it will pass through this area and the quarries would then be within one hundred and fifty miles by rail from Winnipeg. Returning to Lake St. Martin, the shores and islands were examined, some of the latter being found to be composed of good, compact and generally coarse-grained granite (Laurentian).

"After having made the examination of Lake St. Martin we returned to Lake Manitoba, and examined its shores to Water Hen River, up which we proceeded to a trading post belonging to the Hudson's Bay Company.

"From here I sent Mr. Dowling on to Lake Winnipegosis to make a micrometer survey of its eastern and northern sides while I returned to Manitoba House by the west side of Manitoba Lake, making a survey with a patent log of the shores and islands as we passed along.

"Arriving at Manitoba House on Saturday evening, 21st July, I was much pleased to meet Mr. Whiteaves, palæontologist and one of the assistant directors of the Survey, who had arrived direct from Ottawa a few hours before. He had come out to join me for a few weeks for the purpose of studying the palæontology of the Silurian and Devonian rocks of Manitoba, as seen in the field.

"After obtaining an additional canoe, and necessary supplies for a month, we started northward together and examined all the principal

rock exposures around the lake, making a large collection of Devonian fossils, many of which are either new species or were now found for the first time in Manitoba. It had been our intention to examine some of the rocks in Lake Winnipeg, and for that purpose we started down the Fairford River on 10th August, but before we had reached Lake St. Martin, I was seized with an attack of typhoid fever and carried back to the mission at Fairford, where I was received with the greatest hospitality by the Rev. J. Bruce, the Episcopal missionary to the district. From Fairford I was removed to Manitoba House, and thence, by Westbourne, to the General Hospital at Winnipeg, which was reached on the 23rd August. Here I was obliged to remain for the rest of the season.

"Mr. Dowling, after he had left me at the Water Hen River on 18th July, proceeded up the east side of Lake Winnipegosis, surveying it with a compass and micrometer as far as Mossy Portage. Birch Island was also surveyed in passing. Close to this portage there is a meridian township line, which was run by Mr. Wm. Pearce, D.L.S., along the lake on the ice in the winter of 1880. From this line Mr. Dowling made a survy with a transit and micrometer of the north shore of the lake to the mouth of Overflowing River, where he connected with the termination of the survey made in a similar manner by Mr. J. L. Dufresne, D.L.S., in 1887.

"He next surveyed with compass and micrometer the Overflowing River for thirty-seven miles up from its mouth, the Armit or Red Deer River up to the lake, which was found to have an area of about a hundred square miles, and the river for twenty-two miles above the lake. He also connected the final point of Dufresne's survey of the Swan River with the chain survey of the higher part of that river made by Mr. Wm. Wagner, D.L S., in 1878, on the ice. He then made a survey of the islands in Dawson Bay. Since I was unfortunately prevented from meeting him according to arrangement, he paid especial attention to the rocks met with, and made a good collection of fossils.

"He left off work on 11th October, and reached Westbourne on the 27th of the same month, where he left his canoe. After settling all outstanding accounts he returned to Ottawa.

"Twenty-seven photographs of different points of interest round Lake Manitoba were taken during the year.

"Three horses and a buckboard were sold during the year, and there yet remains with Mr. Sinclair, at Rossburn, Manitoba, one horse, with two carts and harness, and some old saddles and pack saddles. The two Peterboro' canoes taken out in the spring are still in good order and ready for another season's work.

"Cost of season's exploration $1,923.44."

Dr. A. C. Lawson, assisted by Mr. Smith, was occupied during the early part of the year in completing his report of the southern part of the Lake of the Woods and Rainy Lake, which is now being printed and will form part of the Annual Report, Vol. III, for 1887-88. In June, on my recommendation, leave was granted to Dr. Lawson to proceed to England to attend the meeting of the International Geological Congress in London. The chief subject to be discussed at the Congress was the origin, age and character of the crystalline schists; an able paper on the subject was presented by Dr. Lawson for the consideration of the Congress, and has been printed in the report of its proceedings.

Mr. Smith continued the preparatory topographical measurements for the Hunter Island and Seine River sheet, which are in continuation of those of the Lake of the Woods and Rainy Lake, the former published with Dr. Lawson's report in 1885, and the latter now being engraved.

On this work Mr. Smith reports as follows:—

"Twelve weeks of the season were occupied in making log and compass surveys of the lakes in "Hunter's Island" and in the region north and north-east of it. As the main points of Hunter's Island had been previously fixed accurately by Mr. McAree's survey and the Minnesota township surveys, this more rapid method was deemed sufficiently accurate. The remaining four weeks of the season were employed in making a micrometer and compass survey of the Quetico Lake route from Pine Portage to the junction of the Quetico and Nameukan Rivers, tying the micrometer survey of last year, and in connecting this latter survey, at the most northerly point of Hunter's Island, with Pine Portage. Besides this, supplementary log surveys and time traverses were made in the adjacent country.

"The work involved in all about 140 miles of micrometer and compass lines, 500 miles of log and compass lines, and 60 miles of time traverses, and from points thus fixed, intermediate points and islands were determined by compass triangulation.

"The region covered extends from the provincial boundary line between the districts of Thunder Bay and Rainy River westward about 65 miles, and from the United States boundary northward about 40 miles, covering an area of about 2,600 square miles. This, with previous reliable surveys, completes the topography of the country included in the Hunter's Island sheet, and about one-fourth of that of the Seine River sheet to the north.

"This region, like all the Archæan countries of central Canada, appears rugged and hummocky, but few hills were observed over 200 feet in height above the lakes which they enclose, and soundings of the latter barely exceeded 80 feet. The numerous lakes form the most

important hydrographic feature of the country, the connecting rivers being short and broken by frequent falls or rapids.

"A very large proportion of the country has been swept by fire and few valuable timber areas are seen from the lake shores. Good farming land is of exceptional occurrence, the occasional and limited areas of drift being usually of a sandy and gravelly character.

"Nearly the whole of Hunter's Island is occupied by Laurentian gneiss and granites, with the exception of a narrow band of mica schists along the north side.

"There is also a broad band of schistose or slaty and trappean rocks containing beds of iron ore, crossing the south-eastern extremity of the island in a north-easterly direction. Dr. Lawson has not yet closely examined this band. Many mining locations have been taken up here within the last eighteen months, but no work has been done further than cutting out portages to facilitate the transport of exploratory machinery.

"To the north of Hunter's Island the gneisses are associated with mica schists, probably an eastward extension of the Coutchiching series of rocks so largely developed on Rainy Lake.

"Many of the pegmatite veins cutting the gneiss contain large crystals of beautiful white mica, which in some places may possibly be developed, of sufficient size to be of economic value."

Cost of season's work of Messrs. Lawson and Smith, $1,065.48.

Dr. R. Bell, assisted by Mr. A. E. Barlow, continued the investigation and survey commenced the previous summer (1886) between the Montreal River and the northern shores of Lake Huron, with a view to further elucidate the geological structure of the Huronian system as developed in that region, especially in connection with the copper, nickel, argentiferous galena, iron ores, gold-bearing quartz veins and other economic minerals which characterize this system, and which apparently occur at intervals in all parts of its distribution.

Dr. Bell furnishes the following summary of the work accomplished: —"I left Ottawa for the field on the 17th of July and made Sudbury, at the junction of the main line of the Canadian Pacific Railway and the Sault Ste. Marie branch, my head-quarters for the summer. Mr. Barlow and party consisting of one assistant and three canoe-men were employed most of the season in making topographical and geological surveys of a number of the lakes around Temagami Lake (which had been carefully surveyed the year before) including Cross Lake on the Temagami River. In the autumn Mr. Barlow made some geological examinations in the Township of Broder and around Lake Panache,

principally with a view to the more exact determination of the boundary between the Huronian and Laurentian systems in that direction.

"The country immediately around Sudbury, which is important on account of the gold, nickel and copper deposits now being developed there, was first examined. Then the main line of the railway was followed on foot from Mark Stay to Straight Lake; and the Sault Ste. Marie branch from Sudbury to Mississagi River, with side explorations in the township of Denison and around Algoma Mills. Onaping Lake and River, and Vermilion Lake and a part of the river of the same name were also examined.

"In 1854-56, the late Mr. Alexander Murray surveyed Wahnapitæping Lake and the Wahnapitæ River below it, as well as a chain of lakes between the former and Sturgeon River. The shores of these waters were further examined geologically by myself during the past summer. Two traverses were also made between the above lake and Vermilion River, and a track survey of about twenty miles of Wahnapitæ River, above the lake. The section of the Sturgeon River, above the part surveyed by Mr. Murray, and below the point at which I struck it in 1875, was likewise examined geologically, so that the rocks of the whole of this stream, from its source to its mouth, are now known. I next made an exploration of the southern half of Obabika Lake and part of the surrounding country, Mr. Barlow having surveyed the northern part of this sheet of water during the present season.

"A number of points requiring further investigation in connection with the geology of Temagami Lake were next attended to, and I then proceeded to Lady Evelyn Lake, which stretches the greater part of the distance between Temagami Lake and Montreal River. The track survey which I had made of this sheet of water the previous year was improved in detail, and additional facts were ascertained in regard to its geology. About seven miles west of Wendabin's house, on this lake, a mountain rises to a height of upwards of 1,100 feet above its level, and afforded some good points of view for making a rough triangulation of the region to the west of it, which has hitherto been a blank on all maps. A track survey was also made of a river from the southwest, which enters Wendabin's Bay, and of two routes between it and Nonwakaming Lake, which lies between the northern outlet of Lake Temagami and Lady Evelyn Lake.

"The work above described will enable us to complete for publication the sheet which was compiled last winter, on a scale of two miles to one inch, measuring 30 by 34 inches, and embracing Lakes Temiscaming and Temagami and a part of the Montreal River; and also one of the regular sheets, 18 by 12 inches, on the scale of four miles to one inch, belonging to the range of sheets next north of that which includes

Grand Manitoulin Island. This sheet embraces the country around Sudbury. Most of it has been surveyed into townships, and the greater number of these are now sub-divided into lots and concessions. The area which it represents is continuous with that shown on the Temagami and Temiscaming sheet.

"Geologically, these areas are occupied mostly by Huronian rocks. Whenever the boundary between the Huronian and the general Laurentian region traverses these sheets, it has been defined with sufficient accuracy. Within the outside boundaries of the Huronian, there are several detached areas of gneiss, apparently Laurentian, the limits of which were ascertained. One of these is in the townships of Denison and Creighton, and another in Snider and McKim. A gneiss area on the western side of Lake Wahnapitæping appears to be isolated as does also one on the south-west side of Lake Anima-nipissing, to the north-east of the main body of Lake Temagami. The two belts of gneiss which cross the Montreal River below the great Bend, may be connected with those to the north-east, discovered by the late Mr. McOuat, on the Blanche, but to the southward they are surrounded by Huronian strata.

"In addition to the large amount of data which was secured regarding the structure and distribution of the Huronian rocks, it is believed that the labors of the past season will throw considerable additional light on the nature and origin of these strata and the alterations which they have undergone. A large number of specimens were collected for study in the office, which, it is hoped, will develop many points of lithological interest.

"The modes of occurrence and the geological relations of the economic minerals of the districts examined were carefully studied. The metals which give most promise at present are the copper and nickel deposits which have been worked for the last three years near Sudbury.

"Early last spring the Government of Ontario having resolved to appoint a Royal Commission 'to enquire into the mineral resources of the province and the best means for their development,' did me the honor to request that I should act upon the commission, and with the approval of the Acting Minister of the Interior and of the Director of the Survey I accepted.

"Much of the data required by the Commission had already been ascertained by the Geological Survey, and my appointment resulted in greatly facilitating the enquiries of this commission, by enabling it readily to utilize whatever might be required of the vast amount of knowledge respecting the geology and the mineral resources of Ontario, acquired by the Survey during the past forty-five years, and embodied

in the Geological Survey reports and maps, which have been published during that period, and with which I was thoroughly acquainted.

"I accompanied the other commissioners only when they were in the vicinity of the district in which my work lay, except about 13 days at the close of the season. Altogether about 50 days were occupied at intervals between July and November, in the work of the Commission."

Cost of season's exploration, $1,485.00.

Mr. A. S. Cochrane's work during the summer was in continuation of that of preceding seasons, the object being to obtain the data necessary for showing the geography of the western peninsula of Ontario, as accurately as possible, on the maps which are being prepared on the scale of four miles to one inch, to illustrate the geology of that part of the country. Respecting this work, Mr. Cochrane reports as follows:—

"I went over the ground carefully and marked in the hill features, rock exposures, positions of streams, and the natural features generally. The distances between side lines and concessions, the crossings of roads and railways, &c., were all checked by odometer measurements. The railway plans on large scales (200 and 400 feet to the inch) had all been reduced in the office during the winter, and with these on hand on the ground, I was enabled to locate all other features along them with accuracy on the map. The levels of all points which could be easily indentified on the ground and fixed on the map, such as intersections of concessions and side lines, or of these with railway lines, &c., were determined by the aneroid barometer. I had with me copies of the official plans of the original Government surveys of all the townships, and it was interesting to note the changes which have been brought about by the clearing away of the primæval forests; for example, the old plans show a large amount of swamp lands in every township. Nearly the whole of these have now disappeared, and the lands which they occupied are the most fertile in the country.

"The work of the present season was confined to the area covered by the remainder of sheet 115 (of the general scheme) which had not been finished last year, and embraced part of the township of Osprey, the whole of the townships of Artemisia, Glenelg, Euphrasia and Holland and half of that of Sullivan. This completes the field work for the above sheet, and all the material is now on hand for compiling it for the engraver.

"The cost of the season's field work was $380."

Mr. A. P. Low left Ottawa in May to continue the surveys and exploration of the eastern coasts, islands and rivers of Hudson Bay, on

which work he has now been occupied for several seasons, and though no important facts relating to the geology of this vast unexplored region have yet been elicited, considerable additions have been made to our previous knowledge of its geography and general physical character. There still remain, however, areas as large as the provinces of Ontario and Quebec, of which nothing is yet known, though there is reason to believe that, in some of these, further exploration would probably result in the discovery of valuable mineral resources and much interesting geological and geographical information.

On the work of the past summer Mr. Low reports as follows:—

"I left Ottawa on the 29th of May and proceeded by the Missinabie River to Moose Factory."

"Here the boat used the previous year was stored; in it the party sailed across the foot of James Bay, and along the east coast to Fort George at the mouth of the Big River, arriving there on the 28th of June.

"Much delay was occasioned *en route* by the large quantities of ice in the bay, which, driven by the prevailing north-west winds, at times completely blocked the way.

"From Fort George the boat was sent along the coast to meet us again at Great Whale River, and the party turned inland to make a track survey up the Big River.

"This stream was followed for forty miles with but one short portage past a small chute, twenty miles from the mouth; beyond this, the river becomes very rough and flows between such steep, rocky banks that it is impossible to portage canoes past the obstructions; a portage route to the South Branch of the Bishop Roggan River was therefore followed through several of the many small lakes which occupy one-half the area of this part of the country.

"The branch was ascended to its head, and crossing the height of land, a small stream flowing into the Big River was descended to the main stream in a large lake forming a part of the main river, one hundred miles above where we had left it.

"Again, passing up stream, still greatly broken by falls and rapids, it was finally left by a north branch sixty miles above the lake. The river here is about three hundred yards wide with a current of three miles an hour; beyond this the guide said no portages occurred for a great distance, the river flowing smoothly along the surface of the interior plateau without a distinct valley.

"Following the branch through several small lakes, a short portage was made to the headwaters of the North Branch of the Bishop Roggan River. Having passed through more lakes drained by this stream, a crossing to the South Branch of the Great Whale River was effected,

descending this river the coast was again reached after a rough trip of about three hundred and fifty miles, including eighty-four portages.

"The country along the route is an exceedingly rough plateau, having an elevation of about twelve hundred feet above the sea, swampy throughout; many low, rocky hills rising above the general level, everywhere strewn with innumerable boulders, afford evidence of great ice action.

"The whole is covered with a small growth of black spruce and tamarac, while burnt portions generally support a small second growth of aspen, poplar and banksian pine, the latter becoming rare along the Whale River. On the bottom of the Big River valley were seen a few white spruce, balsam poplar and balsam spruce, of small size, seldom or never exceeding twelve inches in diameter three feet from the ground. The rock throughout is Laurentian gneiss, a pink hornblendic variety predominating.

"Arriving at the mouth of Great Whale River, on the 26th of July, the party continued its course northward in the boat to Richmond Gulf; from the east bay of which a micrometer survey was commenced, starting with a portage of two miles past a fall of two hundred and sixty feet on a small river falling into the bay.

"This stream was followed sixteen miles, and then another portage made five hundred feet from the river valley up the surrounding hills to the plateau, and a direct route was taken through small lakes for fourteen miles to Clearwater River, which was ascended to Clearwater Lake, a total distance of sixty-three miles from Richmond Gulf. The country and rocks were found to be similar to those above described, the only trees being small, stunted black spruce and tamarac growing in clumps in sheltered parts of the valleys; everywhere else the vegetation consisted of arctic mosses, low shrubs and flowering plants, the whole having a very desolate appearance.

"Owing to the cold and wet season coming on, it was decided to proceed no farther, so the return trip was commenced on the 13th of August, and Ottawa was reached by Moose Factory and Missinabie on the 4th of October.

"Total cost of exploration, $2,034.38."

Mr. E. D. Ingall was engaged during the summer in prosecuting the investigations and surveys, commenced in 1887, but then brought to a close by an accident as stated in my last summary report, for the preparation of a monograph of the phosphate deposits. Ottawa county, P. Q., was selected as the district in which the circumstances affecting the origin, mode of occurrence, and distribution of these deposits might best be studied.

Regarding the lines upon which Mr. Ingall is conducting the work, he says :—

"The Du Lièvre phosphate district has been chosen as the one in which to study the phenomena presented by these deposits, because the greatest number of mines are in active operation there, within reasonably easy reach of each other, and therefore it is there that the features brought out from time to time by their underground development can best be observed, so that not only can the surface features be studied, but the behavior in depth of the deposits can also be followed.

"The questions, also, relating to the rock formations associated with these deposits, are of great importance, and will necessarily receive attention, and an attempt will be made to work out their nature and relationships to the deposits and to each other, as well as their distribution, and thus aid further discovery. As all these points, relating both to the deposits and their associated rocks, will require very detailed and careful study to obtain the results aimed at, it has been decided to concentrate attention on a comparatively small area, comprising about 210 square miles of country, which has been so chosen as to include all the chief mines of this district.

"The elucidation of the nature and origin of these deposits, as a guide, where and how to seek for them, is of course the chief aim of such an investigation, and as this subject has already received considerable attention by many, both amongst and outside of the officers of our Survey, it is felt that only by such detailed and careful investigation can our knowledge on these points be advanced beyond the point at which previous observers have left it. It is also evident that the value of opinions and predictions as to the probable lasting qualities of these deposits, and other things of more immediate practical bearing on the future of the phosphate mining industry, must depend upon the extent to which we understand the true nature of the deposits, and it is therefore hoped that a thorough and careful investigation may advance us, at all events a few steps, towards this desirable goal; and also that when the monograph is completed, it may be found to provide in a compact form a large amount of information, which will prove not only useful to the general public, but also render available for intending investors, mining engineers, &c., such information respecting the general features of the deposits, &c., of the district, as shall materially assist them, in forming opinions as to the value of individual deposits upon which they may be called to pass judgment.

"One of the points which has been especially kept in view in the investigation is: Whether the mode of occurrence of the phosphate is such as to render the view probable, which has been advanced by many, and has tended to check enterprise, that the deposits are confined to

surface; or whether further investigation proving them to occur, either as portions of intrusive rock masses, or in connection with such, would not rather suggest a persistency in depth for which they have not been given credit by many.

"Again, the question arises as to whether all the deposits are necessarily similar in their nature, and whether some may not be filling fissures, whilst others are more of the nature above referred to.

"On these and many other matters connected with the occurrence of phosphate deposits, a certain amount of evidence has already been collected, but, in view of the number of very contradictory theories already advanced at various times, it is felt that it would be wiser to reserve any expression of opinion until the further study it is proposed to make shall give a sufficiently broad basis of fact upon which reliable conclusions may be founded, rather than to venture any premature suggestions or theories which would only be adding to the already too large stock of ill-based speculations on this subject."

In carrying on this work, Mr. Ingall has been assisted by Mr. James White, whose time has been taken up in conducting the topographical measurements necessary for the construction of a map of the area under study, on such a scale, that the details of the distribution and association of the different rocks may be delineated thereon.

Of the 210 square miles comprised, as stated, within the limits of this map, the lakes, rivers, roads, &c., over some 125 square miles have already been surveyed, leaving about 85 square miles to be done next season, when it is hoped to complete the work. These surveys have been plotted on a scale of 40 chains to the inch, and it is proposed to publish plans of special areas immediately surrounding the chief mines, on a scale of 200 feet to an inch, which will form the basis of special studies around these points. With a view to get a general idea of the geological features of the district under study, all the roads in the area, upwards of 200 miles, were travelled over and the outcrops examined. The rest of the season was taken up in commencing the special studies of the phenomena presented by the chief mining experiments, and in visiting the various mines from time to time to ascertain whether any new features had been brought out during their development. It will not be advisable to attempt to give a detailed report on the district till after another season's investigation has been completed.

Cost of season's exploration, $1,289.78.

For about two months and a half during the past summer, Mr. F. Adams continued explorations in the counties of Joliette, Berthier, Maskinongé and St. Maurice, in the province of Quebec, with a view to securing additional data for the north-west sheet of the Eastern Town-

ships map. The south-east sheet of this map was completed and published last year, and the north-east sheet is now surveyed and will be ready for publication in the spring: each of these sheets covers an area of 4500 square miles, represented on scale of 4 miles to one inch, or natural scale of $\frac{1}{253440}$. This season Mr. Adams examined an area of about 1,500 square miles, embracing a part of the Mattawin River and its tributaries, the headwaters of the River du Loup and such portions of the country to the south of these as had not already been examined. On this work Mr. Adams reports as follows:—

"All the northern portion of this district consists of Laurentian gneiss interstratified in places with thin bands of crystalline limestone. On the Cypress River, River du Milieu and on the Mattawin, to the west of the Ile de France, these gneisses dip at rather high angles to the west or south, but to the east of the Ile de France and on the headwaters of the River du Loup, they are flat or nearly so.

"In the southern portion of this district, especially in the township of Brandon, there are many intercalations of various varieties of anorthosite in the gneisses, which latter dip at rather low angles either to the east or west. All the areas of anorthosite now known to occur in the district have been examined, and mapped, and have proved to be either eruptive masses cutting through the gneisses, or masses interstratified with the latter, but probably still of eruptive origin. In the north-east corner of the district is a large mass of very coarse-grained basic red granite, which has already been mapped by Mr. McConnell. All localities where minerals of economic importance were known to occur, especially mica deposits, were visited and examined. Several supposed occurrences of gold were also examined and specimens collected, which have not as yet been assayed. One of these veins, near St. Alphonse, which was worked several years ago and abandoned, has recently been re-opened, and is now been worked to a considerable extent. The rock consists of a band or vein of crystalline limestone about 3 feet wide, flanked on either side by quartzose grey gneiss. The latter has been assayed in Chicago and is said to be rich in gold. Samples were taken for assay. A report on the district is now being written.

"I returned from the field on 5th November.

"Cost of season's exploration, $378.79."

Dr. R. Ells, assisted by Mr. N. J. Giroux, has, during the past summer, continued and extended the re-examination of the complicated geological structure in the valley of the St. Lawrence; on the south side, from Point aux Plateau, about 40 miles above Quebec, to River du Loup, and on the north side, from the mouth of Jacques Cartier

River to the vicinity of Cape Tourmente, including also Orleans and Crane islands and the other islands in the river between these. Several hundred miles of roads in the country on the south side were surveyed, and sections were made on the Etchemin and Bécancour rivers of 30 miles each. The report of this work, giving in detail the facts observed and the conclusions arrived at, will be prepared to accompany the north-east ¼ of the Eastern Townships map, when the measurements have been plotted, the observations studied, and the numerous fossils collected have been examined. The result will be to very greatly modify the geological mapping of a large part of this region, especially that of the south shore below Quebec, as published in the Report of the Geological Survey, 1869. It has now become more than ever plain that the Lauzon and Sillery slates and sandstones are not above but below, and older than the Levis formation; and that no such divisions as are indicated on the map accompanying the report referred to can be recognized on the south shore below Quebec.

The gold districts of the Chaudière and the asbestus mines of Thetford, Coleraine, &c., were also visited, for the purpose of noting the development during the year, and ascertaining the yield from the different mines. On this subject Dr. Ells has furnished the following report, which, as being of more immediate interest and practical importance, is given in full:—

"The principal mining industries in the area examined by us are gold and asbestus. The former has been prosecuted more vigorously than in the previous year, four companies operating in the Chaudière district, viz., The Horace Sewell Co. on the DesPlantes, McArthur and Coupal at St. Francis, Capt. Richards on the Cumberland, and St. Onge Bros. on the Famine. All of these are supposed to be working in old river channels. The DesPlantes works consist of a shaft 30 feet deep, about 60 feet east of the stream and half a mile north of the bridge, near the mouth, at which spot a bed of well washed river gravel was struck, cemented by clay and resting upon altered slates and sandstone with diorites; coarse gold in good paying quantity is taken from this spot, though the high water in the river during the autumn interfered seriously with the work. At the time of my visit, but four men besides the foreman, Mr. Fenton, were employed. The bed of the DesPlantes at one time yielded a large amount of coarse gold.

"The most extensive workings in the district are now carried on at the Ruisseau Meul, a branch of the Millbrook, near St. Francis Village. A tunnel has been driven into the hill to a distance of 600 feet, in an old channel which at 400 feet was 30 feet below the adjoining bed of the brook, from which it was separated by slate reefs. The gravel of the old channel has yielded considerable coarse gold, nuggets from $5

to $15 value having been taken out during the past season. Drifting near the upper end of the tunnel is now being carried on, but much difficulty is experienced from quicksand. Neither here nor at the Des Plantes are there any appliances suitable for saving fine gold, and some changes in this respect will be necessary before satisfactory results will be obtained. From twelve to fourteen men were employed during the past season.

"Captain Richard's work on the Cumberland is yet largely exploratory, and no returns of gold taken out are to hand. Difficulty from quicksand is experienced here also in sinking shafts. No mining has been done on the Gilbert year, but on the Famine the St. Onge Bros. have driven in the east bank, about a mile above the road across the mouth, for several hundred feet in what they claim to be an old channel of that stream, and gold has been taken out in small quantity. The old workings on Slate Creek have been abandoned.

"The asbestus industry of Thetford and Coleraine continues to rapidly increase in importance. The formation of the new Bell Company of London during the past season, by which detached areas have been brought under one management, and the wonderful advance in the stock has incited fresh explorations, and several new openings have been started. Prospecting has been active during the past season, not only in Thetford and Coleraine, but in the great serpentine area of Wolfestown, and good indications of asbestus have been found at several new points. But the largest quantity and the best quality of fibre continues to be derived from the Thetford mines, though the very bad season of 1888 has reduced the output very seriously. The asbestus at these mines differ very materially from the greater part of that obtained at other points, both in Broughton on the one hand, and in Coleraine on the other. That from Coleraine and Wolfe is to a certain extent affected by a harshness and stiffness which pertains to a very considerable portion of the output, rendering the percentage of *firsts* much less than at Thetford. The fibre is also for the most part shorter, and much of it, especially near the surface, is discolored, probably from the percolation of surface waters charged with iron.

"Although large areas of serpentine exist at various points in the townships above named, a great part of them are, in so far as explorations have extended, apparently devoid of profitable veins of good asbestus; in some, short fibred veins of harsh and brittle mineral are found, but these have as yet no economic value, so that the really valuable areas are not very numerous. During the past season all the old mines were carefully examined as well as the new openings being made during the year. Among these last may be mentioned the Megantic Mine, one mile and a half from Coleraine station, first prospected in

1886, but now worked by Fenwick & Slater, of Montreal. A peculiarity of this mine, not noticed elsewhere so far, is the occurrence of considerable quantities of mica in veins with impure asbestus. The rock here is very much shattered near the surface, and the fibre is consequently discolored. Veins up to one inch and a half are found, and in the more solid portions the quality improves. The output from this place has been necessarily small, owing to the time spent in opening the mine, and the delays from bad weather; the quantity mined in four months to October 1st, being 39 tons, of which one-third may be classed as *seconds*, the rest as *thirds*. An average number of twelve men was employed.

"Near Black Lake several openings have been made along the track of the Quebec Central Railway, by Messrs. Johnston & Lomas. Only three to four men were employed, and the work was of a preparatory nature. The quantity of asbestus obtained was not stated. On lot 32, range B, Coleraine, work has been begun by Capt. Williams. At my visit in October, the average number of men employed was 15, and the output to date 29 tons, of which 4½ tons were *firsts*, the rest about equally divided between *seconds* and *thirds*.

"In this district also the Bell Company began operations on the north half of lot 28, same range, formerly the Hayden property. Very good surface indications are here visible, many small veins showing, while in the cut now going in towards the base of the hill, fibre an inch and a half to two inches long of good quality is found. The south half of these lots 28 and 27, belonging to Dr. Reid, has lately been sold to the Wertheims of Frankfort, Germany, who are putting in machinery preparatory to developing the mine. This property is the most elevated of any in the district, being not far from 600 feet above Black Lake Station. The surface indications are here very favorable, veins up to two inches and a half having been found. Prior to the sale about twelve tons were taken from this place, of which two tons were *firsts*, four *seconds*, and six *thirds*. It is now being worked by contract at $25 per ton, ready for the market. On the north side of the Poudrier Road, in lots 27, 22, 29, range A, Coleraine, several openings have been made and good indications have been obtained. At the time of my last visit, veins of asbestus up to an inch and a half were seen with a number of smaller ones. On lot 26, also, an opening in the surface of the hill disclosed small veins. These areas are separated from those of Black Lake proper by masses of white granulite and dioritic rock, a belt of which, closely associated with the serpentine, extends from the shores of Black Lake to the rear of the Thetford mines.

"In the township of Ireland, on the west side of the great serpentine area, which extends north-east from Wolfestown, King Bros. have

started two openings on lot 24, 25, range III. The elevation of these by aneroid is about 500 feet above the surface of Black Lake, which is 200 feet below Thetford station on the Quebec Central Railway. The asbestus here is found principally in two knolls about one-fourth of a mile apart, and occurs at times in a series of thin veins from one-eighth of an inch upward, as many as twenty being sometimes found in a space of six inches. Many of these veins show a selvage of whitish weathering serpentine on either side, separated by a thin vein of asbestus from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch thick. Other veins of greater size are numerous, ranging in thickness to $1\frac{3}{4}$ inches; the aspect of the rock and the veins at this place strongly resemble in many respects those on the Belmina property in Wolfestown. The surface indications in so far as visible are excellent, but the mine has not been thoroughly opened, only two months work with a small force having been spent on it.

" At Thetford, new openings have been made to the west of the Quebec Central Railway by Messrs. Ward Bros., by Mr. Johnston and by King Bros. These prove to a certain extent the serpentine area between the present workings and the Thetford River, and good indications of productive ground are found at all the locations, though the lower lying level of the ground may necessitate drainage works.

" On lot 28, range VI, Thetford, good indications are found, as also on lot 32, R. C. Coleman, but no work has been done on either of these during the past year. Further north, on lots 16, 17 and 18, in range IV, Thetford, a belt of serpentine occurs which has been opened by Dr. Reid, who reports some very good veins of asbestus. Chromic iron, also, is found in this area, but the samples seen by us seemed too poor in chrome to reach the required standard. Noses of serpentine also occur on lot 13 range V, and on range XI, Broughton, from which asbestus has been reported, but, in so far as yet learned not in such quantity as to be economically valuable. The Broughton mine was also worked during the past season; the vein, of which there appears to be only one, in places reaches a thickness of 3 inches; at others it is split up into a number of thin strings of no value. The returns from this mine, have not been received.

" The established mines in all the districts have been working during the past year, though the output has been greatly lessened by the very bad weather, especially during the autumn months. An attempt to obtain the output from each mine has been made, but has been only partially successful, several of the managers neglecting to forward the requisite information in time. Of the Thetford Mines, the output of the Bell Company mine, formerly the Boston Company, still far exceeds the others. The shipments for the season to 1st December being

1,350 tons, of which 930 tons were *firsts*, 105 tons *seconds*, and the rest waste or *thirds*. The quality of the asbestus from all the mines of this district is excellent, and the prices obtained are even higher than quoted in the report of 1886; *seconds* in some cases commanding $75 per ton and *firsts* from $80 to $110. The output from King Bros.' mine for 1888 was *firsts*, 170 tons; *seconds*, 165 tons; *thirds*, 245 tons. Average number of men employed, 32; boys, 20. The returns from the other properties are not yet in, but there has been great activity in them all, and the output has been correspondingly large. Rock drills worked by compressed air have recently been introduced at the Bell mine.

"In the Black Lake district the principal mines in operation are the Scottish-Canadian, the Anglo-Canadian and the D'Auville. Mr. Penhale, the manager of the Scottish-Canadian, states that in the eight months ending 10th November, 400 tons were shipped from that mine, of which 40 tons were *firsts*, 110 tons *seconds*, and 250 tons *thirds*, but operations were hindered by scarcity of men and bad weather, so that the new workings could not be carried on. This mine is equipped with improved machinery, air compressor, rock drills, hoisting engines and dumping skips, with a new set of appliances for crushing the rock and separating the asbestus, more particularly in regard to the lower grades, to avoid the great expense of cobbing by hand. This machine was in operation but a short time, but is claimed by the manager to be a great success. Should this be the case, and the asbestus of short fibre be easily separated, it will largely enhance the profits of the industry, since many of the dumps, most of which now cover very valuable ground, can be profitably worked over and the refuse disposed of for ballasting or other puposes, while, under the present system of hand-cobbing, the shorter veins do not warrant the expense necessary for their separation. The Anglo-Canadian mine for the six months ending 15th November produced, according to Mr. Hopper, about 210 tons, the average number of hands, including cobbers, being 30 to 35. The principal pit at the mine has been sunk to a considerable depth, and Mr. Hopper reports veins at the bottom of very superior asbestus, resembling that from Thetford, from 3 to 7 inches thick. These veins have been uncovered since my visit. The percentage of *firsts* from this mine has, according to the manager, increased from 10 to nearly 20 per cent. Openings in the face of the knoll to the west of the principal pit are now being worked, the indications here being very good. The output of the Fréchette or D'Auville mine, which lies between the two just mentioned, is given by Mr. Hopper for the season to 1st December as about 300 tons.

"The cause of the difference in quality between a great part of the

output from the Black Lake mines and those of Thetford has long been a source of enquiry to the mine owners of those places. By some it is supposed to be due to the difference in level between the two places, the works of the Scottish-Canadian Company being from 250 to 300 feet higher than those of Thetford. Yet this can hardly be taken as satisfactory, since at the Reid mine, 300 feet higher, some excellent fibre is found. A more likely reason may possibly be the driving off of the contained water in the fibre, since asbestus is a hydrous silicate of magnesia, by the action of diorites or the metamorphism proceeding from the presence of the granites, which occupy a considerable area in the Black Lake district. If the soft silky fibre is heated it changes its character at once and becomes harsh and brittle. The serpentine near the contact with the granitic veins or masses is often very considerably shattered, as though the presence of the granite had exercised a marked influence on its condition. At Thetford the granite masses in the mines are limited to small and thin dyke-like veins, which have not produced any great effect upon the asbestus. It must, however, be said that the stiff-fibred mineral is not in all cases confined to the vicinity of visible granitic masses, and other causes may in such cases have produced a similar effect.

" A map of the asbestus region has been compiled from crown lands plans and our own surveys, using the survey of the Quebec Central Railway which has been furnished us from the Department of Public Works, Quebec, as a base line. All the mines have been indicated on it, both the old and the new openings, and it is hoped it will be of use to those interested in the asbestus mining industry. It is proposed to publish it with the detailed report on the district.

" The season's work extended from 31st of May to 29th of October.

" Amount expended, $1,100.

" My assistant throughout was Mr. N. J. Giroux, C. E., P. L. S.

Professor J. W. Bailey, with Mr. McInnes, continued the survey and exploration in northern New Brunswick, and now furnishes the following statement respecting this work, from which it will be seen that only two ¼ sheet maps now remain to complete the general geological map of New Brunswick, the whole of which has been published on a uniform scale of four miles to one inch in consecutive ¼ sheets :—

" One main object of the several explorations was the obtaining of the necessary data for the completion of sheets 17 N.E. and 18 S.E. of the New Brunswick series of maps, being the last two illustrative of the geology of that province. Particulars of this work, which was chiefly carried on by Mr. McInnes, are given below.

" My own attention was more especially directed towards completing the observations, referred to in former reports, regarding the order of succession, equivalence and similar features, of the Silurian system as developed in northern New Brunswick, Quebec and Maine. With this object in view, and that the means might be had, of more directly comparing the Silurian rocks above the headwaters of the St. John River with those of the Gaspé Peninsula, the section afforded by the Metapedia Lake and River was first examined and further collections of fossils made.

" Attempts were then made to explore the somewhat prominent range of hills, forming a portion of the Notre Dame Mountains, which lie a few miles to the westward of Lake Metapedia, and which, from their altitude and comparative boldness of outline, had been regarded as probably containing Pre-Silurian strata, but these, as well as subsequent explorations by Mr. McInnes, failed to afford any evidence of the existence here of other than Silurian rocks.

" It was then proposed to make a revision of the section afforded by the Patapedia and Grand Metis Rivers (see Geology of Canada, p. 416) but the want of water when we were at work in this section prevented this being done. An exploration was, however, made of the Misguegegish, one of the chief tributaries of the Grand Metis, to within a mile or so of its source, and information was thus obtained regarding an extensive district of which but little was previously known. From the Grand Metis the northern edge of the Silurian plateau was carefully traced around, by way of Mount Commis and the Neigette River to Bois Brulé Mountain and St. Blandine near Rimouski. At several points, and especially at the last named, large and important collections of fossils were secured.

" The examination of the country lying between the Rimouski and Lake Temiscouata was then undertaken by Mr. McInnes, and my attention was next directed, in company with that gentleman, to the examination of the admirable section of the so-called Quebec group between Lake Temiscouata and Rivière du Loup, afforded by the newly made cuttings of the Temiscouata Railway. These were found to be largely through the rocks of the Sillery formation, alternating in a succession of folds with bright red and green slates, but we failed to find any fossils, though they were carefully searched for.

" Other work undertaken consisted of the exploration of the country bordering and lying between Pohenogamook Lake and Cabano Lake, of that lying between the eastern and western branches of Fish River, in northern Maine; the ascent of the Aroostook River to the Oxbow Plantations, and the examination of the country in the vicinity of Presqu'île. A visit was also made to the locality north of Frederic-

ton, in which obscure fossils had been found in rocks not previously known to contain organic remains.

" The results of these explorations will be given in detail in the report now in course of preparation.

" In addition to the work above described, the following surveys were made during the season by Mr. McInnes.

" Early in July a micrometer and paced survey was carried across the height of land south of the St. Lawrence, by way of the Quatawamkedgwick and Rimouski rivers. These two streams head quite close together; lakes at the sources of their right and left hand branches respectively are separated only by a low ridge, crossed by a portage 1,536 paces in length. Rocks of supposed Silurian age were found te extend from the Bois Brulé escarpment, nine miles back from the St. Lawrence at Rimouski, over the whole area traversed between that point and the St. John River. Grey calcareous slates, generally banded with more highly calcareous layers, are repeated again and again in a series of folds running roughly at right angles to the general course of the rivers followed. Hard siliceous sandstone, forming the crests of anticlinal folds along the main Rimouski River, seem to be the lowest members of this series. At one point just north of the Provincial boundary line, the strata were found to be fossiliferous, and a small collection was made, which will be further treated of in the extended report.

" Another traverse was made across this watershed by the Trois Pistoles, Boisbouscaché and Tuladi rivers. Here the older rocks (Cambro-Silurian) cover a much broader area; and slates and sandstones, thought to represent the Levis and Sillery formations extend southwards as far as Lac des Iles; beyond this point banded slates, similar to those along the upper part of Temiscouata Lake, were the only rocks seen.

" A survey, partly with micrometer telescope and partly paced, was made through the country lying between the St. John River and Temiscouata Lake. The route taken followed up Baker Brook to the lakes at its head, and thence by a portage of about four miles led to Long Lake which is drained by the Cabano River into Temiscouata Lake; this traverse was wholly within the Silurian area.

" During the season about 220 miles of lakes and streams were surveyed with the micrometer telescope and by pacing, and traverses were made of other streams of which surveys were alrealy available.

" The field work occupied from 28th of June to the 16th November, and the expenditure was $1,816.47."

Mr. R. Chalmers having been occupied during the early part of the year in the preparation of the report and maps relating to the work of 1887, left Ottawa on the 1st of June with instructions to continue the detailed examination and mapping of the surface deposits of southern New Brunswick, the special field of work being the area embraced in the geological ¼ sheet No. 1, N.E. Mr. A. H. Beers, of Montreal, joined Mr. Chalmers at Moncton as volunteer assistant. The work performed is summarized by Mr. Chalmers as follows :—

" Commencing in the north-eastern part of the district we proceeded to examine it south-westwardly on both sides of the Intercolonial Railway as far as Sussex, which we made our headquarters for some weeks. Thence we traversed the surrounding country in all directions and made a large number of interesting notes. On the 18th July we proceeded to St. John and engaged a man and boat with the view of exploring the lower part of the St. John River valley, including Belleisle Bay, Washadamoak and Grand Lakes, &c. This occupied our time till 11th August. Returning to Sussex, we then started to examine the country to the south and south-west as far as Hampton. On the 27th August Mr. Beers left for home. I then commenced the exploration of the elevated tract in eastern King's and southern Albert, and the country bordering the Bay of Fundy. The frequent rains of September, October and November greatly hindered field operations, however, and although a considerable portion of the district referred to was traversed, I was unable to complete the work of the season as I desired. In November I visited Nova Scotia, making some observations on the dispersion of boulders from the Cobequid Mountains, &c., which are of interest when correlated with the facts respecting boulder distribution in New Brunswick. The unfavorable weather continuing, before closing field work, I proceeded to Restigouche a day or two to examine some more deposits which have just been opened up.

" The work of the season has been, on the whole, interesting, and a number of new facts were discovered. Evidences of Post-Tertiary ice action are abundant in most places, but the courses of striæ are somewhat diverse. The higher grounds which occupy the southern part of the district, and near the Bay of Fundy, form a plateau, ice movement and drift-transportation being southward or south eastward towards the coast. In the interior along the longitudinal valleys which lie parallel to the coast, the striæ conform in a greater or less degree to these. In the north-western half of the area included in the map, where the country is low and flat not exceeding 300 to 350 feet in height, the general direction is south to south-east; while in the tract drained by the Petitcodiac River and its tributaries the ice followed the general north-eastward slope. In many places two or more sets of

striæ are recorded upon the same rock surface. The erosion from ice appears to have been slight, judging from the great masses of decomposed rock undisturbed, and from the number of unglaciated areas. In some basin-shaped valleys in the interior, the ice seems to have been motionless, or nearly so, and to have produced striæ around their borders simply by expansion.

"Decomposed rock and till constitute the great bulk of the superficial covering on hill summits and slopes, as well as on the larger part of the flat Carboniferous area. The thicker masses of till generally exhibit a rude stratification or bedding. Near St. John, lenticular masses of stratified clay occur in the till. One of these apparently occupies the bottom of a bank of till 15 to 20 feet in thickness. At Alma, well exposed sections show what have been called "upper" and "lower" till. But the two are really only one deposit, the upper part of which having undergone oxidation from exposure to the atmosphere for a long time, has assumed a yellowish or brown color. The oxidized portion seems, however, to contain less clayey material than the underlying bluish grey till. The whole deposit is made up of the débris of the underlying rocks.

"A considerable amount of data relative to lake basins, the origin of lakes, &c., were obtained. The lakes connected with the lower St. John are on the same level as its waters and are consequently tidal. All these are merely bodies of water ponded back by the narrowness of the St. John at its mouth, and by the obstruction which the tides, when at their flow, offer to the exit of its waters. Grand and Washadamoak Lakes and Belleisle Bay occupy the lower parts of the old valleys of the streams which now flow into their northern extremities. A rise of the land of 175 to 200 feet would enable the St. John to drain out its lower reaches and also these lakes.

"Several basins of extinct Post-Tertiary lakes were observed, notably Sussex Vale. Such of these as occur below the 200 feet level probably had only a brief existence. They originated as the land rose out of the sea, and before the present drainage channels had become established. As soon as the streams passing through them had sufficient time to cut down their outlets these lakes disappeared.

"Stratified gravel, sand and clay are abundant in all the valleys, more especially upon the Carboniferous rocks. The valley along which the Intercolonial Railway runs from Moncton to St. John is terraced with gravel and sand almost throughout its entire length. This valley, was, during the Post-Tertiary subsidence, a strait, and the highland tract between it and the Bay of Fundy was then an island. The terraces both in this valley and on the coast indicate a Post-Tertiary depression of the land of about 200 feet below its present level.

"Dyked salt marshes extend along the Petitcodiac valley and also skirt the coast at Little Rocher. Extensive fresh water flats occur along the St. John, forming all the islands and also wide intervals in parts of the valley. Others occur along the Kennebekasis, Petitcodiac, &c. They are nearly all under cultivation.

"Large portions of the area included in the map are still forest-clad, the northern area being entirely so. In eastern King's and Albert counties considerable tracts also are still covered by the original forest. The central and south-western parts of the district are extensively cleared.

"The agricultural character of the district is varied, depending in each locality largely upon the nature of the underlying rock. On the higher grounds near the coast the soil is stony and clayey; on the Carboniferous, gravelly and sandy, &c. The best land is in the valleys, more especially where lower Carboniferous rocks prevail, and along river banks and the margins of lakes. The country through which the Intercolonial Railway runs contains some excellent, well-cultivated farms. Sussex Vale is frequently called the garden of south-eastern New Brunswick.

"The materials of economic importance observed are infusorial earth at Pollett Lake, King's county, and Fitzgerald Lake, St. John county, referred to in previous reports. Brine springs occur near Sussex, and along Salt Springs Creek. At the former salt for dairy use has been prepared for a number of years. Clay and sand suitable for brick-making, &c., are abundant in many parts of the district.

"In November a short time was spent examining the glacial phenomena and drift deposits of the Cobequid Mountains and adjacent country in Nova Scotia by way of comparison with those of a like character in southern New Brunswick. It was found that the boulders had been transported in both directions from these mountains, *i. e.*, northward and southward. No striæ were observed, but transportation would seem to have been effected chiefly by ice, but to some extent also by the force of running water and gravitation. One fact especially noticeable is that boulders derived from the mountains become smaller and scarcer as we recede from them.

"On the 30th November I left the field for Ottawa."

Cost of session's exploration was $845.91.

Mr. H. Fletcher left Ottawa on the 5th of June for Nova Scotia to continue the work in Pictou and Colchester counties, especially in view of making the additions and alterations referred to in the summary report of last year, as being now required in the map of Pictou coal fields as

published in 1869 by Sir W. E. Logan. This work was partly accomplished during the past year, as well as the survey of the western part of Pictou county and the eastern part of Colchester, required for completion of the geological maps of these counties. Respecting this work Mr. Fletcher reports as follows:—

"Along the northern part of Pictou and Colchester counties, from Big Island, Merigomish to Brulé and Tatamagouche, there is a wide belt of rocks described in the Annual Report, Geological Survey, Vol. 11, Part P., the conglomerate at the base forming Fraser's Mountains, Greenhill, Roger's Hill, Fitzpatrick Mountain, Dalhousie Mountain, the Biorachin and other high lands on its course. This conglomerate is overlaid by a great thickness of red shales and sandstones, these by grey and greenish sandstones from which good building stone and grindstones are quarried.

"Below these strata come the measures of the Pictou coal field, the limits of which were accurately determined by Sir William Logan and Mr. Hartley in 1869. Beneath them, in the eastern part of the district, are lower Carboniferous, Devonian, Silurian and Cambro-Silurian rocks; west of the East River of Pictou, only Lower Carboniferous and Devonian; while on approaching the eastern spurs of the Cobequid Hills, Silurian, Cambro-Silurian and Pre-Cambrian (?) strata are again found.

"Six collieries are in operation in the Pictou coal field, the Vale, East River, Albion, Acadia, Intercolonial (Drummond) and Nova Scotia (Black Diamond), having an aggregate annual yield of about 400,000 tons of coal. It has been supposed that the Permian rocks lying north of this field which hold plants and erect and prostrate tree stems, also include workable coal seams, and many boreholes have been put down to test these measures. The principal of these are: two near Pictou, 667 and 400 ft. deep; one at Logan's tannery, 1,000 ft.; two at Lyon's Brook, 500 ft.; one at Hardwood Hill, 700 ft.; three on Cariboo Island, 500 ft.; one on the East River, 750 ft. Only eight small seams of coal have, however, been cut on Cariboo Island, at the mouth of the Cariboo River, on the East River below New Glasgow, near the mouth of the Middle River and elsewhere, ranging from two feet downward and resembling and perhaps equivalent to, the small seams of Merigomish Island, Little Harbor, Small's Brook and Fraser's Mountain.

"Numerous attempts have at various times been made to work the rich grey sulphides and green carbonates of copper which are found in this formation in layers with lignite, pieces of jet, barytes, calcspar and other minerals impregnating large fossil tree trunks or in concretions; but none of them have proved successful, because the ores,

though containing sometimes 40 per cent. of copper, are not in workable quantity. The best known localities where these ores occur are on the banks of the Cariboo River, eight miles from Pictou, Toney River, at Durham on the West River; Scotch Hill; in Scotsburn Brook about 400 yards above the bridge at the church; and at River John. In the lower rocks traces of copper are found at Hopewell; on the East River; and on the Middle River near the mouth of McCulloch Brook.

"From the Permian formation valuable materials for building, grindstones and millstones are derived. From the Acadia quarries at Sawmill Brooks, West River, 1,200 tons of culvert and building stone were taken in 1888 by Mr. R. E. Chambers, and from the Granton quarry 350 tons of building and monumental stone, shipped principally to Halifax, and 110 tons of grindstone sent to Boston. The quarries at Pictou and at the Four, Six and Eight Mile Brooks of the West River also produced a large quantity of stone. Limestone fit for burning is found at Cape John, Cariboo, River John, Valley and elsewhere. Gypsum of good quality occurs in the neighborhood of Valley, and in very small quantity at Cape St. John. Barytes was exported from River John and from Brookfield, and is known to occur also at other points within the region examined.

"At Brookfield an important deposit of limonite has been opened by Mr. Chambers, and 1,000 tons extracted for shipment to Londonderry Mines. Limonite is also found at upper Stewiacke, and a promising deposit of red hematite at Newton Mills. The iron ore of Bridgeville has been largely worked during the summer of 1888 for transportation to Londonderry.

"A small seam of gold occurs in rocks underlying the Carboniferous limestone and has been opened near West River station at Riversdale, Salmon River, and the North River of Onslow, but is apparently nowhere of workable size and quality.

"At Manganese mines, near Valley, a quantity of black oxide of manganese is found in irregular veins, cutting a reddish slaty rock which underlies Carboniferous limestone.

"At Pembroke, Colchester county, galena, disseminated in a large mass of Carboniferous limestone and not in a definite vein, was unsuccessfully worked before 1877. At Smithfield a large body of sulphides of lead and iron was discovered in similar limestone at its contact with the underlying slates. Assays showed 100 ounces of silver to the ton of lead, and 5 dwts. of gold to the ton of ore. The property has attracted a good deal of attention, and it seems probable that, if the ore is in sufficient quantity, it may be profitably developed. In 1884, 100 tons averaging about 40 per cent. of lead were taken out, a small smelter erected and the ore successfully roasted in calciners.

"Several brickyards lie within the area surveyed and have long been in operation. A new one, lately established at the railway station of Sylvester, on an excellent deposit of clay, is capable of supplying a large demand for bricks.

"Deposits of infusorial earth are known to occur in the bottom of some of the lakes. But as the attempt to utilize the similar deposits at Folly Lake and at St. Anne's, in Cape Breton, have not been successful, nothing has yet been done to develop them.

"Through the kindness of Mr. S. H. Poole, manager of the Acadia Company's collieries, and of Mr. Robert Simpson, manager of the Intercolonial colliery, and of Messrs. Harvey, Graham and John Sutherland, of the Nova Scotia mines, valuable plans were obtained of underground and surface surveys, and around the Pictou coal fields, and much information regarding certain parts was given by Mr. Poole, Mr. Alex. McBean, Mr. James Maxwell, Mr. Fergie, Mr. R. P. Fraser and others."

Mr. Fletcher returned to Ottawa on 22nd December. The cost of the season's exploration, including salary of assistants, was about $700.

Mr. E. R. Faribault left Ottawa on the 31st May, to continue the examination and survey of the gold-bearing rocks of the Atlantic coast in Halifax county. He reports on this work as follows:—

"The district surveyed lies westward of that surveyed in 1887. It comprises the country watered by the two Little West rivers of Sheet Harbor and the Mushaboon, Tangier and Sheet Harbour rivers, an area of some 360 square miles.

"The sharp east and west folds into which these rocks were plicated to the eastward are found here again to continue their course is a westerly (magnetic) direction. They were traced with all possible accuracy, and the relation of the auriferous belts to the anticlinals has been carefully studied.

"The result of the work cannot yet be given in detail; but it may be safely stated in the interest of the mining community, that auriferous belts in Nova Scotia should be looked for only on or near to the anticlinal folds, and more especially on sharp ones. Hence the importance of accurately tracing and mapping these anticlinals to guide the prospector in the discovery of new auriferous belts, and thus prevent, if possible, the expenditure of thousands of dollars annually wasted in prospecting non-auriferous belts, because a few "sights" of gold, probably drifted from a distance, have been found in the vicinity. This consideration led me to devote two weeks last season in re-examining

the interior of the country, which is watered by the Sheet Harbour rivers, with the view of tracing out more accurately and studying more closely the various anticlinals affecting the strata.

"Four gold mining districts are now being worked in the region surveyed and examined: Tangier, Mooseland, Moose River and Caribou. In every one of these the auriferous leads are worked on each side of the anticlinal axes, and in no case are they more than 400 feet from them."

The country underlaid by these rocks and extending from Cape Canso to longitude 62° 19', has been mapped on the scale of one mile to an inch, and is now waiting publication. This map covers eight sheets of 12 by 18 inches, and three more will be ready by next spring.

Mr. Faribault was assisted during the whole season by Messrs. John McMillan and A. Cameron, and part of the season by Messrs. A. P. Faribault and Jas. McG. Cruikshank.

Field work continued to the 1st of October, and the expenditure in connection with it amounted to $1.025.

MINERAL STATISTICS.

Mr. Coste was engaged during the winter and the spring, assisted by Mr. Brumell, in preparing the report on the mining and mineral statistics of Canada for 1887. About 3,000 printed forms for returns of mineral production had been distributed, and later, about 3,000 letters were sent urging the transmission of the returns and seeking further information. Shortly after the close of the year, 1,500 returns and replies to letters had been received, and the full report was printed and issued in September last, and will form Part S. of Vol. III, Annual Report, 1887-88.

At intervals during the summer, Mr. Coste or Mr. Brumell visited a number of localities in Ontario and Quebec, with a view to investigate the occurrence of natural gas and petroleum in those provinces, especially in the formations that underlie the Devonian. In reference to natural gas Mr. Coste states as follows:—"A number of localities where natural gas had been reported were examined, and where possible the gas flow was measured and the logs of the borings and specimens of the drillings were obtained. Respecting wells bored several years ago, it was impossible to obtain any reliable information, and the loss of all such valuable data is very much to be regretted. The result of our investigation is that none of the wells yet bored in Ontario and Quebec produce more than 50,000 cubic feet of gas per diem, and very few even this much. The production of these wells, though small as compared with those of the United States gas region, are nevertheless of some value when in or near towns or villages."

"There seems no reason why further trials, especially in that part of Ontario between Lake St. Clair on the south-west and Lake Simcoe on the north-east, should not prove more successful, and yield as abundant a supply of gas or petroleum as do some of the Ohio wells."

In reference to petroleum, Mr. Coste states that no new oil wells of value have been bored, and that the entire production, 594,273 barrels in 1887, is confined to the county of Lambton and produced from about 2,700 wells, very few of which yield more than one barrel per diem. The average depth of the oil rock in Lambton is 490 to 500 feet from the surface.

Several wells have been bored in Essex county. One at Comber, 1,300 feet deep, is said to yield about one barrel of oil per diem. This oil is probably from the same formation as that of Findley in Ohio.

CHEMISTRY AND MINERALOGY.

The work carried out in the chemical laboratory during the past year has been entirely confined to the examination and analysis of such minerals and specimens, as were deemed likely to prove of economic value. Respecting this work Mr. Hoffmann gives the following details :

"It included :—

1. Analyses of lignitic coals.
2. Analyses of iron, copper, and manganese ores.
3. "Analyses of mineral waters—including analyses of the waters of the so-called "sulphur" and "potash" springs, Harrison Hot Springs, B. C., which were collected by Dr. Selwyn; analysis of a saline water from a boring at Otonabee, Peterborough county, Ont., and an analysis of a water from the boring at Maisonneuve, on the Island of Montreal. Of the foregoing the two first and the last mentioned, promise to prove of therapeutic value."
4. "Analyses of limestones and dolomites. A series of analyses has been commenced of such of these stones as occur in sufficiently extensive deposits—and with due regard to the accessibility of the latter—to be available for building material. On completion of the analyses of a series of the foregoing, the absorbing power (for moisture) and strength (resistance to a crushing force) of the same will also be determined. Dressed cubes of these stones are on exhibition in the Museum, showing their appearance under various "toolings" and when polished. Altogether, the information available in regard to them will be of such a nature as to very greatly facilitate the selection of a material for any special constructive work."

5. "Gold and silver assays. The greater number of the specimens examined were from British Columbia, and of these the results of assay were in a great many instances of a highly encouraging nature."

6. "Miscellaneous examinations embracing the testing of clays, in regard to their suitability for the manufacture of brick or pottery; the examination of pyrites with reference to its value as an ore of sulphur, and a variety of work of a like nature."

"There has been a steady increase, over former years, in the number of those seeking information in regard to minerals, as touching their identity or economic value. In most instances the desired information was communicated in the course of a personal interview; it not unfrequently happened, however, that a more than cursory examination was called for, or the estimation of a particular constituent deemed desirable, in which case the results were communicated by letter. The total number of specimens received—brought or sent—during the period in question, was seven hundred and sixty-five; and the number of letters written—for the most part in connection with same, and partaking of the nature of reports—two hundred and fifty-seven."

"Mr. F. D. Adams has (with the exception of a little over two months, when he was engaged in field work), as assistant chemist, applied himself with great diligence to the work in hand, the result of his labors being the analyses of the mineral waters aforementioned."

"Mr. R. A. A. Johnston, the junior assistant chemist, has proved himself a zealous and good worker. Apart from the gold and silver assays he has completed the analyses of numerous limestones and dolomites, besides doing a good deal of minor work."

"The work in the Mineralogical section of the Museum has progressed in a very satisfactory manner. The permanent labelling—which must by reason of additions be a more or less continuous work—has been almost completed to date. A manuscript catalogue of the scientifically arranged collection of minerals has been prepared, and will shortly be ready for printing, and considerable progress has been made in the preparation of a catalogue of the economic collection of minerals. The collection, which now numbers five thousand seven hundred and sixteen specimens, has, during the past year, been augmented by the addition of some two hundred specimens, including the following presentations:—"

Allan, W. A., Ottawa:—
Magnetite, from the township of Mulgrave, Ottawa county, Q.

Ami, H. M., of the Geological Survey, Ottawa:—
Calcite (nail-head spar) from the new quarries at Hull, Ottawa county, Q.

Colton, G. H., Pembroke, O. :—
Chlorite, from West Bay, Lake Nipissing, O.

Casey, T., East Templeton, Q. :—
Quartz and calcite, from East Templeton, Ottawa county, Q.

Craib, Wm., Nicola Milling and Mining Company, B. C. :—
Silver-ore, from the "Joshua" claim, Stump Lake, B. C.
do "Tubal" claim, do.
do "King William" claim, Stump Lake, B. C.

Egan, H. K., Ottawa. :—
Magnetite, from the township of Litchfield, Pontiac county, Q.

Gragg, Isaac G., Manager, Eastern Development Company, Lim. :—
Chalcopyrite, from the Coxheath copper mine, Cape Breton, N. S.

Henderson, G., Nicola Valley, B. C. :—
Silver ore, from the "Star" claim, Stump Lake, B. C.

Haycock, E. B., Ottawa. :—
Bog iron ore, from vicinity of Fort Natatchewan, Montreal River, district of Nipissing, O.

Kilpatrick, S. J., Kingston, O. :—
Limestone from Wolf Island quarry, Wolf Island, Frontenac county, O.

Keefer, T. A., Port Arthur, O. :—
Silver ore, "Native silver and argentite" from the Porcupine mine, Loc. 96 T, township of Gillies, district of Thunder Bay, O.
Calcite, sphalerite and quartz from the "Rabbit Mountain" mine, district of Thunder Bay, O.; and amethyst, with calcite carrying argentite. An association of calcite, quartz and fluorite, and sphalerite. Quartz with sphalerite and argentite. Galena, pyrite and sphalerite in calcite. Galena, sphalerite and native silver in calcite. Fluorite and quartz. Argentite, all from the "Beaver" mine, district of Thunder Bay, O.

Kidd, W. J., Kingston, O., per T. C. Weston :—
Concretions from beach at Kingston, O.

Murphy, W. H. Ottawa :—
Sphalerite from Calumet Island, Pontiac county, Q.

Morris, W. J., Perth, O. :—
Hematite from the township of Darling, Lanark county, O.

MacNaughton, A. G.:—
Stibnite from West Gore, Hants county, N. S.

McKay, J., per Dr. G. M. Dawson:—
Argentiferous galena, from the "Acadia" claim, McDame's Creek, South Fork, Cassiar, B. C.

Parks, A., Sebastopol, Renfrew county, O.:—
Asbestus from lot 11, range 11, of Sebastopol, O.

Poole, H. S., Stellarton, N. S.:—
Anglesite from the Big Dome mine, Arizona, U. S. A.

Primrose, H.:—
Albertite from River John, west branch, Pictou county, N. S.

Warwick, F. W., Buckingham, Ottawa county, Q.:—
Mountain cork from the "Emerald" mine, township of Buckingham, Ottawa county, Q.

"Mr. R. L. Broadbent has been engaged in the permanent labelling of the specimens, which, as already stated, is now almost completed up to date,—in readjusting the entire collection of scientifically arranged minerals, which had become necessary by reason of the addition of a great many species not previously represented, and in the maintaining of the general collection in an orderly condition. The interest he has manifested in the work, and the diligence with which he has applied himself to the same, has in no small degree facilitated the work, and conduced to the marked progress made in this section of the museum."

"In the early part of the year, Mr. C. W. Willimott was engaged in making up collections of minerals, subsequently in re-sorting and arranging the contents of some two hundred and forty drawers of material employed for this purpose and which in the aggregate amounted to about two tons in weight. A great many species were found to be entirely unrepresented and in order to make good, as far as possible, this deficiency, he spent a portion of the summer months in visiting several of the mineral localities of the provinces of Ontario and Quebec, as also the coast line between Two Islands and Cape d'Or, Minas Basin, Nova Scotia. These visits resulted in the obtaining a large amount of fresh material, amongst which were a great number of handsome specimens, more especially of zeolites, and which as representing species not already shown in the collection or as serving to replace inferior specimens of the same species contained in it, proved a most desirable acquisition. Since his return he has been occupied in unpacking, sort-

ing and arranging this material, and more recently in making up collections of minerals and rocks for educational institutions, &c. Collections of this descriptien have, in the course of the year, been forwarded to:—

	Specimens.
High School, Aylmer	115
University of St. Joseph, Memramcook	115
Christian Bros. training school, Clonmel, Ireland	115
St. John's College, Man	115
Canadian Institute, Toronto	115
J. C. Tremblay, Chicoutimi	115
Lands and Works Department, B. C	54
Royal Military College, Kingston (supplementary)	30
W. C. Van Horne, C.P.R., Montreal (supplementary)	28
Industrial School, Montreal	117
High School, Port Arthur, Ontario	117
St. François Xavier College, Antigonish, Nova Scotia	117
Bolton Institute, Bolton Centre, Q	109
Academy of Mount St. Vincent, Halifax, Nova Scotia	109
St. Hyacinthe College, St. Hyacinthe, Q. (supplementary)	15
Dr. F. A. Genth, Philadelphia, Pennsylvania, U. S. A. (in exchange)	98
	1,484

PALÆONTOLOGY AND ZOOLOGY.

In these divisions Mr. Whiteaves reports as follows: "The letterpress of the illustrated paper on the Triassic Fossils of British Columbia, referred to in the annual report of last year, has been printed and distributed, and the lithographic plates to accompany it will soon be ready. The second and concluding part of a paper entitled "Illustrations of the Fossil Fishes of the Devonian Rocks of Canada," has been written for the current volume of Transactions of the Royal Society of Canada, and is now in type. It consists of twenty pages quarto of descriptions, and is illustrated by two full page plates, and by four of double the ordinary size. The greater part of the manuscript of another illustrated report, "On some Cretaceous Fossils from British Columbia, the North-West Territory and Manitoba," has been written and it is hoped that the whole will be ready for the printer early in the spring. The part written before the 31st of December, 1888, includes descriptions of the various species obtained by Dr. Dawson at the Rink Rapids of the Lewis River in 1887, as well as of those collected by Mr. McConnell, from the Rocky Mountains, three miles north of the east end of Devil's Lake in 1886, and from the Liard River in 1887. A preliminary examination has been made

of a large collection of fossils from the Niagara formation at the north end of Lake Temiscamingue, made by Dr. R. Bell in 1887; of a series of fossils from the Devonian rocks of Lakes Manitoba and Winnipegosis, collected by Messrs. Tyrell and Dowling in 1888; of various fossils from the Cretaceous rocks of Lake Labarge, the Rocky Mountains and the Porcupine and Yukon Rivers, collected by Dr. Dawson and Mr. R. G. McConnell in 1887-88; and of some Cretaceous invertebrata from Millwood, Manitoba, obtained by Mr. J. B. Tyrrell in 1888. During the months of July and August, I was occupied in collecting fossils, with Mr. Tyrrell, from the Devonian rocks at the north end of Lake Manitoba, when, as will be seen in the list of additions to the Museum, a large number of specimens was secured. In the upper flat of the Museum, a new upright wall case has been erected, which is now filled with the larger fossils of the Trenton group, all of which are now properly labelled. Some fine fossil plants from the Carboniferous formation of the South Joggins coast, includiug a trunk of *Dadoxylon* some five feet in height, and more than a foot in diameter, have been added to the collection during the year. New upright glass cases have also been made for the reception of some remarkable mammalian remains from the Tertiary rocks of the Cypress Hills, North-West Territories, and for a series of large dicotyledonous leaves from the Laramie deposits near Calgary, both collected by Mr. Weston during the past summer.

"In the small room devoted to the exhibition of mounted specimens of Canadian mammalia and birds, the wooden shelves in the wall cases have been entirely replaced by strips of glass. A large number of duplicate or inferior specimens of Canadian birds has been removed and their places filled, either with other species or with much better specimens, and nearly the whole series has been labelled in accordance with the check-list of North American Birds published by the American Ornithologists Union. The following is an estimate of the number of specimens and species of native vertebrata exhibited in the Museum in December, 1888.

Mammalia.

99	mounted specimens of	59 species.
8	mounted heads of	8 do
4	mounted skeletons of	4 do
27	separate skulls of	17 do

Birds.

448 mounted specimens of 300 species.

Turtles.

3 mounted specimens of 2 species.

"Among the more attractive of the zoological specimens received during the year may be mentioned a skeleton of the White Porpoise or Beluga (*Delphinapterus catodon*), prepared from a specimen caught in the Lower St. Lawrence, and secured for the Museum by Dr. B. J. Harrington, of McGill University, Montreal; an albino variety of the Grey Squirrel, shot at Lundy's Lane, Ont.; and a remarkable colour variety of the Bronzed Grackle, from the vicinity of Brandon, Manitoba. A commencement has been made of a collection of the eggs of Canadian birds, and those of some rather rare or local species have been recived from Manitoba, the North-West Territory, British Columbia and Hudson's Bay and Strait. The series of recent mollusca from British Columbia, already in the Museum, has been much improved by the addition of several rare species from that province, kindly presented by the Rev. G. W. Taylor, formerly of Victoria, Vancouver Island, and some additions have been made to the collection of foreign shells. The number of official letters written during the year is 184, and throughout the months of September and October, the duties of Acting Director have been performed by the writer."

Mr. T. C. Weston reports that from the first of January to the latter part of June his time was occupied in Museum work in the palæontological and ethnological branches, and in making sections of rocks and fossils for microscopic examination. From the 28th of June to the 17th of September he was engaged in field work, in collecting fossils at various localities in the North-West Territory and at the South Joggins coast in Nova Scotia. The remainder of his time has been occupied in labelling and preparing fossils, &c., for exhibition in the Museum.

Mr. H. M. Ami has examined collections of fossils from upwards of one hundred localities in central Ontario, between Lake Simcoe and Belleville; from thirteen localities in the province of Quebec; from sixteen in New Brunswick, and from several at or in the neighborhood of Arisaig, N. S. With the view of ascertaining the exact geological horizons of the rocks from which they were collected, the species represented at each of those localities have been determined, as far as possible, and systematic lists of them have been made and placed upon record. He has written the manuscript of labels, which have since been printed, for the Cretaceous and Laramie fossils of northern Alberta described by the writer in 1887; for the Tertiary fossils of Skonun Point in the Queen Charlotte Islands; for the Laramie plants of the North-West Territory described by Sir William Dawson in 1887, and for the Cambrian fossils in the Museum, of which latter series he has re-classified and revised the nomenclature. From the duplicates in the Museum he has selected and labelled three sets of fossils, one of

which has been sent to St. Laurent College, Montreal; one to St. François College, Antigonish, N. S.; and one to the Manitoba College at Winnipeg. Some specimens of fossil sponges from the Museum have been loaned to Dr. J. G. Hinde for examination and study. From the 17th of September to the 18th of October, Mr. Ami was engaged in field work in the province of Quebec, under Dr. Ells, and succeeded in obtaining a considerable number of fossils. He has also collected a somewhat large series of fossils from the Chazy, Trenton and Utica formations around Ottawa.

The following collections have been received during the year from members of the staff:—

Dr. Selwyn:—

Three specimens of *Prasopora lycoperdon*, Vanuxem (*P. Selwyni*, Nicholson) from the Trenton Limestone of Snake Island, Georgian Bay, Ont.

Dr. G. M. Dawson:—

Skin (since mounted) of the Hoary Marmot (*Arctomys caligatus*) from the mountains at the head of the Tulameen River, and about 300 specimens of plant and insect remains from the Tertiary rocks of British Columbia.

Dr. R. Bell:—

Specimen of a fresh-water shell from the Sturgeon River and one from the Vermilion River, Ont.

Professor Macoun:—

Eighty-nine specimens of birds from the neighbourhood of Ottawa.

Dr. R. W. Ells, N. J. Giroux and H. M. Ami:—

1500 fossils from various localities on both sides of the St. Lawrence from Bécancour River to Rivière du Loup (en bas) P. Q.

R. G. McConnell:—

500 fossils from the Devonian rocks of the Mackenzie and Hay Rivers; also seventy-five fossils from the Cretaceous rocks of the Mackenzie and Porcupine Rivers, and from the Yukon and Northern Rocky Mountain regions. About one hundred specimens of fossil plants from the Bear River Miocene, Mackenzie River.

Skins of an adult male of the Long-tailed Jaeger (*Stercorarius longicaudus*) of the Long-tailed Duck (*Clangula hyemalis*), of

the Surf, and Whitewinged Scoter (*Oidemia perspicillata* and *O. Deglandi*), all from the mouth of the Bear River, Mackenzie River.

J. B. Tyrrell:—

Fossils from the Cretaceous rocks at Millwood, Man., from the Hudson River formation at Stony Mountain, Man., and at Streetsville, Ont.

Skin of Franklin's Gull (*Larus Franklini*), a young loon (*Urinator imber*), and eggs of the Black Tern (*Hydrochelidon nigra Surinamensis*).

Twenty-five specimens of recent fresh water shells from the Assiniboine River, Man.

J. B. Tyrrell and J. F. Whiteaves:—

About 500 fossils from the Palæozoic rocks at the northern end of Lake Manitoba, and a small series of the recent Unionidæ of the same lake and the Fairford River.

T. C. Weston:—

Portion of a large skull, jaws, detached teeth, vertebræ and limb bones of various mammalia (nearly 300 specimens in all) from the older Miocene of the Cypress Hills.

300 fossil shells, &c., from the Belly River Series of Milk River Ridge, N.W.T.

Sixty specimens of dicotyledonous leaves, &c., from the Laramie formation at Calgary and the Red Deer River, N.W.T.

Thirty specimens of fossil plants from the Carboniferous rocks at the South Joggins, N. S.

H. M. Ami:—

300 fossils from the Utica, Trenton and Chazy formations about Ottawa, 100 nodules from Green's Creek, and fifty fossils from Glenora, Ont.

W. McInnes:—

Forty-five fossils from the Silurian rocks of the region between Rimouski and Lake Temiscouata, P. Q., and egg of the loon (*Urinator imber*).

J. Marshall:—

One Snapping Turtle, caught near Ottawa.

D. B. Dowling:—

150 fossils from the Devonian limestone of Lake Winnipegosis.

J. M. Macoun :—

Seventeen skins of birds and seven skins of mice from the Athabasca River.

The additions to the palæontological, zoological and ethnological departments of the Museum, by presentation, exchange or purchase, are as under :—

By Presentation :

F. R. Latchford, Ottawa :—

Four specimens of *Limnæa ampla*, Mighels, from Brome Lake, P.Q.

Major A. Hamlyn Todd, Ottawa :—

Fine specimen of the Black or Silver Grey Fox (*Vulpes vulgaris*, var. *argentatus*) from the head of Lake Winnipeg A vixen three years old, in winter fur and in the flesh.

W. H. Harrington, Ottawa :—

A White-footed Mouse (*Hesperomys leucopus*) caught in Gilmour Street, Ottawa; in the flesh.

Ruggles Wright, Hull, P. Q. :—

A nearly complete skeleton of a very young seal, probably *Phoca Groenlandica*, from the Post Pliocene clay at Hull.

Captain C. Berkeley Powell, Ottawa :—

Stuffed specimen of a beaver (*Castor fiber*) which was killed at White Partridge Creek on the Petewawa River in the winter of 1885-86.

T. G. Lear, Ottawa :—

Osprey (*Pandion haliætus carolinensis*) shot on the Rideau River, in the flesh.

E. Browne, Ottawa :—

Specimen of the Hairy-tailed Mole (*Scapanus Breweri*) caught swimming in the Ottawa River between Britannia and Skead's mills; in the flesh.

E. H. Carter, Ottawa :—

Flying Squirrel (*Sciuropterus volucella*), shot at Aylmer, P.Q. : in the flesh.

J. A. Doyon, Ottawa :—

A sharp-shinned Hawk (*Accipiter velox*) shot near Ottawa; in the flesh.

Miles Spencer, Fort George, Hudson's Bay :—

Two eggs of the Willow Ptarmigan (*Lagopus lagopus*), one egg of the American Bittern (*Botaurus lentiginosus*), one of the Yellow-legs (*Totanus flavipes*), and three undetermined eggs, all from Fort George.

G. S. Cotter, Moose Factory, Hudson's Bay :—

A collection of butterflies and beetles from Moose Factory.

W. G. Kidd, Kingston, Ont. :—

A large trilobite (*Asaphus platycephalus*) from the Trenton limestone at the village of Wellington, Prince Edward county, Ont.

A. F. Grant, Ottawa :—

Skin of a Long-billed Curlew (*Numenius longirostris*) shot near Fort Macleod, Alberta.

Thomas Patterson, Ottawa :—

Slab of crinoidal limestone from Banff, N. W. T.

John Rutledge, Sydenham, Ont. :—

Antler of American Elk or Wapiti (*Cervus Canadensis*) ploughed up in what was once a cedar swamp, three miles from Sydenham.

Professor J. Fowler, M.A., Queen's University, Kingston, Ont. :—

An unusually perfect and well preserved specimen of *Lituites Americanus*, Emmons, from the Black River limestone of Wolfe's Island, near Kingston.

Dr. A. Jukes, Regina, N.W.T. :—

One atlas, one vertebra, three portions of jaws, four teeth and fragments of teeth and of limb-bones of various fossil mammalia from the "White River" beds of the Cypress Hills, N.W.T., also one specimen of a small *Inoceramus*.

Andrew Christie, Pincher Creek, Alberta :—

Skin of a Bushy-tailed Wood Rat (*Neotoma cinerea*) from Pincher Creek.

Albert J. Hill, New Westminster, B.C. :—

Fifteen specimens of six species of fossil shells and one calcareous annelid tube from the Post Pliocene clays on the bank of the Fraser River at New Wesminster.

Rev. G. W. Taylor, Billings' Bridge, Ont.:—

Specimens of fourteen rare species of marine shells from the coast of British Columbia, one small crab from the same coast, and numerous examples of *Anodonta Nuttalliana* Lea, from Vancouver Island.

G. E. McMartin, St. Andrews, P.Q.:—

A Saw-whet or Acadian Owl (*Nyctale Acadica*) from the Little Rouge, a tributary of the North Nation River, P.Q.; in the flesh.

Dr. T. Tunstall, Kamloops, B.C.:—

One jade scraper and two stone hammers, from Lytton, B.C.

John Murray, Spence's Bridge, Thompson River, B.C.:—

Four flint arrow heads and one small stone paint pot, from the neighborhood of Spence's Bridge.

J. W. McKay, Kamloops, B.C.:—

Three flint arrow heads and four chipped flints, from Kamloops.

D. Armit, Manitoba House, Kinosota, Man.:—

Guard of a Belemnite, from Cretaceous rocks on the east bank of the Assiniboine, a little below the mouth of the Little Souris River; do., from rocks of similar age at Ochre River, Riding Mountain, Man., and a flint arrow head from Fort Ellice, N.W.T.

Dr. J. G. Hinde, Croydon, England:—

Specimens of *Syringolites Huronensis*, Hinde, from the Niagara Limestone of the Manitoulin Islands.

John Macoun, Ottawa:—

Pair of the Chickadee (*Parus atricapillus*); do. of the Red-breasted Nuthatch (*Sitta Canadensis*), a female Goldfinch (*Spinus tristis*) and two male Pine Grosbeaks (*Pinicola enucleator*), all from the neighborhood of Ottawa; skins, which have since been mounted.

E. G. White, Ottawa:—

Specimens of the Silvery-haired Bat (*Scotophilus noctivagans*) from Ottawa, in the flesh, and an American Crow (*Corvus Americanus*), also in the flesh.

Brother Secordian, Hull, P.Q. :—

Specimen of the Brown Bat (*Scotophilus fuscus*) from Hull; in the flesh.

W. E. Saunders, London, Ont. :—

Two small trilobites (*Phacops rana*) from drifted Devonian limestone at London.

John P. Esmonde, Ottawa :—

Necklace procured from a Blood Indian at the Blood Indian Reserve, twenty-two miles south of Fort Macleod.

B. K. Lowry, Maple Creek, Assa. :—

One vertebra of a buffalo with an iron arrow head imbedded in it, and another with a leaden bullet partly buried in it, both from the Cypress Hills.

By Exchange :—

From Dr. W. H. Rush, U.S.N., Philadelphia :—

Specimens of seventeen rare specimens of marine shells from Key West, the Bahamas, Yucatan Channel, Florida Straits, &c.

By Purchase :—

Large Beaver (*Castor fiber*) from Big Lake, Pontiac county, Ont., in the flesh.

Fine specimen of an Ammonite (*Placenticeras placenta*) from the Cretaceous rocks of the St. Mary River.

Skin (since mounted) of an Albino Grey Squirrel (*Sciurus Carolinensis*) shot at Lundy's Lane, Ont.

Remarkable color variety of the Bronzed Grackle (*Quiscalus quiscalus æneus*) from the neighborhood of Brandon, Man.

Pair of Loucheux (*Kutchin*) Indian snowshoes, from Lapierre's house, Porcupine River, Yukon District, and a typical Loucheux knife.

Skeleton of the Star-nosed Mole (*Condylura cristata*) mounted by M. Jules Bailly, Montreal.

Molar of Mammoth (*Euelephas*), dug up in 1887 at St. Catharines, Ont.

One large Snapping Turtle (*Chelydra serpentina*) and a few fine stone implements of Indian manufacture, all from the county of Grey, Ont.

BOTANY, ETC.

The work in this section, under Professor Macoun, has made good progress during the year. Part IV, 248 pages R. 8vo. of the Catalogue of Canadian Plants, referred to in the summary report for 1887, as then passing through the press, was published early in the year and has since been distributed to scientific institutions and botanists in Europe and in America, and has been widely criticized in every case in the most complimentary terms.

During the first week in April, Professor Macoun made a list of all the mounted birds exhibited in the Museum, and found that there were 282 species, represented by 429 specimens. In the drawers 170 species were represented by 352 skins, 52 of which were of species not on exhibition in the cases. A list was then made out of all the birds known to Canada, which shows 564 species. This work was preliminary to that of the preparation of a complete catalogue of Canadian birds of the same character as the catalogue of plants, and Professor Macoun is now engaged on it.

Collections of plants to be examined and named were received during the year from Newfoundland, and from every province in the Dominion, except Prince Edward Island, in all over 1,500 specimens; these were all named and returned. Between January and the 15th of April there were mounted and placed in the herbarium by Mr. J. M. Macoun, 3,015 sheets of specimens, as under:—

Phænogams :—	
Canadian	850
European	775
United States	615
Cryptogams	775

During the same period there were sent to various museums, colleges and individuals 2,153 sheets of specimens, including 400 to McGill College, 300 to Columbia College, New York, 200 to the Department of Public Instruction, Quebec, and 200 to the British Museum. A large number of specimens received in exchange for those sent out, were mounted and placed in the herbarium which now contains 17,516 sheets.

Mr. J. M. Macoun left for the field on the 30th April with a Dominion land survey party. He collected plants and bird skins in the valleys of the Athabasca and Churchill rivers, returning to Ottawa on the 25th of November.

On the 18th of June, Professor Macoun left for Prince Edward Island. Twelve weeks were spent there studying its natural history and collecting specimens. Over 1,100 species of plants were secured, and valuable and interesting notes were made on the summer birds of the island. Returning on the 10th of September to Ottawa, Professor

Macoun then proceeded to Northumberland county, Ontario, where three weeks were spent collecting mosses and other material for Part V of the Catalogue of Canadian plants, the writing of which was then being commenced.

M. Pearson, of Manchester, England, has kindly given a report on the Hepaticæ—165 species—and Dr. Kindberg has examined and named nearly all the mosses, so that Professor Macoun is now in a position to complete Part V of the catalogue during the present winter.

Besides the collections of plants already mentioned, Dr. G. M. Dawson made an extensive one in the region around Kamloops, in British Columbia. Specimens of nearly 1,000 species, chiefly arctic plants, have been received from the British Museum in exchange. These are nearly all of the type species described by Sir W. Hooker in the *Flora Boreali-Americana* published in 1840. Most of the specimens were collected by Menzies, Douglas and Barclay on the Pacific Coast, by Drummond in the Rocky Mountains, and by Franklin and Richardson on the Arctic Coast.

MAPS.

There is now in course of preparation, and in various stages of readiness for publication, a large number of maps covering areas in all parts of the Dominion, amounting in the aggregate to 41,460 square miles. Some of these will require to be reduced for publication. They are as follows:—

No.	——	Scale.	Area in Sq. Mls.
1	Yukon district, N. W. T., and adjacent northern part of British Columbia	8 miles to 1 inch.	
2	Index map of above.		
3	Big River, Great Whale River, &c., east coast of Hudson's Bay	8 do 1 do	
4	British Columbia, part of southern interior	4 do 1 do	
5	North-western Manitoba, preliminary map	8 do 1 do	12,000
6	Western Ontario, Rainy River district	4 do 1 do	3,456
7	do Hunter's Island	4 do 1 do	1,450
8	Ontario, Madoc and Marmora township	½ do 1 do	105
9	do Lake Temiscaming to Lake Huron	4 do 1 do	180
10	do Preliminary map, Lakes Temagami and Temiscaming	2 do 1 do	3,828
11	do General map	4 do 1 do	
12	do sheet 115 of same	4 do 1 do	3,456
13	Quebec, N.-E. ¼ sheet (Eastern Townships map)	4 do 1 do	4,500
14	do phosphate deposits, Ottawa county	½ do 1 do	210
15,16	do and New Brunswick, ¼ sheet, 17 N.-E. and 18 S.-E	4 do 1 do	4,593
17,18	Nova Scotia, ¼ sheet, 4 N.-E. and 4 S.-E.	4 do 1 do	6,912
19,20	do parts of ¼ sheets 11 N.-W. and S.-W.	4 do 1 do	770
21	Various traverses in region of Mackenzie and Porcupine Rivers being reduced.		41,460
	Nos. 1, 2, 3 and 21, are plans of routes of exploration by land, river and lake, of a total length of about 5,900 miles.		

LIBRARY.

Dr. Thorburn reports that from 2nd January to 31st December, 1888, the total number of publications issued in connection with the Survey, including Annual Reports, parts of ditto, special reports and maps, has been 9,992. Of these, 6,567 were distributed in Canada, the remainder were sent to foreign countries, including Great Britain and Ireland, the Continent of Europe, the United States, South America, India, China, Japan, Australia, &c.

The number of reports in French distributed was 502.

There were received during the past year, as exchanges, 2,000 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets and maps. Besides these, 56 publications were purchased and 40 scientific periodicals subscribed for.

There were 150 volumes bound during the year. The number of letters received relating to library matters was 1,927. The letters sent out by the Librarian were 1,119. There are now in the library about 7,500 volumes and 2,600 pamphlets.

VISITORS.

The number of visitors to the Museum during the year, from 1st of January to the 31st December, was 17,414. being a decrease of 161 as compared with the previous year.

In my summary report for 1875, I called attention to the question of opening the Museum on Sunday afternoon, and I then gave some very remarkable statistics of attendance, the result of this course having been adopted at the Australian Museum in Sydney, showing that on the 52 Sundays, afternoons only, the daily attendance was largely in excess of that of the 313 week days, the average being 986 on Sundays and 275 on week days; such a fact needs no comment, and I venture again to express a hope, in the interests of education and knowledge, that the time is not remote when a similar experiment will be tried in Ottawa.

There will, doubtless, be strong objections urged against such action, based chiefly, if not entirely, on the very erroneous, but unfortunately very prevalent idea, that a museum is a place of amusement, whereas it is essentially as much a place of instruction as is the church and Sunday-school; and the principal difference between the two, concisely stated, is, that in the Museum the *work*, and in the church and school the *word*, of the *Creator* is expounded. This admitted, there seems no obvious or intelligible reason why the one establishment should be closed and the other opened on the Sabbath.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is 53, viz., professional 35, ordinary 17.

During the calendar year Messrs. Robert Chalmers and William McInnes were appointed as geologists to the permanent staff, and the following promotions were made:—

Professor John Macoun, from the 1st Class to Assistant Director.

Mr. Chas. W. Willimott, from the 3rd Class to 2nd Class.

The amount available for the fiscal year ended 30th June, 1888, was:—

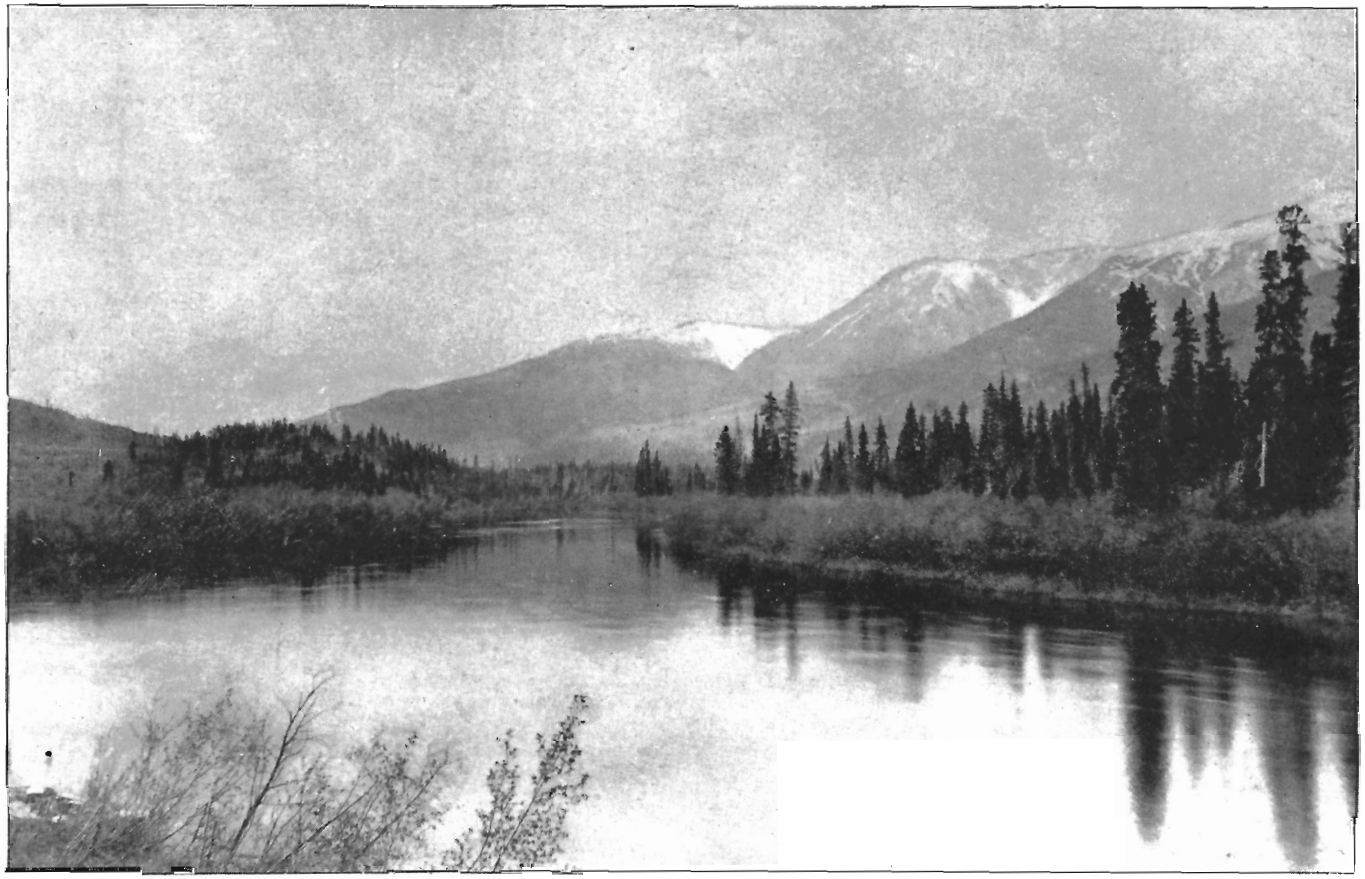
	$ cts.	$ cts.
Civil List appropriation		44,800 00
General Purpose Appropriation		57,598 43
The expenditure may be summarized under the divisions named as follows:—		
Civil List Salaries	42,478 82	
Wages of temporary employés	16,671 55	
Exploration and survey	23,255 27	
Printing and lithography	11,655 28	
Purchase of specimens	2,091 85	
Purchase and binding of books, and purchase of instruments	967 48	
Laboratory apparatus and chemicals	324 87	
Stationery, mapping materials and Queen's Printer	1,294 12	
Incidental and other expenses	1,733 12	
	100,472 36	
Less—Paid in 1887	3,930 44	
	96,541 92	
Add—Advances to field explorers	3,479 42	
	100,021 34	
Unexpended balance Civil List Appropriation	2,321 18	
do of Contingency do	55 91	
	102,398 43	102,398 43

The correspondence of the branch shows a total of 7,662 letters sent, and 6,564 received, from 1st January to 31st December, 1888.

In conclusion I may again call attention to the inadequate Museum accommodation, referred to in previous reports, in the hope that some steps will be speedily taken to obviate this difficulty, which is constantly increased by the large annual additions now being made to the collections.

To raise the roof of the building and make a wide gallery around the upper flat supported with iron pillars, would be the least costly plan, and while much improving the external appearance of the building, would afford all the accommodation needed for some time to come.

ALFRED R. C. SELWYN,
Director.



G. M DAWSON, PHOTO., JUNE 19, 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

DEASE RIVER ABOVE "FIRST LAKE," LOOKING WEST.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON AN EXPLORATION IN THE

YUKON DISTRICT, N.W.T.,

AND

ADJACENT NORTHERN PORTION OF

BRITISH COLUMBIA.

1887.

BY

GEORGE M. DAWSON, D.S., F.G.S.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S,

Director of the Geological and Natural History Survey of Canada.

SIR—I beg to present herewith a report on a portion of the Yukon District, N.W.T., and adjacent northern part of the Province of British Columbia. The exploration upon which this report is based was carried out as part of the work of the Yukon Expedition, of which I had the honour to be placed in charge. The further explorations and surveys carried out by Messrs. R. G. McConnell and W. Ogilvie will form the subject of separate reports.

It may be explained that the greater part of the present report was completed in June last, but that having been engaged in field work during the summer, it was impossible to send the manuscript to the printer at that time.

I have the honour to be, sir,

Your obedient servant,

GEORGE M. DAWSON.

OTTAWA, Dec. 1, 1888.

NOTE.—The bearings throughout this report are given with reference to the true meridian, unless otherwise specially noted.

REPORT

ON AN EXPLORATION IN THE

YUKON DISTRICT, N.W.T.,

AND

ADJACENT NORTHERN PORTION OF

BRITISH COLUMBIA.

BY

GEORGE M. DAWSON, D.S., F.G.S.,

Introductory.

The Yukon expedition, to which the present report relates, was undertaken for the purpose of gaining information on the vast and hitherto almost unknown tract of country which forms the extreme north-westerly portion of the North-west Territory. This tract is bounded to the south by the northern line of the Province of British Columbia (Lat. 60°), to the west by the eastern line of the United-States territory of Alaska, to the east by the Rocky Mountain Ranges and 136th meridian, and to the north by the Arctic Ocean. The region thus generally defined is referred to as the Yukon district, this name being rendered appropriate from the fact that the greater part of its area lies within the drainage-basin of the river of that name.

Yukon Expedition.

Yukon district.

The Yukon district, as above defined, has a total area of approximately 192,000 square miles, of which, according to the most recent information, 150,768 square miles is included in the watershed of the Yukon. The superficial extent of the district may perhaps best be realized when it is stated that it is nearly equal to that of France, greater than the United Kingdom by 71,100 square miles, ten times the area of the province of Nova Scotia, or nearly three times that of the New England States. It is unnecessary to add that the present report must be considered merely as a first contribution to our knowledge of this wide country.

Area of Yukon district.

Purpose of the Expedition.

The immediate necessity for the exploratory and surveying work undertaken by the expedition, arose from the fact that somewhat important developments of placer gold-mining had of late been attracting a yearly increasing number of miners and prospectors into a portion of the district in question; and the work decided on, included the preliminary determination of the point at which the Yukon or Pelly River crosses the 141st meridian, which here constitutes the boundary between the North-west Territory and Alaska.

Organization.

The writer was placed in general charge of the expedition, with Mr. R. G. McConnell, B.A., and Mr. J. McEvoy, B.Ap.Sc., also of the Geological Survey, as assistants, while Mr. W. Ogilvie, D.L.S., was intrusted with the conduct of instrumental measurement and the astronomical work in connection with the determination of the position of the 141st meridian.

Work by Mr. Ogilvie.

In consequence of information gained from persons having some knowledge of the region to be traversed, it was decided that Mr. Ogilvie should carry out an instrumentally measured traverse of the route from the head of Lynn Canal to the Lewes and along the line of the river to the 141st meridian, where he was to make arrangements for wintering, and in the spring and summer of 1888 continue his surveys north-eastward to the Mackenzie River and up that river to connect with previously surveyed lines on Athabasca Lake.

Work by the writer.

Having ascertained that there was a fair probability of his being able to carry a line of survey and exploration from the Cassiar district in northern British Columbia, by way of the Upper Liard and across the height of land to the Yukon basin, the writer decided on attempting that route, which, though known to be difficult, appeared to offer, in conjunction with Mr. Ogilvie's work, the best opportunity of adding to our knowledge of the country as a whole.

Work by Mr. McConnell.

Mr. McConnell was entrusted, in the first instance, with the instrumental measurement of the Stikine River, from the point to which surveys had previously been carried, as far as the head of navigation, and subsequently, with the exploration of the lower portion of the Liard River; the original intention being that he should return after reaching the Mackenzie, in the autumn of 1887, by the ordinary trade route up that river. Before we finally separated from Mr. McConnell,

Change of plan.

at the confluence of the Dease and Liard, however, so many unexpected delays had occurred, that it was considered advisable to instruct Mr. McConnell to endeavour to make arrangements for passing the winter of 1887-88 on the Mackenzie, and subsequently to descend the Mackenzie, cross the northern extremity of the Rocky Mountains to the Porcupine River, and by following that river and ascending the Lewes, to return to the Pacific Coast at Lynn Canal. This arrangement further

provided for the examination of a great additional region of which the geological structure was altogether unknown. Mr. McConnell has since successfully completed the arduous journey thus outlined. A preliminary report of his work, as far as the mouth of the Liard, is given in conjunction with that of the writer, in Part III, Annual Report of the Department of the Interior, 1887. A progress report of Mr. Ogilvie's work forms a portion of Part II of the same volume. Reports.

The present report relates exclusively to the exploration by the writer in 1887, with the following exceptions:—(1.) Mr. McConnell's traverse and geological observations on a portion of the Stikine are included in the description of that river and are incorporated on the accompanying map. (2.) The Lewes River, as laid down on the map, (with the exception of the mountain features in its vicinity and some additions to the outlines of the lakes), is from the survey of Mr. W. Ogilvie. The results of Mr. McConnell's work, carried out after his separation from us at the mouth of the Dease, will form the subject of a separate report of the Geological Survey, and Mr. Ogilvie will also prepare an independent report of his survey on his return. The present report.

In order to present within a reasonable compass the results of the portion of the work of the expedition here reported on, the daily record of progress, which the unknown character of the country traversed might otherwise appear to warrant, has been discarded, and but slight allusion is made to the modes of travel adopted and the numerous vicissitudes encountered during our journey. This, while resulting in the loss of interest which a connected narrative might possess, has distinct advantages in other respects. On account of the extent of the region treated of, the descriptive portion of the report has been divided into separate chapters, each treating of a distinct portion of our route and constituting practically a separate short report. In the pages immediately following this introduction, some general notes on the region as a whole, are given. Arrangement of matter.

Summary of Proceedings.

The following summary of our proceedings in connection with the expedition is substantially the same as that given in my preliminary report before alluded to.— Journey to the Stikine.

We left Ottawa on the 22nd of April, 1887, travelling by the Canadian Pacific Railway to Victoria, but, in consequence of irregularity in the sailing dates of the Alaskan mail steamers, were unable to reach Wrangell, at the mouth of the Stikine River, where our work may have said to have begun, till the 18th of May. Here Mr. McConnell stayed behind, for the purpose of getting Indians and canoes to enable him to make a micrometer survey of the Stikine from the end of the

line measured by Mr. J. Hunter in 1877, to Telegraph Creek, while I proceeded up the river by the first steamer of the season to Telegraph Creek, the head of navigation. From this place, goods are carried by pack animals to Dease Lake, the centre of the Cassiar mining district; and here again a delay of several days occurred, as the animals had not been brought in from their range or shod for the season's work at the date of our arrival. Finally, on June 5th, we reached the head of Dease Lake, and found the greater part of the lake still covered with ice. It was not till the 9th that we were able to reach the point on the shore near Laketon at which two men, previously sent on in advance with an Indian packer, were sawing lumber for boats. Seven days were here busily employed in this work and in constructing three boats for the purposes of the expedition. On the evening of the 16th, a strong wind having broken up the remaining barrier of ice, we reached Laketon with our boats, Mr. McConnell, with a crew of five Coast Indians intended for my work on the Upper Liard, having meanwhile joined us. On the 18th, having completed our supplies and outfit at Laketon, we left that place, and on the 23rd reached the "Lower Post" at the confluence of the Dease and Liard Rivers. Here Mr. McConnell, with one boat and two men, separated from us for the purpose of surveying and geologically examining the Lower Liard.

Journey to Dease Lake.

Building boats.

Departure from Dease Lake.

On leaving the confluence of the Dease and Liard, my own party included, besides myself, Mr. McEvoy, Messrs. L. Lewis and D. Johnson, engaged at Victoria, two Tshimsian and three Stikine (Thlinkit) Indians, all good boatmen. Two local Indians hired as guides, and to help in portaging, deserted a day or two after engaging, and from the "Lower Post" to near the confluence of the Pelly and Lewes, for an interval of more than six weeks, we met neither whites nor Indians.

Personnel of parties.

The ascent of the Liard and Frances rivers to Frances Lake proved unexpectedly difficult and tedious, the rivers being swift throughout and three bad cañons having to be passed through. Frances Lake was reached on the 8th of July, and after spending a few days in examining and mapping the lake, making the observations necessary to fix its position, and in the endeavour to find some Indian trail by which we might travel across to the Pelly, we began the work of portaging on the 17th.

Journey to Frances Lake.

As we had been unable to discover any route now in use by the Indians, and no trace whatever remained of the trail employed by the Hudson Bay Company in former years; and further, as no local Indians could be found to act as guides or to assist in carrying our stuff, it was evident that the crossing of this portage (which had been estimated by Mr. Campbell at about 70 miles in length) would be a difficult matter,

Journey overland to Pelly River.

and that we might indeed find it impossible to carry over a sufficient supply of provisions for work on the Pelly. We therefore, constructed a strong log *cache* on the shore of Frances Lake, and left there, to be taken to Dease Lake by the Indians when they returned, everything we could possibly dispense with. Had we been unable to effect the portage, there was in our *cache* a sufficient supply of provisions to enable the whole party to return to the "Lower Post." After a very toilsome journey, we were, however, so fortunate as to reach the bank of the Upper Pelly on the 29th of July, with still nearly a month's provisions for four persons, our instruments and a small camping outfit, a canvas cover from which a canoe might be constructed, and the tools and nails for building a wooden boat, should that prove to be necessary. Our Indians, who had for a long time been very uneasy because of their distance from the coast and the unknown character of the country into which they had been taken, were here paid off, and to their great delight allowed to turn back.

Descent of the Upper Pelly.

As a dangerous rapid was reported to exist on the upper part of the Pelly, it was decided to construct a canvas canoe in preference to building a boat, which it might prove impossible to portage past the rapid. Having completed the canoe, we descended the Pelly, making a portage of half a mile past Hoole Rapid or Cañon, and arrived at the confluence of the Lewes branch with the Upper Pelly on the 11th of August. We had now reached the line of route which is used by the miners, and expected to find, at the mouth of the Lewes, a prearranged memorandum from Mr. Ogilvie, from whom we had separated in May. As we could not find any such notice, and as Mr. Ogilvie had not been seen on the lower river by a party of miners whom we met here on their way up the Lewes, we were forced to conclude that he had not yet reached this point. The same party informed us that there had been few miners during the summer on the Stewart River, where most of the work had been carried on in 1886, but that in consequence of the discovery of "coarse" gold on Forty-mile Creek, over 200 miles further down the river, most of the men had gone there. We were also told that Harper's trading post, where I had hoped to be able to get an additional supply of provisions should we fail to connect with Mr. Ogilvie, had been moved from the mouth of the Stewart to Forty-mile Creek. From the place where we now were we still had a journey of nearly 400 miles to the coast, with the swift waters of the Lewes to contend against for the greater part of the distance. If therefore it should have become necessary to go down stream 200 miles to Forty-mile Creek for provisions, so much would have been added to our up-stream journey that it would become doubtful whether we should be able to afford time for geological work on

Proceedings at Mouth of Lewes.

Building our fifth boat.

the Lewes, and yet reach the coast before the smaller lakes near the mountains were frozen over. I therefore decided to set about the building of another boat, suitable for the ascent of the Lewes, and on the second day after we had begun work, Mr. Ogilvie very opportunely appeared. After having completed our boat and obtained Mr. Ogilvie's preliminary report and map-sheets, together with the necessary provisions, we began the ascent of the Lewes, from the head-waters of which we crossed the mountains by the Chilkoot Pass and reached the coast at the head of Lynn Canal on the 20th September.

Reach Lynn Canal.

Reported Indian troubles

In addition to the physical obstacles to be encountered on the long route above outlined, some anxiety was caused by reported Indian troubles on the Yukon. We heard a most circumstantial account of these from a couple of miners who followed us in to Dease Lake, the report being that the hostile Indians had retreated up the Pelly. As it was impossible either to confirm or refute these reports without practically abandoning the scheme of work, it was determined to proceed according to the original arrangement. On reaching the mouth of the Lewes we ascertained that the story was entirely false, but it had none the less kept us in a state of watchfulness during a great part of the summer.

Main Geographical Results.

Geographical data obtained.

The main geographical results of the Yukon expedition, in so far as those are covered by the present report, are best shown by the accompanying maps, which may be compared with previous maps of the same region. Mr. Ogilvie's instrumentally measured line from the head of Lynn Canal to the intersection of the Yukon or Pelly by the 141st meridian, will form a sufficiently accurate base for further surveys. In addition to this we now have an instrumental survey of the Stikine from its mouth to the head of navigation (Telegraph Creek), which is connected with Dease Lake by a carefully paced traverse. This is continued by a detailed running- or track-survey following the lines of the Dease, Upper Liard and Pelly rivers, and connecting with Mr. Ogilvie's line at the mouth of the Lewes, the total distance from the mouth of the Stikine to this point, by the route travelled being about 944 miles. Adding to this the distance from the mouth of the Lewes back to the coast at the head of Lynn Canal (377 miles), the entire distance travelled by us during the exploration amounts to 1322 miles. This, taken in connection with the coast-line between the Stikine and Lynn Canal, circumscribes an area of about 63,200 square miles, the interior of which is still, but for the accounts of a few prospectors and reports of Indians, a *terra incognita*. The same description,

Length of route traversed.

with little qualification, applies to the whole surrounding region outside the surveyed circuit, but much general information concerning the country has been obtained, which will facilitate further explorations.

Positions fixed.

Along the routes thus travelled numerous points have been carefully fixed in latitude by sextant observations, and a sufficient number of chronometer longitudes have been obtained by which to lay the whole down within small limits of error. Special attention was paid to the sketching and fixing of mountain topography in sight from the line of travel, and the approximate altitudes of a number of the more prominent peaks was ascertained.

No reference is made here to the further work carried out by Messrs. Ogilvie and McConnell in 1888, which will, as above stated, be separately reported on.

Orography and General Features.

Drainage system.

The region traversed by the routes just mentioned, including the extreme northern part of British Columbia and the southern part of the Yukon district (as previously defined), is drained by three great river systems, its waters reaching the Pacific by the Stikine, the Mackenzie, (and eventually the Arctic Ocean,) by the Liard, and Behring Sea, by the Yukon. The south-eastern part of the region is divided between the two first named rivers, whose tributary streams interlock, the Stikine making its way completely through the Coast Ranges in a south-westerly direction, while the Liard, on a north easterly bearing, cuts across the Rocky Mountains to the Mackenzie valley. The watershed separating these rivers near Dease Lake has a height of 2730 feet, and both streams may be generally characterized as very rapid.

Watershed.

To the north-westward, branches of the Stikine and Liard again interlock with the head-waters of several tributaries of the Yukon, which here unwater the entire great area enclosed on one side by the Coast Ranges, on the other by the Rocky Mountains. As the general direction of this line of watershed is transverse to that of the main orographic ridges of the country, it will probably be found, when traced in detail, to be very sinuous. The actual watershed, between the Liard and Pelly, on our line of route, was found to have an elevation of 3150 feet, but it is, no doubt, much lower in the central portion of the region between the Rocky Mountains and Coast Ranges.

To the north of the Stikine, at least one other river, the Taku, cuts like it completely across the Coast Ranges, but its basin is comparatively restricted and little is yet known of it.

Courses of Rivers.

It will be noticed, that while the several branches of the Yukon con-

form in a general way to the main orographic axes, the Stikine and Liard appear to be to a large degree independent of these, and to flow counter to the direction of three mountain ranges.

Relief of the region.

The region as a whole, being a portion of the Cordillera belt of the west coast, is naturally mountainous in general character, but it comprises as well important areas of merely hilly or gently rolling country, besides many wide, flat-bottomed river-valleys. It is, moreover, more mountainous and higher in its south-eastern part—that drained by the Stikine and Liard,—and subsides gradually, and apparently uniformly, to the north-westward; the mountains at the same time becoming more isolated and being separated by broader tracts of low land. The general base-level, or height of the main valleys, within the Coast Ranges, thus declines from about 2500 feet, to nearly 1500 feet at the confluence of the Lewes and Pelly rivers, and the average base-level of the entire region may be stated as being a little over 2000 feet.

Trend of ranges.

Disregarding minor irregularities, it is found that the trend of the main mountain ridges and ranges shows throughout the entire region here described a general parallelism to the outline of the coast. In the south-eastern and more rugged tract, the bearing of such ranges as are well defined is north-west by south-east, while beyond a line which may be drawn between the head of Lynn Canal and Frances Lake the trend gradually changes to west-north-west.

The Coast Ranges.

The Coast Ranges, with an aggregate average width of about eighty miles, the whole of which is closely set with high, rounded or rugged mountains, constitutes the most important orographic uplift in the entire region, and here reproduces geographically and geologically the features characteristic of it in the more southern portion of British Columbia. Beyond the vicinity of Lynn Canal, this mountain axis runs behind the St. Elias Alps, ceasing to be the continental border, and may be said to be entirely unknown, as any indications of mountains which have appeared on this part of the map are purely conjectural. Notwithstanding the great width of the Coast Ranges, it is not known that any of their constituent mountains attain very notable altitudes, but it is probable that a great number of the peaks exceed a height of 8000 feet. These ranges are composed of very numerous mountain ridges, which are not always uniform in direction, and, so far as has been observed, there is no single culminating or dominant range which can be traced for any considerable distance.

Rocky Mountain Ranges.

The mountain axis next in importance to that of the Coast Ranges, is that which forms the water-parting between the Upper Liard and Yukon, on one side, and the feeders of the main Mackenzie River on the other. This represents the north-western continuation of the Rocky Mountains proper. Its eastern ridges were touched on during

the present exploration in the vicinity of Frances Lake and the head waters of the Pelly River, and are there designated on the map as the Tootsho Range. This forms, so far as has been ascertained, the culminating range of a number of more or less exactly parallel ridges, and summits in it attain heights of from 7000 to 9000 feet. It has, however, been traced to a comparatively limited distance only, and it appears probable that a very complicated mountain system remains to be worked out in this portion of the region.

Cassiar Range.

A third notable mountain axis, which I have designated on the map as the Cassiar Range, is cut through by the Dease River in its upper course, and further to the north-westward appears to form the line of water-parting between the tributaries of the Upper Liard and those of the branches of the Yukon. Peaks near the Dease, in this range, exceed 7000 feet, but it is probable that none much exceed 8000 feet, and that the range in a general way becomes lower to the north-westward.

In the north-western and less elevated moiety of the region, the mountain ranges and ridges are in general lower and become discontinuous and irregular, or while retaining a general parallelism, assume an overlapping or echelon-like arrangement.

Granitic rocks.

In each of these mountain chains above described granitic rocks appear in greater or less force, as more fully noted on succeeding pages. In the intervening and subordinate mountain systems of the south-east, granitic axes are not found and do not exist as prominent features.

Orography of neighbouring regions.

Scarcely anything is known of the character of the country drained by the Macmillan, Stewart and White rivers, but it is probable that the basins of the two first-named streams closely resemble that of the Upper Pelly, which is described in following pages. Miners who have ascended the Stewart for a hundred miles or more, report the existence f a continuous range of mountains of considerable height, which runs parallel to the river on the north, from a point about fifty miles from its mouth onward. The absence of tributaries of any size along the south-west side of the Lewes below the Tahk-heena, with the general appearance of the country in that direction, so far it has been overlooked, seems to show that the basin of the upper portion of the White River must be comparatively low, and situated as it is within the St. Elias Alps, this country must possess most remarkable features, both geographically and from a climatic point of view, and well deserves exploration. It would further appear to be nearly certain that the sources of the Tanana River are to be looked for in this district, well to the east of the 141st meridian.

Effects of the glacial period.

The topographical features of the entire region here described have been considerably modified by the events of the glacial period, and the

changes produced at that time have more particularly affected the drainage-basins and the courses of the various streams. The valleys and lower tracts of country are now more or less completely filled or covered by extensive deposits of boulder-clay, gravel, sand and silt laid down during that period. To these deposits are due the flat floors of the larger valleys, and also to a great extent the appearance which the more irregular mountain regions present of being partly submerged in level or rolling plains. Many changes in direction of flow in river-valleys have doubtless also been produced during this period, though most of these yet remain to be worked out. The general result has been to produce systems of "inconsequent" drainage wherever the natural slopes of the country are easy and the limiting ranges irregular. Most of the rivers at the present day have done little more than cut out new channels in the glacial *débris*, touching only here and there upon the subjacent rocky floor.

Sources of the Yukon and Nomenclature.

Confused nomenclature.

Such particulars as have been ascertained relative to the various rivers examined in the course of the exploration, are given in a subsequent part of this report. As, however, some confusion has arisen in respect to the nomenclature of the Yukon and its tributaries, and erroneous statements have been made as to the "source" of the river, it may be appropriate here briefly to note the facts in the case in so far as I have been able to ascertain them. Further details of the early exploration of the river are given on page 136 B.

First exploration of Yukon.

The estuary of the Yukon appears to have been first explored by the Russian, Glasunoff, in 1835 to 1838, and the river was then named by the Russians the Kwikhpak, which name, according to Mr. W. H. Dall, is in reality that of one of the channels by which it issues to the sea. The lower part of the river, however, continued to be known under this name for a number of years, and it is so called on the (Russian) map of Lieut. Zagoskin, made from reconnoisance surveys which, in 1842-43, he carried up as far as Nowikakat. The mouth of the river is shown on Arrowsmith's map of 1850, but is there nameless.

Origin of the name.

The name Yukon was first applied in 1846 by Mr. J. Bell, of the Hudson Bay Company, who reached the main river by descending the Porcupine, and called it by what he understood to be its Indian appellation. The head-waters of one of the main tributaries of the Yukon had previously been attained by Mr. R. Campbell (also an officer of the Hudson Bay Company) in 1840, and in 1850 he descended the river as far as the mouth of the Porcupine, naming the whole river thus traversed the Pelly, and naming also the Lewes, White and Stewart rivers, as well

as numerous smaller tributaries. Campbell's nomenclature and his sketch of the river appear on Arrowsmith's map published in April, 1854, and Campbell practically established by his journey the identity of his Pelly River with the Kwikhpak of the Russians. The connection between the two is given by a sketch (shown in broken lines) on the map just cited, on which also the mouth of the Tanana River (under the name Mountain-men River) is shown, and other details represented with reasonable accuracy. The sketch of the river below the mouth of the Porcupine appears to have been due to the Hudson Bay Company's traders, who, before Campbell had communicated his geographical information in London (in 1853), had already met the Russian traders at the mouth of the Tanana. Much later, in 1863, I. S. Lukeen, of the Russian Trading Company, ascended the river to the Hudson Bay post, Fort Yukon, at the mouth of the Porcupine.*

Connection of Yukon and Kwikhpak.

The name Yukon does not appear at all on Arrowsmith's map of 1854, that of the Pelly standing for the whole length of the river explored by Campbell, but since that date the term Yukon has gradually become applied to the main river. The next map in order of publication in which original data are employed is, I believe, that accompanying Mr. Whymper's paper of 1868, in the Journal of the Royal Geographical Society,† which is also reproduced in his book, Travels in Alaska and on the Yukon (1869). His general map gives the name Pelly for the whole river above the mouth of the Porcupine, "Kwich-Pak or Yukon," for the lower part. In his large-scale map, on the same sheet, the river above the Porcupine is named the Yukon or Pelly. Whymper refers to the river as the "Yukon (or Pelly) as it has long been called on our maps."‡ In the United States Coast Survey map dated 1869§ the main river between the Porcupine and Lewes is definitely named the Yukon; but in the map accompanying Raymond's official report (1871) this name is again confined to the river below the Porcupine, and the statement is made in the report (p. 21) that from Lake Labarge to Fort Yukon the river is called the Lewes.

Usage on subsequent maps.

* By a singular oversight, Mr. W. H. Dall states in the first part of his work, Alaska and its Resources 1870 (p. 4), that "the identity of the Yukon [Pelly] River with the so-called Kwikhpak of the Russians" remained to be established when the explorations of the Telegraph Survey commenced on the river in 1865, while giving the credit of this achievement to Lukeen on a subsequent page (p. 277). Raymond repeats this error in his Report of a Reconnoissance of the Yukon River (1871). Mr. Dall's work above cited constitutes a veritable mine of information on the subjects of which it treats, and is frequently referred to in the sequel. Where, therefore, as in the above case, criticisms are offered, it is in no spirit of detraction.

† Vol. xxxviii.

‡ *Op. cit.*, p. 223.

§ In United States Coast Survey Report for 1867 the same nomenclature is adopted, as it is also in the map accompanying Mr. Dall's Alaska (1870), in the Ethnological map of Alaska by the same author (1875), and in most later maps. These, however, do not embody any original data for this region.

Further confusion of nomenclature.

Much later, Lieut. Schwatka, in the maps accompanying the official report of his explorations of 1883 and in other maps elsewhere published, in defiance of the fact that the name of the Lewes had a published priority of thirty years, erased it completely, extending the name Yukon so as to include under that designation the Lewes River. This extension of the name Yukon appears to be justified by Lieut. Schwatka on the ground that the Lewes is the larger branch at its confluence with the Upper Pelly. As elsewhere stated, this is no doubt true, but from what is now known of the Upper Pelly, that river is almost certainly the longer, its sources are furthest removed from the mouth of the Yukon and its course is more directly in continuation of its main direction than is the case with the Lewes. Granting, however, that the Lewes excelled in all these particulars, it would still, I believe, be unjustifiable to alter an old established name for the sole purpose of giving to a river a single name from its mouth to its source. In any case it is incorrect to state that the Yukon (Lewes) rises in Lake Lindeman, or streams flowing into it, as is done by Schwatka, for by far the greater part of the water of the river enters by the Taku arm of Tagish Lake.

With respect to the substitution of the name Yukon for that of Pelly on the portion of the river between the Porcupine and Lewes, it is simply a question of well established priority *versus* use. It is possibly a matter of small importance which shall be employed in future, but no valid excuse can be offered for the attempt to substitute any new name for that either of the Lewes or Pelly above the site of old Fort Selkirk.

True sources of the Yukon.

From the point of view of the physical geographer, and apart from the question of nomenclature, the position of the furthest source of the great Yukon River is, however, an interesting subject of enquiry; though it may yet be some years before we are in possession of sufficient information to settle this question definitely. It may be confidently assumed that this point is to be found by following up either the Pelly or the Lewes from their confluence at the site of old Fort Selkirk. As already stated, the Lewes there carries the greater volume of water, but draining as it does a considerable length of the humid Coast Ranges, which bear throughout the year great reserves of snow and numerous glaciers, it does not compare on terms of equality with the Upper Pelly, which unwaters a region relatively dry. Whether reckoned by size or distance from its mouth, the source of the Lewes must be placed at the head waters of the Hotilinqu River,* explored by Byrnes, of the Telegraph Survey, in approximate latitude 59° 10′,

* The Tes-lin-too occupies the main orographic valley above its confluence with the Lewes, but is smaller than the Lewes, and besides doubles back on its course, as is shown on the map.

longitude 132° 40′. In regard to the Pelly, it is not yet absolutely certain that the Pelly proper rises further from the common point at Fort Selkirk than its great branches, the Macmillan and the Ross rivers, but it is highly probable that it will be found to do so.

Comparison of tributaries.

With the above facts premised, we may compare the respective distances of assumed or probable sources of the Yukon as below, the distances being in each case measured in a straight line from the common point at Fort Selkirk :—

Fort Selkirk to summit of Chilkoot Pass, source according to Schwatka (position fixed)	.....	224	miles.
" " to head of Hotalinqu River of Telegraph Survey (position approximate)	.....	294	"
" " to "Pelly Banks" (position fixed)	.....	213	"
" " to head of Pelly Lakes (above "Pelly Banks," according to Campbell's sketch)	.....	276	"

The upper lake on the Pelly must be fed by a considerable stream or streams, the addition of the length of which, if known, would add considerably to the last of the above distances.

Size of the river.

I must confess to having been somewhat disappointed in the size of the Pelly or Yukon where we saw it below the confluence of the Lewes. The river is there, when undivided by islands, about 1700 feet only in width, with a maximum depth scarcely exceeding ten feet when at a stage which may be considered as its approximate mean. It appeared to me to be about equal in size and velocity to the Peace River at Dunvegan and Mr. Ogilvie, who is also familiar with the Peace, concurred in this estimate. Below this place the river, of course, receives a number of important tributaries, but at any fairly comparable point on the two rivers I believe that the Mackenzie must far exceed the Yukon in volume. Numerical data on this point are unfortunately still almost entirely wanting, but the comparison of the drainage-areas of the two rivers, according to the latest available information, strongly bears out the statement just made, that of the Yukon being 330,912 square miles as against 677,400 square miles in the case of the Mackenzie.* In other words, the drainage area of the Mackenzie is more than double that of the Yukon, while nothing is known to show that the mean annual precipitation over the two areas, as a whole, differs very greatly. Exaggerated statements which have been made, to the effect that the Yukon discharges a volume of water approaching that of the Mississippi, appear to carry their own refutation in the fact that the basin of the latter river has an area of no less than 1,226,000 square miles.

Comparison with Mackenzie River.

* Of the area drained by the Yukon, about 150,768 square miles are in Canadian, 180,144 square miles in United-States Territory.

Discharge of rivers.

Some attempt was made by us to gage the flow of several of the rivers in the Yukon basin, as more fully stated further on. The discharge of the several rivers above the site of the old Fort Selkirk may be roughly summarized as follows. The figures given in heavy type are derived from measurements more or less approximate, the others are based merely on comparisons made by eye and without any attempt to cross-section the streams. The scheme may, however, serve to give a general idea of relative dimensions. All the figures represent cubic feet per second and refer to the latter part of the summer, when the rivers may be assumed to be at their mean height. In common with all the streams of the interior region these are highest in the early summer and lowest toward the end of the winter.

Pelly River, at "Pelly Banks"	**4,898**
Ross River, at mouth	4,898
Macmillan River, at mouth	9,796*
Tes-lin-too, at mouth	**11,436**
Lewis River, above confluence with last	**18,664**
Big Salmon	**2,726**
Total thus accounted for	52,418
Pelly or Yukon at site of Fort Selkirk	**66,955**
Difference from above total, not accounted for	14,537

Upper Pelly and Lewes compared.

By adding two-thirds of the water thus not accounted for to the Pelly and one-third to the Lewes, to represent the flow of numerous smaller tributaries not enumerated, the discharge of these two rivers above Fort Selkirk will stand thus :—

Lewis	37,672
Pelly	29,283
Total as above	66,955 †

* The discharge of the Ross is taken as equal to that of the Pelly at "Pelly Banks," that of the Macmillan as equal to the combined waters of the Pelly and Ross.

† For the purpose of comparison, the following extract from a table of various rivers, contained in the General Report of the Minister of Public Works for the fifteen years from 1867 to 1882, is quoted :—

NAMES.	Area of drainage in square miles.	Length in miles.	Discharge in cubic feet per second.		
			Low Water.	Mean.	High Water.
Mississippi	1,226,000	4,400	447,200	.....	1,270,000
St. Lawrence	565,000	2,600	.....	900,000	.....
Ganges	432,000	1,680	36,300	207,000	494,200
Nile	520,200	2,240	23,100	220,000	.....
Thames	5,000	215	1,330	.....	7,900
Rhone	38,000	560	7,000	21,000	204,000
Rhine	88,000	700	13,400	33,700	164,000
Ottawa (Grenville)	80,000	700	35,000	85,000	150,000

Navigable Waters and Routes of Travel.

Navigable rivers.

The numerous large and important rivers by which the Yukon district and the adjacent northern portion of British Columbia is intersected, constitute the principal routes of travel, and during the summer months render inter-communication comparatively easy. The Stikine is navigable by stern-wheel steamers for a distance of 138 miles, as more fully stated in a subsequent part of this report, where also details respecting the connecting trail to Dease Lake are given (pp. 46 B, 64 B). This constitutes the travelled route to the Cassiar mining district. A trail was, at one time, opened from Fraser Lake overland to Dease Lake by which cattle were driven through, but of late no travel has occurred on it (p. 89 B). The Dease River can scarcely be considered as navigable for steamers, though constituting a fairly good boat route (p. 91 B). The Upper Liard and Frances rivers, above the mouth of the Dease, are also passable for large boats, with occasional portages, but not so for steamers (p. 102 B). The difficulties of the Lower Liard, however, are such as to render it an undesirable route, even for boats, and scarcely suitable as an avenue of trade between Cassiar and the Mackenzie. Numerous tributary streams in this district may also be ascended by boat or canoe for considerable distances, though with many interruptions from rapids and bad water.

Possible railway route.

Communication may easily be established by railway from the mouth of the Stikine to the centre of the Cassiar district and beyond, when this shall be called for, and it is probable also that this district might, without difficulty, be connected by rail with the more southern portions of British Columbia by one or more routes of which the main outlines can already be indicated. Following the river-valleys, by a route practicable for a railway, from Rothsay Point at the mouth of the Stikine to the mouth of the Dease, the distance is found to be 330 miles. Thence to Fort Simpson on the Mackenzie, is a further distance of 390 miles, making the total distance by this route, from the Pacific to the navigable waters of the Mackenzie about 720 miles only.

Taku River and trails.

Little is yet known of the Taku River, but the Indians ascend it in canoes to a point at a distance of about eighty miles from the head of Taku Inlet, and Indian trails lead south-eastward from this vicinity to the Tahl-tan, eastward to Tes-lin Lake and north-eastward to the lakes ar the head of the Lewes. From what has been ascertained of these, it is probable that it would not be difficult to construct a trail suitable for pack-animals, if not a waggon road, from the vicinity of the head of navigation on the Stikine to these lakes connecting with the navigable waters of the Lewes.

Tributaries of Yukon.

The rivers draining the Upper Yukon basin, have in general lower grades, and afford better navigable water than those above referred to, and are in consequence likely to prove of greater importance in connection with the exploration and development of the country. The distance to which they may be respectively ascended by boat or canoe, has as yet been determined in only a few cases.

Navigable lengths of rivers.

It may, however, be stated that the Yukon is continuously navigable for small steamers from its mouth, on Behring Sea and following the Lewes branch, to Miles Cañon. Thence, after an interruption of about three miles, to the head of Bennett Lake and to an additional considerable—though not precisely determined distance—by the waters extending south-eastward from Tagish Lake (p. 165 B). The Tes-lin-too is probably navigable for stern-wheel steamers for a hundred and fifty miles or more from its mouth, (p. 154 B) while the Tahk-heena and Big Salmon rivers may probably both be ascended by steamers of the same class for some distance. From the site of old Fort Selkirk, again, the Pelly might be navigated by small steamers of good power to within about fifty miles of the site of old Fort Pelly Banks, (p. 133 B) and the Macmillan branch is also navigable for a considerable, though not ascertained distance (p. 129 B). The same may be said of the Stewart River, but White River is, so far as known, very swift and shoal.

Aggregate length of navigable waters.

The total length of the waters which may be utilized for navigation by light stern-wheel steamers on the main river and its branches to the east of the 141st meridian or Alaskan boundary, measured in straight lengths of fifty miles, is therefore at least 1000 miles, and following the sinuosities of the various streams would be very much greater. This does not include the Porcupine River, and with the exception of the single break above referred to on the Lewes, forms a connected system, all parts of which lie to the east of the above meridian. If the upper portion of these rivers, above the first obstacles to such navigation, were included, the total here given would doubtless be greatly added to.

Means of access to Yukon District.

At the present moment but three routes of access to the Yukon district are employed. (1). That of the portage by the Chilkoot Pass from the head of Lynn Canal to the navigable waters of the Lewes. (2). That from Peel River, near its confluence with the Mackenzie by portage to La Pierre's House on a branch of the Porcupine. (3). That from Behring Sea by the main river. The first is that almost exclusively used by the miners, the second is employed only by the Hudson Bay Company, and the last is that of the Alaskan traders.

There are now three small stern-wheel steamers on the lower river, which ascend each year as far as the trading post at Forty-mile Creek,

bringing the greater part of the goods used in trade with the Indians and for the supply of miners. It is not possible, however, for miners to reach the scene of their operations by this route in time to make a season's work, and the chances of reaching or leaving the Yukon mouth are few and precarious. Particulars relating to the Chilkoot Pass and Lewes River will be found on pages 173 B, 174 B. The character of the pass is such that it would scarcely be possible to construct a useful trail across it for pack-animals, but the White Pass appears to offer a better opportunity for making a trail or road which, if constructed, would render the entire region much more easy of access. Another route, also leading from the head of Lynn Canal to navigable water connecting with the Lewes, is that by the Chilkat Pass. This was formerly much employed by the Indians, but entails a much longer land carriage, one which is said to occupy the Indians for twelve days when carrying packs, as against two days of packing by the Chilkoot Pass.

Indian routes.

The Indians inhabiting the region to the south and east of the site of old Fort Selkirk are poor boatmen and follow the various rivers in the course of their periodic journeys to a very limited extent. Most of their travelled routes appear, indeed, to run nearly at right-angles to the direction of drainage, the rivers being crossed in summer on rafts, the remains of which may frequently be observed. In travelling thus they carry their entire small camping outfit on their backs.

Climate, Agriculture and Flora.

General character of climate.

While the available information as to the climate of the northern portion of British Columbia and the Yukon district is necessarily as yet very imperfect, its general features are sufficiently obvious, repeating as they do those met with in the similarly circumstanced region to the south, with such modification as is produced by their higher latitude. The coast and coastward slopes of the Coast Ranges constitute a belt of excessive humidity and great precipitation, with somewhat equable temperatures, while the interior region to the eastward of these ranges is relatively dry, with a temperature of extremes.* In the interior, however, the climate is largely influenced by the altitude of each particular district, and in consequence of the general lowering of the country beyond the 60th parallel (constituting the north line of British Columbia), it is certain that the climatic conditions are there much more favorable than in the Cassiar district.

Regions of heavy and light rainfall.

The mean annual temperature of the coast region is considerably higher than that of the interior; yet, in consequence of the great

* A mean of the total annual precipitation for Fort Tongass, Wrangell and Sitka gives a general mean for the coast of 86·84 inches.

depth of the snow-fall and persistently clouded character of the skies, the Coast Ranges are found to support numerous and massive glaciers, while these are almost or altogether absent in the Cassiar Mountains, in the mountains about Frances Lake and in the other ranges seen by us in the interior. The heavy accumulation of snow upon the Coast Mountains and in their valleys, retards the progress of spring, as is very clearly evidenced on the Stikine, and explained more fully elsewhere. (p. 58 B). The depth of snow in winter continues to be inconsiderable or moderate, at least as far down the Pelly (Yukon) as the mouth of Stewart River and Forty-mile Creek, while at Nulato, on the lower river and in a similar latitude, but 500 miles further west, the depth of snow from April to November is said to average eight feet and often to reach twelve feet.* Mr. Dall also writes: "The valley of the Lower Yukon is somewhat foggy in the latter part of summer; but as we ascend the river the climate improves, and the short season at Fort Yukon is dry, but pleasant, only varied by an occasional shower." Relatively to the country of the Upper Yukon basin, the advent of spring is much retarded in the country to the west, and it is stated that on the river below Nulatto alder buds were found just opening and tender leaves beginning to appear on the 4th of June. These and other facts seem to show conclusively, that in the absence of a continuous mountain barrier in that region, the humid winds of the Pacific are enabled to push eastward a long way up the Yukon valley, carrying with them the belt of heavy snow-fall, which ceases to be conterminous with the Coast Mountains, as it is to the south-eastward.

Progress of spring.

Dry belts.

As in the more southern parts of British Columbia, the dryest country is found to occur in a belt bordering the eastern or lee side of the Coast Ranges, and this phenomenon recurs, though in a less marked degree, in connection with each of the well-defined mountain ranges of the interior. Thus a region of greater humidity is found near Dease Lake, on the western side of the Cassiar Mountains, with a dry belt on the east side of the range; while humid conditions, with recurrent showers in summer, characterize the district in the vicinity of Frances and Finlayson lakes. Further illustrations of this fact, with other climatic observations, will be found in the body of this report and in Appendix VI.

Summer and winter winds.

A noteworthy circumstance in connection with the Stikine valley, the passes leading from the head of Lynn Canal, and doubtless in all the low gaps in the Coast Ranges, is the change in direction as between the summer and winter winds. During the summer strong winds blowing up these valleys inland, are of very frequent occurrence and they commonly freshen in the afternoon and die away toward night. In

* Alaska and its Resources. W. H. Dall, 1870, p. 437.

the winter months the conditions are precisely reversed, the strongest winds blowing seaward. The summer winds are doubtless homologous with the sea breezes observed in many other regions, while the direction of the winter winds probably depends on the existence of a persistent anti-cyclonic area in the interior during that season.

Temperatures of coast and interior.

The temperature of Wrangell, just off the mouth of the Stikine, may probably be taken as fairly representative of that of the coast in these latitudes. For the interior region, here particularly treated of, we are unfortunately without a series of thermometer readings extending even over a single year, but some idea of its climate may be formed from that of Fort Yukon, which is, however, situated far to the north, almost exactly on the Arctic circle. The mean seasonal temperatures for these two stations may be compared as below.*—

	Wrangell.	Fort Yukon.
Spring	40.4	14.6
Summer	57.1	56.7
Autumn	43.0	17.4
Winter	28.3	—23.8
Year	42.2	16.8

Comparison with Russia.

In the central provinces of European Russia the thermometer descends to —22° and —31°, and occasionally even to —54°, in the winter months, but rises at times to 104° and even to 109° in summer. The rain-fall is small, varying from sixteen to twenty-eight inches, the maximum precipitation taking place during the summer months, and not, as in western Europe, in the winter, while the months of advanced spring are warmer than the corresponding months of autumn.† So far as our information goes, the above statement might almost be adopted as characterizing the climate of the southern half of the Yukon district.

Crops and cultivation.

At Telegraph Creek and in its vicinity on the Stikine, to the east of the Coast Ranges (lat. 58°), wheat, barley and potatoes are successfully grown with the aid of irrigation. Their cultivation has so far been attempted on a limited scale only, on account of the want of any market, and wheat has been grown only experimentally, as it cannot, like barley, be employed for feeding pack-animals. None of these crops can be successfully grown or ripened on the coastward side of the mountains. At Fort Yukon (situated, as above noted, on the Arctic circle) Mr. Dall states he was informed that barley had once or twice been tried in small patches and had succeeded in maturing the grain, though the straw was very short.‡ A few cattle were also

* From the United-States Coast Pilot, Alaska, Part I, 1883, p. 269.
† Encyclopedia Britannica, vol. xxi, p. 67.
‡ *Op. cit.*, p. 441.

kept here at one time, when the post was in the possession of the Hudson Bay Company. Petroff, in his Census Report on Alaska, endeavors to discredit Dall's statement as to the growth of barley at this northern point, but I am fortunately in possession of independent evidence as to its accuracy, the late Mr. James Anderson, of the Hudson Bay Company, having noted in an official report on the district that both potatoes and barley have been grown at the fort.

Conclusions as to possible agriculture

Taking into consideration all the facts which I have been able to obtain, as well as those to be derived from an examination of the natural flora of the country, and the observed advance of vegetation, which, in the absence of actual experiments, are capable of affording valuable data, I feel no hesitation in stating my belief that such hardy crops as barley, rye, turnips and flax can be successfully cultivated in the Yukon district as far north as the former position of Fort Selkirk, near the 63rd parallel, or in other words about 1000 miles north of Victoria. Taken in conjunction with the physical features of the region, this means, that chiefly within the drainage area of the Yukon, and for the most part to the north of the 60th parallel, there exists an area of about 60,000 square miles, of which a large proportion may, and doubtless in the future will—be utilized for the cultivation of such crops, and in which cattle and horses might be maintained in sufficient number for local purposes, without undue labor, as excellent summer grazing is generally to be found along the river-valleys and natural hay-meadows are frequent. I do not maintain that the country is suitable for immediate occupation by a large, self-supporting agricultural community, but hold that agriculture may before many years be successfully prosecuted, in conjunction with the natural development of the other resources of this great country, of which by far the most valuable portion lies to the east of the line of the Alaskan boundary.

Trees.

A note on the distribution of the various species of trees and on that of some of the herbaceous plants forms a separate section of this report (Appendix I), while in Appendix III, Prof. Macoun gives a list of the plants collected.

Timber.

Remarks on the quantity and quality of timber along the various routes are given under the local headings. It may suffice here to state, in this connection, that the country is generally wooded,* and that in all portions of it, in valleys and on low lands, there is an abundance of white spruce, of fair to good quality, well suited for purposes of construction. The other species of trees present are of inferior economic importance.

* No areas of *tundra* or frozen morass, such as are stated to be characteristic of the country of the Lower Yukon, were found in the region here reported on.

Fauna.

The fauna of the region traversed by us, does not differ notably from that of other parts of the northern country which are already moderately well known. There are, no doubt, many interesting points yet to be determined in respect to distribution, but our opportunities for obtaining information of this kind were very limited. The smaller black-tailed deer (*Cariacus Columbianus*) occurs on the islands of the southern portion of Alaska and the adjacent mainland coast, but is nowhere found on the inland side of the Coast Ranges. The mountain goat is moderately abundant in the Coast Ranges, and is also found in the mountainous inland regions, probably throughout. The big-horn or mountain sheep occurs, together with the last-mentioned animal, on the mountains about the head of the Lewes and other parts of the inland spurs of the Coast Ranges, but does not inhabit the seaward portions of these ranges. It is also found generally in the mountains of the interior, including the Rocky Mountains. Larger animals noted.

The moose is more or less abundant throughout the entire inland region, and together with the caribou, which is similarly ubiquitous, constitutes a great part of the food of the Indians. We found the moose particularly plentiful along the Upper Liard River, and it is stated that the country drained by the White River is noted among the Indians as a moose and beaver region. The caribou is everywhere common, but is scarcely seen in the valleys or lower country during the summer, when it ranges over the high, alpine moors and open slopes of the mountains.

The black and grizzly bears roam over the entire region and are often seen along the banks of the rivers in the latter part of the summer when dead or dying salmon are to be obtained with ease. Wolves are not particularly abundant, but the cross-, black- and silver-fox are more than usually common.

The smaller fur-bearing animals, being similar to those found generally in the northern parts of the continent, do not require separate enumeration. The entire Upper Yukon basin, however, yields furs of exceptionally high grade. Some notes as to the quantity of furs annually obtained from the region will be found in a subsequent paragraph (p. 28 B). Smaller fur-bearing animals.

Among a few skins brought back by us, is that of a mouse which Dr. C. H. Merriam has found to be a new species, and has described under the name of *Evotomys Dawsoni*.*

The salmon ascend the Lewes River as far as the lower end of Lake Marsh, where they were seen in considerable numbers early in Sep- Salmon.

* American Naturalist, July, 1888.

tember. They also, according to the Indians, run almost to the head-waters of the streams tributary to the Lewes on the east side. Salmon also run up the Pelly for a considerable distance above the mouth of the Lewes, but their precise limit on this river was not ascertained. The lakes and rivers generally throughout the country are well supplied with fish, and a small party on any of the larger lakes would run little risk of starvation during the winter, if provided with a couple of good gill-nets and able to devote themselves to laying in a stock of fish in the late autumn.

Other fishes.

As might be anticipated from the interlocking of streams tributary to the Mackenzie and Yukon in this region, the fishes in both drainage-areas appear to be identical, so far as I was able to observe, with the exception of the salmon, which is, of course, confined to the Yukon tributaries. The principal fishes noticed are white-fish (*Coregonus Nelsoni*), lake trout (*Salvelinus Namaycush*), grayling (*Thymallus signifer*), pike (*Esox lucius*), and sucker (*Catostomus catostomus*). The names above given are on the authority of Dr. T. H. Bean, of the U. S. Commission of Fish and Fisheries, who has very obligingly examined for me the photographs of fishes which were taken. No photograph, unfortunately, was obtained of the salmon seen on the Lewis, etc., but Dr. Bean informs me, from my description of its size, that he has little doubt it was the king salmon, *Oncorhynchus chuicha*.

Insects.

Appendix IV includes a list by Mr. James Fletcher, F.R.S.C., of the species of insects collected

Mining and Minerals.

Placer gold-mining.

Mining has so far been confined within the Cassiar district and in the Upper Yukon basin to the working of gold placers, and in the latter, almost entirely to river-bar mining, the inception of which indeed dates only from 1880. Particulars with reference to the rich creeks of Cassiar will be found on page 83 B, and facts relating to the rivers tributary to the Yukon on page 181 B. Almost all the large streams which have been prospected in the Yukon basin have been found to yield placer gold in greater or less quantity and the aggregate length of the rivers thus already proved to afford gold is very great, but little has been done toward the examination of their innumerable smaller feeders. Similar river-bar mining on the Stikine and Liard rivers proceeded the discovery of the smaller creeks in which the richer deposits of "heavy" gold were obtained, and a few miles in length each of Dease, Thibert and McDame creeks produced the greater portion of the $2,000,000 worth of gold credited to Cassiar in 1874 and 1875. Discoveries similar to these may be expected to occur at any time in

the Yukon district, the generally auriferous area of which already proved is very much greater than that of Cassiar. Scarcely anything has been done as yet even in the Cassiar district toward the search for or proving of metalliferous veins, and practically nothing in the Yukon district, but there can be no reasonable doubt that such deposits exist.* The present activity in mining enterprise in the southern part of British Columbia will, before long, spread to this northern region also, and then, if not before, its valuable character as a portion of the metalliferous belt of the continent will be realized. Metalliferous veins.

The Yukon district with the northern part of British Columbia, measured from the vicinity of Dease Lake to the intersection of the Pelly (Yukon) with the 141st meridian comprises a length of over 500 miles of the Cordillera belt of the west, which, wherever it has been examined, has been found rich in minerals and particularly in the deposits of the precious metals. The width of this particular part of the Cordillera belt is also great, as it appears, so far as our explorations have gone, to extend from the coast to the eastern ranges of the Rocky Mountains in the vicinity of the Mackenzie River. This portion of the Cordillera region, together with that of the more southean part of British Columbia, gives an aggregate length of between 1200 and 1300 miles, almost exactly equal to the length of the same metalliferous belt contained by the United States, and in all probability susceptible of an eventual mining development equally great. Importance of Metalliferous belt.

In the northern districts here reported on, it is true that the winter climate is a severe one, rendering the working season for ordinary placer-mines short and likely also to present some special difficulties in the way of "quartz mining." There is, however, on the other hand an abundance of wood and water, matters of great importance in connection with mining, and means of communication once provided, mining operations should be carried on here at less cost than in dry and woodless regions such as are great portions of Arizona. Bearings of climate on mining.

Statistics of the former and present gold production of Cassiar are given in connection with that district, on page 82 B. It is difficult if not impossible to arrive at even an approximate statement of the total amount of gold which has been so far afforded by the Yukon district, but from such enquiry as I was able to make in 1887, I estimated the value of gold obtained in that year at a minimum of $60,000; the number of men engaged in mining at 250. Statistics of gold.

A specimen of asbestus (chrysotile) being part of a small vein of that material about half an inch in thickness, has been brought from Asbestus.

* A speciman of galena obtained from McDame Creek, Cassiar, was found to contain 75 ounces of silver to the ton (see p. 86 B) and of seven specimens of vein stuff collected by us on the Upper Pelly and Lewes, five proved to contain distinct traces of gold on assay.

the Stewart River, and the occurrence of serpentine in large mass elsewhere, tends to show that workable asbestus deposits may yet be found in the region.

Platinum. Platinum is found in small quantities along all or nearly all the tributaries of the Yukon, in association with the gold. It has also been observed in the Cassiar district.

Fur Trade.

Exports of furs. Gold and furs are at present the only articles of value derived from the great region here referred to as the Yukon district. It is impossible to secure accurate information as to the value of furs annually obtained, but sufficient is known to show that it must be very considerable. Petroff, in his report, states that the total annual value of the furs shipped by the Yukon probably does not exceed $75,000,* and it is known that a great, if not the greater, portion of this total is derived from the region lying east of the 141st meridian. Dall states, that at the date of his visit (1867), the value of furs annually obtained at Fort Yukon, then maintained by the Hudson Bay Company, was not less than $50,000. Captain Raymond notes that the total number of skins collected in 1869, at this place, was stated at 10,000, but adds that he believes this estimate to be excessive.† Practically the whole of these may be regarded as having been brought by Indians from the region east of the Alaskan line. An approximate estimate of the furs derived from Canadian territory and taken down the Yukon, obtained from Mr. François Mercier, who spent many years trading on the river, places the annual value at about $27,000. The annual catch is made up, according to the same authority, about as follows:—

Beaver	1200 to 1500	skins.
Cross fox	100	"
Black fox	100	"
Red fox	300	"
Bear	300	"
Marten	4000	"
Otter	200	"
Mink	2000	"
Lynx	600	"
Wolverine	150	"
Wolf	100	"
	9350	"

* Report on the Population Industries and Resources of Alaska, p. 5, U. S. 10th Census, vol. viii.

† *Op. cit.* p. 115.

Routes of export of furs.

In addition, however, to the furs taken from the Yukon district by this route, the Hudson Bay Company obtains a large quantity of skins from their posts on the Porcupine, which reach the market by the Mackenzie River route. A certain number of skins derived from the country north of British Columbia is, further, annually traded at the little post at the mouth of Dease River, and taken out by the Stikine. A considerable quantity of furs also each year finds its way by the Chilkoot and Chilkat passes to the head of Lynn Canal, and some are brought down by the Taku River to the coast, though the greater part of these last is probably derived from the north-western corner of the province of British Columbia. Information obtained on the spot indicates that the value of the furs reaching Lynn Canal from the interior is from $12,000 to $15,000 annually.

Economic Importance of the Region.

Value of the Yukon district.

Without including the northern part of British Columbia, respecting which more has already been made known, but restricting ourselves to the great area of 192,000 square miles situated to the north of the 60th parallel and west of the Rocky Mountains, which I have referred to as the Yukon district, it may be said that the information now obtained is sufficient to warrant a confident belief in its great value. Very much yet remains to be learned respecting it, but it is known to be rich in furs, well supplied with timber, and it is traversed by a great length of navigable rivers. It is already yielding a considerable yearly product in gold, and presents every indication of a country rich as well in other metals, and including deposits of coal. In its southern portion, situated between the 60th and 65th degrees of latitude, is comprised an area of probably not less than 30,000 square miles, suitable for eventual agricultural occupation, and presenting none of the characters of a sub-Arctic region, which have, in advance of its exploration, been attributed to it by some writers. In each of these particulars and in climate it is greatly superior to the corresponding inland portion of the territory of Alaska. It may, in fact, be affirmed with little room for doubt, that the region here spoken of as the Yukon district surpasses in material resources the whole remaining northern interior portion of the continent between the same parallels of latitude.

Isothermal lines.

The winter climate of the whole of this great region is known to be a severe one, and its northern extremity lies within the Arctic circle, but it must be remembered that the climatic conditions on the western and eastern sides of the continent are by no means comparable, and that the isothermal lines, representing the mean annual temperature,

trend not westward but north-westward from the Manitoba region. The lines, in particular, which would represent the mean summer temperature would assume, in the far north-west, a proximate parallelism with the Pacific coast, instead of tending to follow lines of latitude. It is needless here to recapitulate the well known causes which produce this remarkable difference in climate, but the lines as already approximately drawn upon the maps, represent in a generalized form the aggregate of influences which, working together, produce at the site of old Fort Selkirk on the 63rd parallel of latitude in the Upper Yukon basin, an attractive landscape, decked with well-grown forests and with intervening slopes of smiling meadow, while in the same latitude in Hudson Strait we find, even at midsummer, merely a barren waste of rocks and ice.

Comparison with province of Vologda.

To instance a region which reproduces the general conditions of the Yukon district and adjacent northern portions of British Columbia, we must turn to the inland provinces of Russia, to which allusion has already been made in connection with climatic features. (p. 23 B.) The province of Vologda, in European Russia, appears to offer the nearest parallel. It is circumstanced relatively to the western shores of Europe, as is this district to the western shores of the North American continent. Its area is 155,498 square miles, situated between the 58th and 65th degrees of latitude. The climate in both cases is a continental one, in which severe winters alternate with warm summers, and the actual degrees of cold and heat, so far as our information goes, are not dissimilar. There is no very heavy rainfall in either region, such as we find near the western coasts bordering on the Atlantic and on the Pacific respectively. The agricultural products from the province of Vologda are oats, rye, barley, hemp, flax and pulse. The mineral products comprise salt, copper, iron and marble, but the precious metals do not appear to be important, as in the Yukon district. Horses and cattle are reared, and the skins of various wild animals, as well as pitch and turpentine, are among the exports. The population of the province is stated at 1,161,000.

Ultimate development assured.

While the Yukon district and the northern portion of British Columbia are at present far beyond the limits of ordinary settlement, we may be prepared at any time to hear of the discovery of important mineral deposits, which will afford the necessary impetus, and may result, in the course of a few years, in the introduction of a considerable population into even its most distant fastnesses. To-day it may well be characterized by the term which has been employed in connection with the Mackenzie basin, a portion of "Canada's Great Reserve." It appears meanwhile eminently desirable that we should encourage and facilitate, in so far as may be possible, the efforts of the miners

and others who constitute our true pioneers in the region, and to whom, in conjunction with the fur companies and traders, the peaceful conquest of the whole of our Great West has been due. In the future, there is every reason to look forward to the time when this country will support a large and hardy population, attached to the soil and making the utmost of its resources.

General Geology.

Difficulties of the field.

In a reconnaissance carried out along a single line, in which the greater part of one's time is necessarily occupied in overcoming the difficulties of the route and in securing the necessary geographical data, it is difficult to obtain any very complete knowledge of a region geologically complicated. In the present case this difficulty is increased by the circumstance that the geology of the corresponding portion of the Cordillera belt in the southern part of British Columbia, is as yet very imperfectly understood, though considerable attention has been devoted to it; while with respect to the older rocks of the analogous region in the western part of the United States very little published information of a systematic kind is available.

General similarity British Columbia.

Speaking broadly, however, and with reference to the general features of the region, the rock-series represented are evidently similar to those found in the southern portion of British Columbia between the Rocky Mountains and the coast, and an important general result of the work here reported on, is the further demonstration of the great constancy in lithological characters of the several formations, when followed in the direction of the main north-west and south-east axes of uplift—a constancy which contrasts markedly with the diversity found when comparisons are made as between localities situated at right angles to this direction.

Rocks of the Coast Ranges.

The Coast Ranges, where traversed by the valley of the Stikine, and again where crossed still further north by the Chilkoot Pass, are found to consist, for the most part, of granite and granitoid rocks, almost invariably of gray colour and frequently rich in hornblende. With these are occasionally included stratified or stratiform masses of mica- and hornblende-schists, and both these and the granites are frequently traversed by pegmatite veins, diabase dykes and intrusive masses of coarse diorite. The schistose portions of these ranges may possibly represent the still recognisable remnants of rocks of Archæan age, or may be merely portions of much newer series which have suffered extreme alteration.

No demonstration of the date of the origin of the granitic rocks of the Coast Ranges was obtained in this region, but there is every reason

to believe that it is comparatively recent, and due to a time lying between the Triassic and the Cretaceous, as has been found to be the case with their continuation to the south, near the northern part of Vancouver Island. *

Rocks of the coast archipelego.

The argillites of Wrangell, together with those met with near Juneau, and at Sitka, on the Alaskan coast, and also in various places along the east side of Lynn Canal, together with the altered volcanic rocks found in association with these on Lynn Canal and elsewhere (examined by me particularly in the vicinity of Seduction Point), closely resemble rocks of the same class composing the Vancouver group of the Queen Charlotte and Vancouver Islands. Though no fossils were obtained at these northern localities, the rocks may, like those just referred to, be provisionally classed as Triassic, with the reservation, (as made in the case of the similar series of the Queen Charlotte and Vancouver Islands), that Palæozoic strata may also be represented.

General features of coast belt.

The width of the belt of granitoid rocks composing the Coast Ranges is, on the Stikine, about sixty-five miles, measured from their sea-border inland at right angles to the main direction of the mountains. It is somewhat less in the latitude of the Chilkoot Pass, but may be assumed to occupy a border of the mainland about fifty miles in width along the whole of this part of the coast. Broadly viewed, however, the coast archipelago in reality represents a partly submerged margin of the Coast Ranges, and granitic rocks are largely represented in it also. The examination of these two northern cross-sections of the Coast Ranges, serves, with observations previously made, to demonstrate the practical identity in geological character of this great orographic axis, from the vicinity of the Fraser River to the 60th parallel of north latitude—a length, in all, of about 900 miles.

Formations of the interior region.

East and north-east of the Coast Ranges, the interior region traversed is, for the most part, floored by Palæozoic rocks of very varied appearance, and probably referable to several of the main sub-divisions of the geological scale. In so far as the information obtained in the region here in question enables conclusions on the subject to be formed, the lowest part of the rocks, (1) consists of greenish and grey schists, generally felspathic or hornblendic, but often quartzose and including distinctly micaceous and talcose schists, with some bands of limestone; the lithological character of this sub-division being exceedingly varied. Apparently overlying these are, (2) grey and blackish, often lustrous and sometimes more or less micaceous calc-schists and quartzites, including beds of limestone of moderate thickness, which are often more or less dolomitic. These are associated with, or pass up into, (3) black

* See Annual Report Geol. Surv. Can., 1886.

argillites or argillite-schists, also containing thin beds of limestone, which, at one locality on the Dease, have afforded a small number of graptolites of Cambro-Silurian age (see p. 99 B). Next above these is a series (4) consisting chiefly of massive limestones, generally of grey or blue-grey colour where unaltered, but often locally changed into white or variegated crystalline marbles. These are closely associated with quartzites which usually show the peculiar fine grained cherty character of those of the typical Cache Creek series on the Fraser and Thompson rivers. The thickness of this sub-division cannot (any more than that of those previously mentioned) be stated with precision, but that of the limestones alone must be several thousand feet in some places. On the Dease, on the Frances, and again on Tagish Lake fossils of Carboniferous age, including more particularly a species of *Fusulina*, have been detected in some beds of this limestone series, probably belonging to its upper portion. Forms of the genus *Fusulina* are characteristic in certain zones of the Carboniferous limestone in California. They have been found by the writer in a number of places in British Columbia, which, with the discoveries here reported on, occur at intervals along a belt of country to the north-east of the Coast Ranges for a distance of over 800 miles. The limestone last-mentioned appears to be conformably followed or even in part interbedded with (5) a great mass of more or less evidently stratified rocks of volcanic origin, comprising amygdaloids, agglomerates, and other more massive materials which apparently represent old lava-flows. All these are highly altered, so much so that in some cases their original physical character is scarcely demonstrable, while they have suffered changes also in constitution, having been converted for the most part into diabases.

Fusuline limestones

Analogy with the southern portions of British Columbia which I have examined, leads me to believe that the greater part of these volcanic materials are also to be classed as of Carboniferous age, but it is quite probable that here, as to the south, they comprise as well rocks of similar appearance which are of Triassic age, but which we are at present unable to separate from them. This is further rendered probable by the occurrence in certain black argillites at Glenora, on the Stikine, of Triassic fossils (p. 56 B) and by the discovery by Mr. McConnell of fossils of this age on the Lower Liard River, some distance to the east of the region covered by this report.*

Altered volcanic materials.

No unconformity has been proved to occur throughout the whole of the above Palæozoic series, but the examinations made were scarcely of a sufficiently detailed nature for the detection of any stratigraphical break unless of a very obvious character. Respecting the first-mentioned of the above sub-divisions, I feel some doubt as to whether

Relations of the rock series.

* See Summary Report of the Operations of the Geological Survey for 1887, p. 11.

it really constitutes a lower member of the series or whether it may represent some of the other members—particularly the rocks of volcanic origin—in a highly altered state, as seems, from late observations, to be the case with rocks of similar appearance in southern British Columbia. The proximity of the rocks classed under the first sub-division to certain granitic axes is equally explicable on either hypothesis. It must also be added that there appears to be a recurrence of rock materials originally volcanic in greater or less force in several parts of the series, and that important beds of serpentine occur at one or more horizons.

Geological notes on map.

For the purpose of assisting future more complete enquiry, and in view of the tentative character of the classification here offered, the more important details observed are noted on the face of the map accompanying this report, for which it would be premature to attempt a geological colouring.

Interior granitic axes.

The preponderantly Palæozoic floor of the region east of the granites of the Coast Ranges, is broken through on two main lines by granitic axes. The first of these is cut across by the Dease River, a short distance below Dease Lake, and was again met with—over 300 miles north-westward—on the Pelly near the mouth of the Macmillan. Though referred to as a single granitic axis, this uplift probably consists rather of a series of alternating and more or less irregularly shaped granitic masses, which, however, preserve a general alignment. There are on the Upper Pelly in fact three separate granitic ridges in place of the single one met with on the Dease. In close association with these granites are some gneissic rocks and holocrystalline mica- and hornblende-schists, which have not been referred to in previous paragraphs as they are regarded as probably Archæan, rather than as representing highly altered Palæozoic rocks. A small tongue of granite occurs on the Lewes a few miles above the mouth of the Little Salmon, which may be connected with the south-western side of this granitic axis, but with this exception its continuity between the Dease and Pelly is indicated merely by the statement of Mr. J. McCormick that granites and mica-schists occur on the south-west side of Quiet Lake and near the Big Salmon River, below that lake. Its further extension in a north-westerly bearing is, however, proved by the occurrence of a great preponderance of rocks of the same character in the collection made by Mr. Ogilvie* on the lower Pelly or Yukon, between the mouth of the Lewes and Forty-mile Creek.

Connexion of gold with the rock series.

On comparing the position of this irregular granitic axis and its surrounding altered rocks (in part referable to several of the Palæozoic sub-divisions previously described) with that of the richer deposits of

* Sent out by him in charge of the latest party of miners in the autumn of 1887.

placer gold so far discovered and worked, it will be found that they are closely associated. The chief placers and river-bars are, in fact, scattered along this line or belt, and extend, like it, all the way from Dease Lake and McDame Creek to Forty-mile Creek. Evidence was moreover found on the Pelly, to show that the development of quartz veins in the Palæozoic rocks had occurred contemporaneously with the upheaval of the granites, and probably by some action superinduced by the granite masses themselves while still in a formative condition. While cutting the stratified rocks, the quartz-veins seldom or never cut the granite masses in this district. These observations should afford an important clue to the further search for auriferous ground, as well as for the lodes from which the placer gold has itself been derived.

Granites of Too-tsho Range.

Of the second granitic axis of the interior region very little is yet known, but it is probable that it is still less regular in character than the last. It occurs in the mountainous region to the east of Frances Lake and River, and probably also in the vicinity of the Pelly Lakes (see p. 121 B). Its lithological characters and those of the rocks in its neighborhood are similar to those of the last described, and here again in its vicinity, on Frances Lake and on the Liard (pp. 105 B, 113 B) paying gold placers have been found. The district is, however, so difficult of access that it can scarcely as yet be said to have been at all prospected.

Age of granites.

I am inclined to believe that the two granitic axes of the interior region above described are of much greater age than that of the Coast Ranges. The reasons for assigning a comparatively late date to the latter have already been alluded to. It is found, too, that while the stratified rocks usually conform to an ascending order in receding from these granitic axes, there is evidence along the north-eastern flanks of the Coast Ranges of an irregular line of junction, and though on the Stikine the Palæozoic rocks appear to rest upon the granites of the Coast Ranges, the supposed lower members of the series are not seen, while on the lakes near the head of the Lewes some of the upper portions of the Palæozoic are directly in contact with and have apparently been broken through by the granites. The granitoid rocks of the interior region are, moreover, different in general appearance from those of the Coast Ranges, and resemble more closely the probably Archaean granites of the Gold Ranges in southern British Columbia.

Lithological character.

Lithologically the granites and granitoid rocks of the Coast Ranges are generally fresh and unaltered in appearance, grey in colour and not often distinctly foliated, while those of the ranges of the interior show evidence of considerable alteration subsequent to their formation, are more highly quartzose and often reddish in tint. Some particulars respecting a few of the granites of the region which has been microscopically examined by Mr. F. D. Adams will be found in Appendix V.

Cretaceous and Laramie rocks.

Besides the Triassic rocks previously referred to, the Mesozoic period is represented also by strata of Cretaceous and Laramie age. These rocks are distinctively more recent in appearance than, and rest quite unconformably on all the older formations, though they have since been to some extent involved in their flexures. On the lower part of the Lewes, below the mouth of the Little Salmon, these rocks are cut across by the river for a distance of at least thirty-five miles. Some fossil molluscs and plants have been obtained from this area, from which it would appear to include beds referable to the Middle or Lower Cretaceous and to the Laramie period (p. 146 B), and it is not improbable that the series is a consecutive one between these limits, as the total thickness represented must be very great. The strike of these beds varies much in direction, and the angles of dip are so irregular that no even proximate estimate of thickness could be formed, and it is impossible to arrive at any definite conclusion with respect to the trend of the basin in which they lie. The rocks comprise, in their lower portion, coarse conglomerates, grauwacke-sandstones, yellowish and grey quartzose sandstones and dark calcareous slates. The upper portion, in which Laramie plants are found, consists chiefly of rather soft sandstones, shales and clays, generally of pale colours. Evidence of contemporaneous volcanic action is observable in both parts of the series, and the higher beds include lignite-coal of good quality (p. 148 B).

Some miles further up the Lewes, midway between the Little and Big Salmon rivers, peculiar green, grauwacke-sandstones and green, highly calcareous conglomerates occur, which are also provisionally referred, though with some doubt, to the Cretaceous. They are at least newer than the Palæozoic rocks, being composed of fragments of these and of the granites.

Cretaceous of Lake Labarge.

Conglomerates and sandstones similar to the last are again found near the lower end of Lake Labarge, on the east side, and are associated with black calcareous slates, which recur in several places along the same side of the lake, further up, and from which a few fossils have been obtained. These seem to show that the beds are on or near the horizon of Series C. of the Queen Charlotte Islands, which is of Middle Cretaceous age, approximately equivalent to the Gault (p. 158 B).

Cretaceous of Upper Pelly.

On the Upper Pelly River, forty-three miles below Hoole Cañon, a single low outcrop of hard, dark shales, containing fossil plants of Cretaceous or Laramie, age was found, but in the absence of further exposures along the river in that vicinity, nothing can be said of the extent of this area, except that it must be quite limited in width. Again, on the Stikine River, between Glenora and Telegraph Creek, there are local occurrences of conglomerates and soft sandstones which

may be regarded as probably Cretaceous, though no palæontological evidence is forthcoming.

Relations of the Cretaceous.

The position of these last-noted areas, as well as that of those along the Lewes River, occurring as they do in a zone of country immediately within the line of the Coast Ranges, is analogous to that held by Cretaceous rocks on the Skeena and in other localities still further southward in British Columbia. Further investigation will probably show that rocks of this age occur in many additional places, and occupy somewhat extensive areas in this belt of country. In the vicinity of the Lewes, particularly, it is noted that the plane of the original base of the Cretaceous, now thrown into a number of folds, is about that of the present surface of the country, and these rocks may therefore be expected to recur frequently in the form of troughs or basins, more or less strictly limited and only to be discovered in detail by thorough examination. The loose material brought down by the Big Salmon River, appears to indicate the existence of a considerable development of these rocks not far up the valley of that stream.

Tertiary rocks.

No wide-spread Tertiary areas like those of the southern interior portion of British Columbia appear to occur in the region here described. The most important occurrence of beds of this age met with, is that which occupies the wide valley of the Upper Liard, but its extent to the north-west and south-east was not ascertained. The rocks are soft shales, sandstones and clays, generally of pale color, and holding beds of lignite in some places. Flows of basalt either cap these rocks or are included in their upper portion, and from the considerable angles of dip observed, the formation would appear to have suffered some flexure subsequent to its deposition (p. 101 B).

Basalts.

In the Stikine valley, east of the Coast Ranges, important local basalt-flows are met with, overlying old river- and valley-gravels (p. 57 B), and the lignite reported to exist some miles up the Tahl-tan is, doubtless, also of Tertiary age and inferior in position to the basalts. Basalt effusions of a sporadic character may be frequent in other places in the region, as such were actually noted in three other widely separated localities, viz., above Hoole Cañon on the Pelly, at Miles Cañon on the Lewes, and again at the confluence of this river with the Pelly.

Age of basalts.

The basalts are at least pre-glacial in age, and though no characteristic fossils were observed in the associated bedded deposits, both may be provisionally classed from their analogy with similar deposits in the more southern portion of British Columbia, as Miocene.

Occurrence of Jade on the Lewes.

Occurrence of jade pebbles.

Having become interested in the question of the origin of nephrite or jade, on account of its former extensive employment by the natives of the west coast for the manufacture of implements, * I kept a close watch for this mineral along our route, and ultimately succeeded in finding several rolled pieces of it in gravel-bars along the Lewes (p. 147 B). Of the pebbles collected by us, at least five have the specific gravity and other physical characters of jade, though they have not yet been subjected to chemical or microscopical analysis. Several of these are evidently, however, pure and typical jade, of which the finest and most characteristic was found by Mr. W. Ogilvie, near Miles Cañon. This specimen is a pale-green translucent to sub-transparent variety weighing a pound and three-quarters, after a piece, probably equal to about one-fourth of the original mass, had been broken off and unfortunately lost. Some of the specimens collected, but not referred to in the above remarks, appear to show the passage, by admixture of other materials, of the pure jades into various altered rocks of volcanic origin, as described in the publication above referred to. So far as I have been able to ascertain, the discovery of jade here noted is, with one exception, the first actually direct one made in the region of the Pacific slope. The exception above alluded to is that of jade found at the Kwichpak mouth of the Yukon during Captain Jacobson's stay in that vicinity and which was obtained by him and taken to Berlin.†

Glaciation and Surface Deposits.

Such details as appear to be of interest respecting glaciation, and the superficial deposits, are given in the subsequent descriptive portion of this report. The general bearings of these are here merely summarized in the briefest possible manner.‡

Previous observations in British Columbia

Previous observations in British Columbia§ have shown that at one stage in the Glacial period—that of the maximum glaciation—a great confluent ice-mass has occupied the region which may be named the Interior Plateau, between the Coast Ranges and the Gold and Rocky Mountain ranges. From the 55th to the 49th parallel this great glacier has left traces of its general southward or south-eastward movement, which are distinct from those of subsequent local glaciers. The southern extensions or terminations of this confluent glacier, in

* See Canadian Record of Science, vol. ii. No. 6, April, 1887.

† See paper by Prof. A. B. Meyer, Jahresbericht des Vereins für Erdkunde zu Dresden, 1884.

‡ The substance of this summary has been published in advance in the Geological Magazine. Decade III, vol. v. p. 347 (Aug. 1888).

§ Quart. Journ. Geol. Soc. vol. xxxi. p. 89. *Ibid.* vol. xxxiv. p. 272. Canadian Naturalist, vol. viii.

Washington and Idaho Territories, have quite recently been examined by Mr. Bailley Willis and Prof. T. C. Chamberlin of the U. S. Geological Survey,* and their observations tend to confirm the views above outlined, which had previously been stated by the writer. There is, further, evidence to show that this inland-ice flowed also, by tranverse valleys and gaps, across the Coast Ranges, and that the fiords of the coast were thus deeply filled with glacier-ice, which, supplemented by that originating on the Coast Ranges themselves, buried the entire great valley which separates Vancouver Island from the mainland, and discharged seaward round both ends of the island. Further north, the glacier extending from the mainland coast touched the northern shores of the Queen Charlotte Islands. The observed facts on which these general statements are based have been fully detailed in the publications already referred to, and it is not here necessary to review former work in the region, further than to enumurate the main features developed by it, and to connect these with the observations made during the summer of 1887, in the more northern region described in the present report.

Glaciation of the coast.

The littoral of the south-eastern part or "coast strip" of Alaska, presents features identical with those of the previously examined coast of British Columbia, at least as far north as lat. 59°, beyond which I have not seen it. The coast archipelago has evidently been involved in the border of a confluent glacier which spread from the mainland and was subject to minor variations in direction of flow dependent on surface irregularities, in the manner described in my report on the northern part of Vancouver Island. † No conclusive evidence was here found, however, in the valley of the Stikine River or in the pass leading inland from the head of Lynn Canal, to show that the inland-ice moved seaward across the Coast Ranges, though analogy with the coast to the south favours the belief that it may have done so. The front of the glacier must have passed the outer border of the archipelago, as at Stika, well-marked glaciation is found pointing toward the open Pacific ‡ (average direction about S. 81° W. astr.).

Glaciation of the interior region.

It is, however, in the interior region, explored and examined by us in 1887, between the Coast Ranges and the Rocky Mountains proper, and extending northward to lat. 63°, that the most interesting facts have come to light respecting the direction of movement of the Cordilleran glacier. Here, in the valleys of the Upper Pelly and Lewes, traces were found of the movement of heavy

* Bulletin U. S. Geol. Survey, No. 40, 1887.

† Annual Report Geol. Surv. Canada, 1885, p. 100 B.

‡ Mr. G. F. Wright has already given similar general statements with regard to this part of the Coast of Alaska, American Naturalist, March, 1887.

glacier-ice in a northerly direction. Rock-surfaces thus glaciated were observed down the Pelly to the point at which it crosses the 136th meridian and on the Lewes as far north as lat. 61° 40′, the main direction in the first-named valley being north-west, in the second north-north-west. The points referred to are not, however, spoken of as limiting ones, for rock exposures suitable for the preservation of glaciation are rather infrequent on the lower portions of both rivers, and more extended examination may result in carrying evidence of the same kind further toward the less elevated plains of the Lower Yukon, as elsewhere detailed. Neither the Pelly valley nor that of the Lewes is hemmed in by high mountainous country except toward the sources, and while local variations in direction are met with, the glaciation is not susceptible of explanation by merely local agents, but implies the passage of a confluent or more or less connected glacier over the region.

On Lake Labarge, in the Lewes valley, both the sides and summits of rocky hills 300 feet above the water were found to be heavily glaciated, the direction on the summit being that of the main (north-north-west) orographic valleys, while that at lower levels in the same vicinity followed more nearly the immediate valley of the river, which here turns locally to the east of north.

Glaciation was also noted in several places in the more mountainous country to the south of the Yukon basin, in the Dease and Liard valleys, but the direction of movement of the ice could not be determined satisfactorily, and the influence of local action is there less certainly eliminated.

Deposits of the glacial period.

While the greater part of the area traversed is more or less completely mantled with glacial deposits, it will be observed, in referring to subsequent pages, that true boulder-clay was found in certain parts only of the southern and more mountainous portion of the region, while it spreads over almost the entire length of the Upper Pelly and Lewes valleys, though not found exposed quite to their confluence. The boulder-clay generally passes upward into, and is covered by, important silty beds, analogous to the silts of the Nechacco basin, further south in British Columbia, and to those of the Peace River country to the east of the Rocky Mountains. It may be stated also that the country is generally terraced to a height of 4000 feet or more, while on an isolated mountain-top near the height of land between the Liard and the Pelly rivers (Pacific-Arctic watershed) rolled gravel of varied origin was found at a height of 4300 feet, a height exceeding that of the actual watershed by over 1000 feet.

Mastodon remains.

No remains of mastodon or mammoth were observed in the country traversed by us, but according to Campbell such remains occur not far

from the site of Fort Selkirk, and they are known to be moderately abundant at points further down the river. Sir J. Richardson speaks of a tibia of *Elephas primigenius* sent to England by Roderic (Robert) Campbell from this region.*

Reverting to the statements made as to the direction of the general glaciation, the examination of this northern region may now be considered to have established that the main gathering-ground or *névé* of what I have called the great Cordilleran glacier or confluent glacier-mass of the west coast, was included between the 55th and 59th parallels of latitude, a region which, so far as explored, has proved to be of an exceptionally mountainous character. It would further appear that this great glacier extended, between the Coast Ranges and the Rocky Mountains, south-eastward nearly to lat. 48°, and north-westward to lat. 63°, or beyond, while sending also smaller streams to the Pacific Coast. General facts established.

In connection with the northerly direction of ice-flow here ascertained, it is interesting to recall the observations which I have collected in a recently published report of the Geological Survey, relating to the northern portion of the continent east of the Mackenzie River.† It is there stated that for the Arctic coast of the Continent, and the Islands of the Archipelago off it, there is a considerable volume of evidence to show that the main direction of movement of erratics was *northward*. The most striking facts are those derived from Prof. S. Haughton's Appendix to M'Clintock's Voyage, where the occurrence is described of boulders and pebbles from North Somerset, at localities 100 and 135 miles north-eastward and north-westward from their supposed points of origin. Prof. Haughton also states that the east side of King-William's Land is strewn with boulders of gneiss like that of Montreal Island, to the southward, and points out the general northward ice-movement thus indicated, referring the carriage of the boulders to floating-ice of the glacial period. Other instances of northward glaciation.

The copper said to be picked up in large masses by the Eskimo, near Princess-Royal Island, in Prince-of-Wales Strait, as well as on Prince-of Wales Island,‡ has likewise, in all probability been derived from the copper-bearing rocks of the Coppermine River region to the south, as this metal can scarcely be supposed to occur in place in the region of horizontal limestone where it is found.

Dr. A. Armstrong, Surgeon and Naturalist to the *Investigator*, notes the occurrence of granite and other crystalline rocks not only on the south shore of Baring Land, but also on the hills at some distance

* Am. Journ. Sci. and Arts, vol. xix., 1855, p. 132.

† Notes to accompany a Geological Map of the Northern Portion of the Dominion of Canada East of the Rocky Mountains, p. 57 R., Annual Report Geol. Surv. Can., 1886.

‡ De Rance, in Nature, vol. xi. p. 492.

from the shore. These, from what is known of the region, must be supposed to have come from the continental land to the southward.

Dr. Bessels, again, remarks on the abundance of boulders on the shore of Smith's Sound in lat. 81° 30′, which are manifestly derived from known localities on the Greenland coast much further southward, and adds: "Drawing a conclusion from such observations, it becomes evident that the main line of the drift, indicating the direction of its motion, runs from south to north."*

It may further be mentioned that Dr. R. Bell, has found evidence of a northward or north-eastward movement of glacier ice in the northern part of Hudson Bay, with distinct indications of eastward glaciation in Hudson Strait. † For the northern part of the great Mackenzie valley we are as yet without any definite published information, but Sir J. Richardson notes that Laurentian boulders are scattered westward over the nearly horizontal limestones of the district.

Two great glacier-masses.

Taken in conjunction with the facts for the more northern portion of the continent, already pretty well known, the observations here outlined would appear to indicate a general movement of ice outward, in all directions, from the great Laurentian axis or plateau which extends from Labrador round the southern extremity of Hudson Bay to the Arctic Sea; while a second, smaller, though still very important region of dispersion—the Cordilleran glacier-mass—occupied the Rocky Mountain region on the west, with the northern and southern limits above approximately given, and a length, in a north-west and south-east direction, of at least 1200 miles.

It is inexpedient at the present moment to enter into any detailed discussion of the glaciation of the extreme north-west, as Mr. McConnell's observations, made in the prosecution of his portion of the work of the expedition, are likely to add much to our store of facts bearing on the subject.

Economic importance of facts elicited

It may be added, that while the study of the phenomena of the glacial period is one not without its bearings on economic problems even in the eastern part of the continent, it has, in British Columbia and the Yukon district, a direct value in its connection with the distribution of the placer gold deposits and on the existence and position of the buried channels of rivers and streams, in which some of the richest of those deposits are often found to occur. Thus the greater part of the "fine" gold found along the river-bars and banks of the larger streams in the Yukon district is doubtless proximately derived from the gravels

* Nature, vol. ix.

† Annual Report Geol. Surv. Canada, 1885, p. 14 D.D. and Report of Progress, 1882-84, p. 36 D.D.

and other superficial deposits in which these streams have re-excavated their beds since the period of glaciation. By the general dispersion and intermixture of these materials, composed of the *débris* of the older rock formations, it is even possible that the existence of a few comparatively limited areas of great richness might account for the wide-spread auriferous character of the alluviums of the Upper Yukon basin. In the former direction of ice-movement, and consequently that of its transport of material, we obtain an important clue as to the source of the finer gold which may now be found in any particular area. This subject is too wide in its ramifications to be followed out here, but it is one to which considerable attention has been devoted, and to which I hope to return at an early date in greater detail.

Volcanic Ash Deposit.

Extent of the deposit.

A circumstance of some interest in connection with the later superficial deposits of that part of the Upper Yukon basin drained by the Lewes and Pelly rivers, is the occurrence of a wide-spread layer of volcanic ash or pumiceous sand. The existence of a peculiar white line or band in the upper parts of scarped banks along the river, was first remarked not many miles below the point at which we reached and embarked on the Pelly. As its character was not at first understood, I omitted to note the precise point at which it was first seen but am of opinion that it probably extends to the east of the place where we reached the river. After recognizing its character and importance, however, it was looked for and noticed almost continuously along the whole course of the Pelly, as far down as the mouth of the Macmillan, beyond which, to the site of Fort Selkirk at the mouth of the Lewes, it was not distinctly recognized, but according to Mr. McConnell (1888) it extends down the river for about ten miles below Fort Selkirk. It is likewise seen along nearly the whole course of the Lewes, being last noted at the narrows between Lake Nares and Bennett Lake, known as Caribou Crossing. *

Origin of the deposit.

This ash deposit appears to be entirely due to a single period of eruption. It is homogeneous in character wherever seen, forming a single layer not divided by intercalations of other material, and has been spread everywhere over the entire area characterized by it. It is much more recent in date than the white silt deposits, which are the last of those properly referable to the glacial series, having been deposited after the river-valleys were excavated in the glacial materials, and at a time when the rivers had cut down nearly or quite to their

* I found subsequently that Schwatka had observed this peculiar layer along the Lewes and correctly characterized it as a volcanic ash. Along Alaska's Great River, p. 196.

present levels, a fact rendered evident by the circumstance that it overlies the deposits of river- and valley-gravels and sands in all cases, except in those of some low river-flats, where these deposits sometimes cover it to a depth of several feet. In most places it is overlain merely by the surface soil with a depth of six inches to two feet, and in a few instances it was noted as constituting the actual surface of terraces of moderate height, the present forest being rooted in it.

Mode of deposition and thickness.

The ash appears to have fallen tranquilly, much in the manner of snow deposited from a calm atmosphere. The examination of scarped banks along the two rivers showed it to occur near the surface of terraces about 200 feet in height, as well as on lower terraces and river-flats down to within about ten feet of the actual river-level in August and September. It was also detected in some places on the sloping fronts of terraces. The thickness of the layer was no doubt originally pretty uniform, and it still retains this uniformity where it rests upon wide flat terraces. Its average normal thickness for the Pelly, as a whole, was estimated at about five inches, but this is somewhat exceeded along the part of the river immediately above the Macmillan. On the Lewes, below Rink Rapid, its normal thickness is about a foot, but above this point it becomes much less and where last seen, at Caribou Crossing, is not over half an inch thick, and only to be recognized when carefully looked for.

Local accumulation.

In addition to these differences in normal thickness, however, and much more striking than them, is an irregularity due to local circumstances. Thus in hollows, and particularly when these occur at the foot of steep slopes, the material has evidently been washed together by rains occurring shortly after its deposit, and sometimes attains a thickness of as much as three feet. In correspondence with this it has been completely removed from some sloping or exposed surfaces. The same local circumstances explain the varying depth in different localities of the soil or ordinary sand which overlies the ash deposit.

Where the ash deposit rests undisturbed upon the original surface, this appears very generally to be a yellowish or reddish quartzose sand. There are, in some cases, remains of burnt trees at the base of the layer, and traces of similar forest fires are found as well in the sand or soil overlying it.

Source of the ash deposit.

So far as the observations I was able to make go, the volcanic ash is thicker on the lower part of the Lewes than elsewhere, and the thickest part of the deposit on the Pelly lies nearly due east of the portion of the Lewes just referred to. The greater mass of the deposit in that direction, seems to show that it was derived from the westward, and a line drawn across the portions of the Pelly and Lewes above defined, lies between the 62nd and 63rd parallels of latitude, with a nearly east-and-

west bearing, so that if produced to the westward it would pass, at a distance of about 200 miles, through the mountain region near the Copper River, of Alaska, which includes Mount Wrangell. Mount Wrangell is the nearest known volcano,* and this or one of the

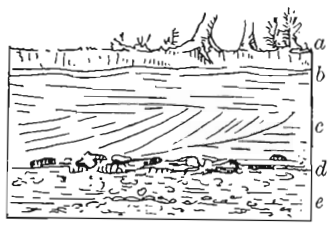


FIG. 1. RELATIONS OF ASH-BED ON THE LEWES RIVER.

a. Soil. *b*. Ash-bed. *c*. Stratified sands and gravels. *d*. Buried drift-wood. *e*. Stratified gravels.

neighbouring mountains in the same group, may not improbably have been the source of the material which has been so widely spread over the Upper Yukon basin. It should be stated, however, that the Indians report the existence of a burning mountain near the head-waters of the White River, and that it is uncertain whether this report refers to Mount Wrangell or to some still unknown mountain which may be even nearer to the district here described.

Date of the eruption.

Respecting the date of the eruption to which the ash-bed is due, very little can be said with certainty. As already noted, the rivers have not certainly cut their beds perceptibly deeper since the deposit occurred on their flood-flats, so that the period to which it belongs cannot be an exceedingly remote one. It was further observed in one place, on the Lewes, to rest upon stratified sands a few feet thick, which in turn overlie a mass of drift logs still quite sound and undecayed. This fact, with the general appearance and mode of occurrence of the deposit, leads me to believe, that while the eruption must have happened at least several hundreds of years ago, it can scarcely be supposed to have taken place more than a thousand years before the present time. Dall, in his work on Alaska, gives a list of volcanic eruptions (derived from Grenwingk) which have occurred in the Aleutian Islands and along the western part of the Alaskan Coast from the year 1690. † While it is quite improbable that any of these was connected with the formation here described, it is interesting to note that great quantities

* See Lieut. H. T. Allen's Reconnaissance in Alaska, Washington, Government, 1887.

† Alaska and its Resources, 1870, p. 466.

of ash were observed to fall on several occasions, notably in 1825, when the whole peninsula of Alaska was covered with black ashes.

Volume of ash ejected.

That the eruption of which the occurrence is marked by the ash-bed of the Lewes and Pelly, was on a great scale, is sufficiently evident from the extent of the deposit; which must necessarily be very much greater than the area to which the present observations refer. By drawing a line such as to include the outer limits of the observed extent of the ash, a roughly triangular area of about 25,000 square miles is outlined, and if we assume the average depth of the layer over this area alone to be three inches, the mass represented would be equivalent to a prism one mile square, with a height of 6240 feet or (making allowance for interspaces in the comminuted material) equal to nearly a cubic mile of rock.

Lithological character.

It has not been considered necessary to make a complete examination of the character of this ash. In appearance it is a fine, white, sandy material, with a harsh feeling when rubbed between the fingers Microscopically it is found to consist chiefly of volcanic glass, part being merely frothy and pumiceous, but of which the greater portion has been drawn out into elongated shreds, frequently resembling the substance known as "Pele's hair," in which the enclosed vesicles become more or less completely tubular. In addition to this glass, fragments and small perfect examples of sanadine felspar crystals occur together with portions of minute crystals of hornblende and probably of other minerals.

The Stikine River.

General Features.

River cuts across the Coast Ranges.

Since the year 1873, when the placer gold mines of Cassiar were first developed, the Stikine River has become a somewhat important avenue of communication from the coast to the interior of the northern part of British Columbia. Like the Fraser, the Skeena, the Nass and several other smaller streams, it rises to the east of the broad belt of mountains which constitutes the Coast Ranges, and cuts completely through this belt with a nearly uniform gradient. In size and general character the Stikine closely resembles the Skeena, which reaches the coast 200 miles further south. It is navigable for stern-wheel steamers

Route to the interior.

of light draft and good power, to Glenora, 126 miles from Rothsay Point, at its mouth, and under favourable circumstances to Telegraph Creek, twelve miles farther. Above Telegraph Creek is the "Great Cañon" which extend for many miles and is quite impassable either for steamers or boats, though traversed by miners in winter on the ice. The head-waters of the Stikine are unknown, but lie for the

most part to the south of the 58th parallel of north latitude, in a country said to be very mountainous, interlocking there with northern branches of the Nass and western feeders of the Black or Turnagain River, a tributary of the Liard. From Telegraph Creek, the head of navigation, a pack-trail sixty-two miles and a-half in length, constructed by the British Columbian Government, follows the valley of the Stikine, generally at no great distance from the river, and eventually crosses from the Tanzilla or Third North Fork to the head of Dease Lake, which may be regarded as the centre of the Cassiar mining district. This route has long been known to the Indians, the Stikine having been to them from time immemorial an important avenue of trade, by which, as by the Skeena, the coast tribes penetrated a considerable distance inland.

Information obtained.

My personal acquaintance with the Stikine, as far as Telegraph Creek, was such only as could be made from the deck of the little steamer in which we ascended the river to that point, and merely enabled me to note the main features of the valley. This was supplemented, however, by the observations of Mr. McConnell, who remained behind for the purpose of making a micrometer survey of the river from the furthest point reached by Mr. Hunter's survey of 1877 to Telegraph Creek. Mr. McConnell's notes and map with specimens collected by him have been consulted in the following sketch of the river, and are drawn upon particularly in respect to its geological features.

Map of the river.

As the result of Mr. McConnell's survey, taken in conjunction with that of Mr. Hunter, we are now for the first time in possession of a correct map of the river to the head of navigation. The best general map of the river and route to Dease Lake previously in existence, was a sketch made by Mr. G. B. Wright and published in the report of the Minister of Mines of British Columbia in 1875. This map also includes Dease Lake and part of the Dease River, and I may take this opportunity of stating that much credit is due to Mr. Wright for its general accuracy, taking into consideration the circumstances under which it was made.

Trend of the main valley.

The general trend of the Stikine valley for twenty miles from the sea, is east-and-west, corresponding in direction to Bradfield Canal, which penetrates the coast thirty miles to the south, and also to part of the northern portion of Behm Canal and Burroughs' Bay, still further south. At this distance from the coast the river bends through a quadrant of arc, and assumes a nearly due north direction, which it maintains for about sixty-six miles, beyond which the valley is continued in a nearly direct north-eastward course to the vicinity of Dease Lake, but in its upper portion is occupied, not by the main river, but by the Tanzilla or Third North Fork, the main river entering this continuous valley from the southward.

The Coast Mountains.

The particular range of the Coast Mountains, which locally assumes a culminating or axial character on the Stikine, is that which is traversed by the river-valley near the great bend above alluded to. As seen from the sea, at some distance off shore, it is notably higher and rougher to the north of the river-valley than to the south of it, and is surmounted by sharp, jagged, rocky pinnacles in some places. The highest summits in this range here probably average about 8000 feet. It carries much snow throughout the year, and in it are the sources of the principal glaciers which debouch along the north-and-south part of the river above the great bend. The inland border of the Coast Mountains may be said, on the Stikine, to be near Glenora, giving a transverse width, from the coast, for this rugged belt of country of nearly eighty miles.

Current of the river.

The current of the navigable portion of the Stikine is swift throughout, but there are no rapids properly so called, though the Little Cañon (fifty-three miles above the great bend) forms a serious impediment to navigation when the river is at its highest stage in June or July, in consequence of the great velocity of the current in this narrow and rocky though deep gorge. Near the mouth of the river the current scarcely surpasses two miles an hour, but it increases as the river is ascended, till it attains a rate of six to seven miles in many places between the great bend and Telegraph Creek, the swifter water being chiefly met with above the Little Cañon. The average rate of flow of the navigable portion of the river must be about five miles an hour. The width of the Stikine immediately opposite Telegraph Creek was found on May 29th to be 480 feet only, but it is here deep, and had a velocity of 6·08 miles per hour, as determined from several observations. A few days later it was rising fast, and the velocity was considerably greater.

Navigation.

Stern-wheel steamers for the navigation of the river should have good engine power, and should draw not more than four feet of water when loaded.

The height of the river above sea-level at Telegraph Creek, as deduced from simultaneous barometric observations at the mouth and at this place, is 540 feet, giving an average fall of over four feet to the mile by the course of the stream. The actual fall on the upper part of this length of the river must, however, considerably exceed this figure, while that of the lower portion is inconsiderable. Under ordinary circumstances the ascent of the river to Telegraph Creek, with a suitable steamer, occupies about three days, and it is generally necessary to carry a line ashore at a few places. The extensive flats near the mouth of the river render it necessary to enter it about high-tide. Mr. Hunter ascertained that the channel across these

flats has from one to two feet only of water at low tide. A considerable proportion of the traffic is carried on by Indians with canoes, and the Stikine Indians are very expert in all the necessary operations of tracking and poling in swift water.

Notes on the dates of opening and closing of the river will be found on page 60 B.

Lower part of river at one time an inlet.

The entrance to the Stikine from the sea is not distinguishable in its main orographic features from that of many of the salt-water inlets by which this part of the West Coast is dissected. The lower portion of this river-valley may, in fact, be regarded, like that of the corresponding part of the Skeena, as an inlet which has become filled with detritus in consequence of the great size and sediment-carrying capacity of the river which has emptied into it. Unlike the Skeena, however, the *débris* brought down has in this case been projected seaward so as to completely block the wide channel between the mainland coast and Mitkoff Island with shallow tide-flats and bars, above which several smaller, high, rocky islands project. The mountains immediately bordering the valley of the Stikine at its seaward entrance are from 2000 to 3000 feet in height, and rise abruptly from the wide alluvial flats, through which the river there winds, often without even touching the lower spurs of the hills.

Character of valley to Little Cañon.

The flats are generally covered with fine groves of cottonwood, mingled with spruce and other trees, and are often cut through by sloughs and channels, which become so numerous in some places as to render it difficult to decide which is entitled to rank as the main stream. The valley-bottom maintains an average width of from two to three miles as far up as the Little Cañon, which place may be regarded as nearly marking the head of the old salt-water inlet which has been silted up by the river. The cañon is about three-fifths of a mile long, and in places not more than fifty yards wide. It is bordered by massive granite cliffs, 200 to 300 feet in height, above which, on the west side, rugged mountain slopes rise. On the east, are low rocky hills representing part of a former spur of the mountain, through which the cañon has been cut. A tract of low land separates these hills from the eastern side of the main valley, and it is difficult to explain under what circumstances the river has taken its present course.

Valley above Little Cañon.

For some distance above the Little Cañon the Stickine valley appears to cut very obliquely through a series of somewhat irregularly parallel ranges. Eight miles further up is the "Kloochman Cañon," which to some extent repeats the features of the last, but it is nearly 300 feet in width and offers no impediment to navigation. At four miles above the "Kloochman Cañon" is the so-called "Grand Rapid," which, in consequence of recent changes in the river, is now by no means formid-

able, though the water is still particularly swift and the river wide and shallow. Here the valley begins very markedly to open out, the mountains retiring further from the river and decreasing in altitude, while irregular, basaltic hills, of no great height appear between the river and the bases of the mountains. This, taken in conjunction with the dry climate which characterizes the country to the east of the mountains, and the fact that most of the slopes have been bared of timber by fire, gives an entirely different aspect to the landscape.

Iskoot River.

The Stikine is joined by some important tributaries in the part of its course above described, though none of these have yet been examined in detail. The Iskoot or Skoot, which flows in from the eastward about thirty-five miles from the mouth, or just within the locally culminating range of the Coast Mountains, is known to be navigable for some distance by canoes, and one branch is said to head not far from the extremity of Portland Canal, to the southward. By following this river to its head and there making a portage, the Indians are reported to be able to reach the Nass River without difficulty. The Iskoot has been prospected by a few miners, but apparently without any notable result, though the Indians report the occurrence of coal. The northern branch of the Iskoot, to the east of the Coast Mountains, was traversed in 1867 by P. J. Leech, of the Western Union Telegraph Exploration Survey, who crossed from it to the head of the First South Fork of the Stikine. The valley is there reported to be from 2500 to 3700 feet above sea-level, generally timbered, but with some open, grassy slopes.

Scud River.

About seven miles below the Little Cañon, the valley of the Scud River opens to the east, but the exact position of the mouth of the stream has not been fixed on the map. Some gold has been found by prospectors on this stream, but no workable placer deposits. It is said to head in a low country behind the Coast Mountains, and if this be correct, must nearly inosculate with branches of the Iskoot and First South Fork of the Stikine.

Clearwater River.

Six miles above "Kloochman Cañon," the Clearwater River enters the Stikine on the west side, by several mouths. This is a stream of considerable size, and is navigable for canoes for some distance. It is said to head near the sources of one branch of the Taku River, and is noted by the Indians on account of the great number of salmon which ascend it.

First South Fork.

The First South Fork joins the Stikine about a mile and a-half below Telegraph Creek. It is a large turbid stream, and for a number of miles from the main river, flows in a rough narrow gorge, between high hills and mountains. Further up, according to the Telegraph Exploration sketch, it is bordered by level, partly timbered terraces or

"benches." The summit between its head-waters and those of the Iskoot, on the route followed by Mr. Leech, is given on his authority at 5000 feet. Salmon do not ascend this stream.

Telegraph Creek and Glenora.

Telegraph Creek is an inconsiderable stream, which falls rapidly to the river through a narrow rocky cleft in the bordering hills of the right or north-west bank of the Stikine. Its name is due to the fact that here the Western Union Telegraph line was intended to cross the Stikine. The little town of Telegraph Creek occupies the narrow delta of the stream and the lower terraces bordering it on both sides, its site being identical with that of "Fort Mumford" of the older maps. Glenora, twelve miles below Telegraph Creek and on the same side of the Stikine, consists of a single row of houses built along the edge of the river at the foot of a steep bank. Both places were at one time busy little towns, but are at present very much reduced in importance, though I believe it will probably not be long before further mining developments in the Cassiar district will lead to the renewal of their activity.

Glaciers.

Previous notes on the glaciers.

The glaciers constitute one of the most remarkable features of this part of the Stikine valley. There are a number of these on both sides of the river, in its lower part; but four only of special importance, all of which are situated to the west of the river, and all but the first on the eastern slopes of the most massive central ranges of the mountainous region. The only detailed previous notice of these glaciers is that given in a report by W. P. Blake.* Mr. Blake's account of the glaciers is transcribed in the Fifth Annual Report of the United States Geological Survey, where it is placed under the somewhat misleading title of Glaciers of "Alaska." Two of the glaciers are illustrated in the last-mentioned volume by reproductions of photographs taken under the direction of Dr. J. W. Powell, Superintendent of Indian Affairs in British Columbia. That named the "Orlebar Glacier" represents part of the front of the Great Glacier of the miners and of Mr. Blake's map. The "Bernard Glacier" I am unable to identify with any certainty, but the illustrations evidently represents part of either the Flood or Dirt Glacier.

Mr. John Muir, who spent some time on the Stikine in 1879, gives an interesting popular description of its glaciers in a letter dated from Sitka in December of that year, and published in the San Francisco Bulletin. Mr. Muir informs me that no more systematic account of his observations in this region has yet been made public. The glaciers

*Geographical notes upon Russian America and the Stikeen River. W. P. Blake, Washington, Government. 1868.

are also noticed at some length in an account of a trip on the Stikine by Mr. W. H. Bell in Scribner's Monthly, 1879, Vol. XVII. The accompanying illustrations, though striking and artistic, have been idealized so far as to be scarcely recognizable.

Little Glacier. The glacier known as the First or Little Glacier by the miners (named the Popoff Glacier by Blake) fills a high valley on the north side of the river, about ten miles from its mouth. As seen from a distance it offers no features of particular interest, resembling many other minor glaciers of the Coast Mountains.

Great Glacier. The next and most important glacier, is that universally known on the river as the Great Glacier, and so named also by Mr. Blake, who gives an excellent description of its main features. The high snow-fields from which this glacier must take its rise are not seen from the river, the glacier entering the wide valley of the Stikine nearly at right-angles, through a break in the mountains two to three miles distant from the river bank. Before entering the Stikine valley, the glacier has a width estimated at from one-half to three-quarters of a mile, but upon freeing itself from the bordering mountains immediately expands in a fan-like manner, its actual front upon the river being from three to three and a-half miles in width. The slope of the surface of the glacier where it issues from the mountains was estimated — as seen at right angles — at above five degrees. Beyond this point it flattens out, and portions of the surface become extremely rugged, breaking off near the front in series of descending steps, as described by Mr. Blake. When seen by us, on the 20th of May, much of the surface was still covered by the new snow of the preceding winter, but notwithstanding this, a great quantity of rocky *débris* was visible, giving a grey tint to portions of the ice. The front of the glacier appears to be quite close to the edge of the river, but is actually about a third of a mile distant at the nearest points. This interval is occupied by moraines and marshy pools, the outer tier of moraines, or that nearest to the river, forming wooded hills about one hundred and fifty feet high. The newer moraines were partly covered and overridden by the front of the decaying ice. Large streams issue from beneath the ice, the position of outflow frequently changing from year to year.

Next to its size, the most remarkable feature about this glacier is the regularity of the fan-like form in which it terminates. It resembles in this respect the Davidson Glacier on Lynn Canal.

Recession of the glacier. The miners state, that during the few years which they have known the Stikine the Great Glacier has steadily and notably receded, though the total amount of such recession can evidently not have been more than the distance from the wooded bordering-moraine to the present

ice-front. The Indians relate as a tradition, that at a former period the glacier stretched completely across the valley, the Stikine passing beneath the ice through a tunnel-like opening. It is, however, impossible to determine whether this is a remembered fact or a fancied inference. Curiously enough, a copious hot spring is situated immediately opposite the glacier on the east side of the Stikine valley.

Dirt Glacier.

Ten miles above the Great Glacier, and also on the west side of the valley, is the Dirt Glacier, so named by the miners because of the great quantity of rocky *débris* with which its surface is covered.* This is much smaller than the last, having a width estimated at a quarter of a mile, but possibly greater than this. Like the Great Glacier, it comes quite down on the river-flats.

Flood Glacier.

The last important glacier, sixteen miles still further up the river, is the Flood Glacier. This also comes down to the level of the river-flats, but does not closely approach the river. From the valley of this glacier a great rush of water occurs almost every year towards the end of the summer. This, no doubt, arises from the blocking by the glacier of the mouth of some lateral valley in which a lake is formed and from time to time breaks through the glacier dam. The quantity of water thus liberated is so great as to raise the river from a low stage to half-flood level for a short time. There is a large quantity of *débris* also on this glacier, though less than on the last.

Geological Notes on the Stikine.

Mr. Blake's observations.

The only information as to the geology of the Stikine, up to the present time, has been that embodied in notes in Mr. Blake's report, already referred to,† and these include the lower portion of the river alone, as his furthest point was a few miles above the Little Cañon. The results of Mr. Blake's examination are by himself summed up in the following terms:—"The mountains of the Stikine valley, from the Little Cañon down to near the coast, are formed of syenite and granite, with some metamorphic beds at intervals. The walls of the Little Cañon are granite. At the mouth of the river, and below the Indian villages, the rocks are quite different, being formed of the great sandstone and shale formation already described. The direction of uplift of these strata is about N. 80° W. magnetic. This formation is some thousands of feet thick, and resembles the rocks of San Francisco, but is more changed by metamorphic action. They are probably of the secondary period. It appears to pass into mica-

* Also so named on sketch map in Report on Customs District, Public Service and Resources of Alaska Territory, by W. G. Morris, 1879.

† Mr. Blake's notes on the geology of the river are also given in Petermanns Mitteilungen, vol. x, 1864.

slate just above the site of an old stockade or fort of the Hudson Bay Company, where I found a locality of garnets like those of Monroe, in Connecticut."*

Rocks of Wrangell Island.

The rocks seen along the west shore of Wrangell Island, in the vicinity of the town and harbor, are chiefly black, flaggy argillites, remarkably uniform and regular in their bedding and with a westward dip. They are considerably indurated and contain small staurolite crystals in some layers, while on the surface of others crystals of mica have been developed. Similar rocks are found on other parts of the coast, both to the north and south, and from a lithological point of view, they much resemble the Triassic argillites of the Queen Charlotte Islands, though no fossils were found at this place. The ridge behind the town of Wrangell is chiefly composed of rather fine-grained grey granite, which is probably intrusive and may have been the cause of the incipient crystallization observed in the argillites. The north point of the island is formed of similar granite, probably a continuation of the same mass.

Rocks at mouth of river.

On crossing to the mainland, to the eastward, mica-schists and granites are met with, and beyond Rothsay Point (which may be regarded as the entrance to the Stikine River) granitic rocks only were seen for some miles. Near Rothsay Point, at a short distance from the shore,

Garnets.

is the locality from which are obtained fine claret-colored garnet crystals, sometimes an inch or more in diameter. The matrix of these, as seen in hand specimens, is a dark, highly crystalline mica-schist, but the locality was not visited. The general strike of the rocks west of Rothsay Point is about S. 35° E., with prevailing westward dips.

Rothsay Point to Great Glacier.

From Rothsay Point to the Great Glacier, the mountains bordering the river are chiefly composed of granites and granitoid rocks. These alternate with gneissic and schistose rocks of similar composition, including mica-schists; but massive granites probably form much the greater part of the whole. The granites are usually grey in colour, and contain both hornblende and mica, with white felspars, which are often porphyritic, giving the rock a spotted appearance.† Some varieties become granitoid diorite, while others are highly quartzose, and contain little or no hornblende. The series as a whole closely resembles that cut across by the Fraser River in its lower course, and generally characteristic of the Coast Ranges of British Columbia.‡

Rocks brought down by the glacier.

The Great Glacier, rising many miles back in the higher ranges of the mountains, in the material which it has brought down and deposited in its moraine, affords a mode of ascertaining the gen-

* This does not appear to be the locality near Rothsay Point, subsequently mentioned.

† See note on the lithological character of the granites, Appendix V.

‡ Compare Annual Report Geol. Surv. Can., 1886, p. 11 B.

eral composition of the central ranges. This material was found by Mr. McConnell to consist almost entirely of grey granite of medium grain, composed of felspar, quartz and hornblende in nearly equal proportions, but holding also a little mica and occasional crystals of sphene. Diorites and mica-schists occur in smaller quantity, together with coarse pegmatite, which is evidently derived from veins intersecting the granite.

Kloochman Cañon to Grand Rapid.

Similar granitoid rocks, with occasional schistose areas, constitute the whole of the rock-exposures seen along the river to the so-called Grand Rapid, about four miles above "Kloochman Cañon". The mountains bordering the valley also appear to be entirely, or almost entirely, composed of the same materials, though at one place, (nearly opposite the site of the Hudson Bay Company's old post) the upper portion of a mountain seems to show a massive bedding, recalling that of the Cretaceous quartzites of Tatlayoco Lake, which occur there in a similar position relatively to the Coast Ranges.* No further evidence was, however, met with tending to show that rocks of this age occur here.

Stratified rocks at Grand Rapid

A short distance below the "Grand Rapid," distinctly stratified rocks of dark colour are seen capping some of the mountains and resting upon the granites. These beds have a dip of N. 70° E. $<$ 30°, which brings them down to the level of the river near the rapid. They are there found to consist of hard argillites and grauwacke-quartzites, interbedded with shaly, grey and brownish impure limestones, the whole being considerably disturbed and cut near the granites by coarse grey porphyritic dykes of that rock. The argillites were not observed to hold staurolite, mica, or other crystalline minerals like those of Wrangell, and otherwise differ somewhat in appearance from these, though their relation to the granitic rocks appears to be similar. They are followed in ascending order by a massive grey-blue subcrystalline limestone of considerable though undetermined thickness, which can be traced in the mountains for some distance on both sides of the valley. These limestones are believed to represent those afterwards noted on the Dease and there referred to the Carboniferous period.

Altered volcanic rocks.

About two miles and a-half above "Grand Rapid," near the mouth of the Clearwater, the limestone is followed—apparently still in ascending order—by a series of altered volcanic rocks which are, for the most part of grey and greenish colours. These are apparently chiefly diabases, but include also porphyrite-like rocks. The rocks are generally rather fine grained, and would require microscopic examination before they can be named in detail.† Though clearly forming a

* Report of Progress, Geol. Surv. Can., 1875-76, p. 253.

† One of these which has been microscopically examined by Mr. F. D. Adams is described in Appendix V. as a diabase-porphyrite (Stikine No. 16.)

stratified series, evidence of bedding can seldom be detected in the exposures, in consequence of their homogeneous composition and shattered state. They seem to be identical with those forming a part of the Câche Creek group, in the southern interior of British Columbia, and though no fossils were found in the limestones previously mentioned, they, and possibly also the argillites beneath them as well, may be referred with considerable probability to the same Upper Palæozoic age.

Argillites and limestones.

Altered volcanic rocks only, like those above noted, were seen along the river for about twelve miles above the Clearwater, but there is reason to believe that outliers of Tertiary basalt also occur in this part of the valley. At the distance just mentioned above the Clearwater, and about six miles and a-half below Glenora, exposures are found of slaty argillites and dark shaly rocks, containing some impure limestone, all very much broken and disturbed, and associated with altered volcanic materials. Some beds of these shaly limestones prove on microscopical examination to consist chiefly of organic fragments which are not, however, sufficiently distinctive for the reference of the beds.

Triassic fossils.

Dark shaly rocks occur near Glenora which were not specially examined. It is probably from these that some specimens containing Triassic fossils, which were given to me some years age by Mr. J. W. McKay, were derived. The form represented is a species of *Holobia*, probably a finely sculptured variety of *H. Lommeli*.

Tertiary volcanic rocks.

From this point to Telegraph Creek, basaltic and other comparatively modern volcanic rocks become prominent features, the basalts appearing as remnants of horizontal flows, the broken edges of which form scarped cliffs. These rocks are due to a period antecedent to that of the glacial deposits, and are of Tertiary age. Analogy with neighboring parts of British Columbia indicates that they may be assigned with probability to the Miocene. The basalts have evidently flowed along and partially filled the old river-valley, and unconformably overlie the old altered volcanic rocks previously alluded to, as well as all the other rock series.

About two miles below Glenora, the basaltic rocks were noticed in one place to have filled the old river-bed, conforming in their lower layers to the slopes of its sides, and to have been subsequently cut across obliquely by the present river. Other examples of this character are mentioned on following pages and are of special interest in connection with the occurrence of placer deposits of gold.

Palæozoic and Cretaceous rocks.

Between Glenora and Telegraph Creek, the rocks seen below the basalts include at least two distinct series. The first and oldest of these is represented by a number of occurrences of altered volcanic rocks, like those previously referred to, as well as by considerable exposures

(beginning about a mile above Glenora) of grey and blackish, rather cherty quartzites, often nearly on edge. The second consists of slightly indurated conglomerates, sandstones and shales, the conglomerates being often very coarse and containing pebbles both of the older volcanic series and of the granites and granitoid rocks. These lie at comparatively moderate angles of inclination. No fossils were observed in them, but in their lithological character as well as in their position relatively to the Coast Ranges, they resemble rocks of Cretaceous age met with in other parts of British Columbia, both to the south and north of the Stikine, and may be provisionally referred to that period.

Rocks near Telegraph Creek.

In the immediate vicinity of Telegraph Creek, the prevalent rock is a grey-green, speckled, altered volcanic material, which proves to be a fine-grained diabase-tuff. * The high hill immediately opposite Telegraph Creek, on the other side of the river, is composed of similar old volcanic rocks, comprising compact diabase and a massive diabase-agglomerate.

Basalt flows.

About two miles below Telegraph Creek, on the right bank of the river, a portion of the basaltic filling of the old valley forms a range of columnar cliffs about 200 feet above the present water-level. A second similar remnant occurs just above Telegraph Creek, on the same side, and a portion of it extends up Telegraph Creek itself for a mile or more. Basaltic dykes, which may have served as sources of supply of molten material at the time of eruption, are found cutting the older rocks. Though in some cases simulating the appearance of terraces, the basaltic shelves along the sides of the valley are quite distinct from, and of earlier date than these.

Notes on map.

Notes on the various rocks met with will be found on the face of the map accompanying this report. The country to the east of the granitic rocks of the Coast Ranges would require much time and attention before its somewhat complicated geological structure could be properly defined.

Fossiliferous limestone.

In the gorge of Telegraph Creek, a large boulder of grey sub-crystalline limestone was found, closely resembling in character and degree of alteration that seen near the "Grand Rapid," but in this case containing large branching corals and numerous *Fusulinæ*, indicating its Carboniferous age. It is of course impossible to state with certainty whence this boulder was derived, but it may very probably have come from the mountains to the north within the drainage-area of Telegraph Creek.

The portion of the Alaskan coast which I have seen, viz., that to the south of the 59th parallel, shows the same general absence of

* See Appendix V. (Stikine No. 25.)

Terraces.

terrace deposits which has already been noted and commented on in the case of the British Columbian coast. In the vicinity of the mouth of the Stikine, terraces fifteen to twenty feet in height are found, resembling the wooded flats met with further up the river, but as they are here upon tide-water, indicating, doubtless, an elevation of the coast-line to that amount. Further up the river, the first appearance of high-level terraces is at about two miles below the Great Glacier. Those here seen are quite narrow, and were estimated to be 500 and 700 feet, respectively, above the river. The river, for the first time, shows bordering-terraces of from thirty to fifty feet in height, about six miles below the Little Cañon, and similar terraces are frequently seen above this point. On the mountain above Glenora a distinct but small terrace was seen from a distance at an estimated height of 1500 feet above the river. At Telegraph Creek the two principal terraces are 90 and 200 feet respectively above the river-level.

Gold.

The mode of occurrence of gold on the Stikine, and the placer mining which has occurred along the river, are described on a subsequent page, in connection with facts on gold mining in the Cassiar region generally. (See p. 79 B.)

Climate.

Two distinct climatic regions.

The traverse of the Coast Ranges by the Stikine River, from its mouth to Telegraph Creek, affords an excellent illustration of the difference between the coast and inland climates, repeating to a great extent the phenomena met with in making a similar traverse of the same ranges in the southern part of British Columbia. It is here, however, all the more remarkable, as so great a difference between these climates would scarcely be anticipated in this northern latitude. Some records of observations in Appendix VI may be referred to for details, but it may be stated here, as showing the broad general contrast, that while the annual precipitation at Wrangell, at the mouth of the Stikine, is over sixty inches,* that in the vicinity of Telegraph Creek on the inland side of the mountains, is so small that it is necessary to irrigate cultivated land.

Nor does this comparison of rain-fall sufficiently mark the great diversity which actually obtains between the two climates, the prevalence of clouded skies in the coast region being accompanied by a saturated state of the atmosphere, while precisely opposite conditions are found on the eastern side of the mountain belt, at not more than

* U S. Coast Pilot, Alaska, Part I, 1883, p. 271. The precipitation at Wrangell is moreover much less than that at more exposed parts of the Coast, for at Tongass and elsewhere it exceeds 100 inches annually,

eighty miles inland from the general line of the coast. The coast climate is, of course, much more temperate than that of the interior, which, even no further off than Telegraph Creek, becomes one of extremes. It is probable that the total annual precipation is even greater in the vicinity of the culminating and central ranges of the Coast Mountains than at Wrangell, and as a large proportion of this occurs as snow, it sufficiently accounts for the existence of the important glaciers and the heavily snow-covered appearance of the mountains till late in the summer. Miners state that the snow accumulates on the river-flats of the lower part of the Stikine, within the mountains, to a depth of from eight to ten feet, while at Telegraph Creek and on the Tahl-tan River it seldom exceeds eighteen inches, and at the latter places horses and mules have been wintering out for a number of years. The great depth of snow retards the advance of spring all along the portion of the river where it occurs, and thus by a cumulative effect conserves the already large quantity of snow for the supply of the glaciers, which are consequently due rather to the extremely heavy snow-fall than to the actual latitude of the region.

Bearing of snowfall on existence of glaciers.

When we left the coast, on the 19th of May, the hills near the sea were generally denuded of snow to a height of several hundred feet, but on entering the river patches of snow began to appear on the low flats, and a few miles further on these flats and the gravel-bars of the river were almost entirely covered with the old snow, quite down to the water's edge. The quantity of snow was observed to diminish somewhat where the river first turns to the north, but was again greater in the vicinity of the glaciers, and it was not till the Little Cañon was reached that the flats were found free from snow. From this point on, the improvement in the climate became quite marked, and the limit of snow retreated far up the mountain sides.

Observations on depth of snow.

In correspondence with the above facts, the vegetation is much further advanced in spring on the inland side of the Coast Ranges than elsewhere. Thus, at the date above mentioned, the cotton-woods and other deciduous trees at the mouth of the Stikine and along its lower part showed merely a general faint greenish tint as the buds opened. Four days later, in the vicinity of Telegraph Creek, the appearance was almost that of early summer. *Shepherdia Canadensis*, *Amalanchier alnifolia*, *Corydalus aurea* var. *occidentalis*, *Actæa spicata* var. *arguta*, *Prunus Virginiana*, *Arnica cordifolia*, *Viburnum pauciflorum*, *Saxifraga tricuspidata*, *Androsace septentrionalis*, amongst other plants, were in flower, and butterflies and humming-birds were abundant.

Climate and vegetation.

The change in species of plants met with in ascending the river is also clearly indicative of that from a very moist to a dry climate, as a reference to the lists in an appendix to this report will show. The

devil's club (*Fatsia horrida*) extends only a few miles above "Kloochman Cañon," while *Elæagnus argentea* and other forms characteristic of a dry region were first seen at Telegraph Creek. The state of progress of the season at this place appeared to be nearly, if not quite, equal to that found at a similar date in the vicinity of Ottawa or Montreal.

Local climatic differences.

The local differences of climate are, however, quite important. Thus Glenora, though about twelve miles only from Telegraph Creek, is said to experience much greater cold in winter, and the snow-fall is also greater, being estimated at three feet and a-half. Less snow falls on the Tahl-tan than elsewhere, the amount increasing both to the east and west of that place. Strong winds blowing up stream or inland are prevalent in the Stikine valley in summer, but occur in the reverse direction, as a rule, in winter. Further observations on the winter climate of the Stikine are given in Appendix VI.

Notes at Telegraph Creek.

During the few days spent at Telegraph Creek, in the latter part of May, the wind generally blew up the river and was often strong. The high distant ranges of the Coast Mountains to the west, were usually enveloped in clouds and heavy showers were there evidently of constant occurrance. The sky at Telegraph Creek was also as a rule largely obscured, but after passing over the Coast Mountains the clouds were more broken and produced merely a few drops of rain now and then, the conditions being similar to those met with in the dry country to the east of the same range in the Fraser valley, much further south.

Cultivation.

Cultivation in the vicinity of Telegraph Creek and Glenora is practically confined to the raising of small quantities of vegetables and of barley and fodder for animals. There is, however, in this vicinity, in the aggregate, a considerable area of land which might be tilled if there were sufficient local demand to warrant it. Excellent potatoes are produced, and though the leaves are occasionally touched by frost, the crop is seldom affected. It has further been ascertained by actual trial on a sufficient scale that not only barley, but wheat and oats will ripen, and that all ordinary garden vegetables can be produced. The record is a remarkable one for the 58th degree of north latitude.

Opening and closing of the river.

According to Mr. J. C. Callbreath, of Telegraph Creek, the Stikine generally opens for navigation between April 20th and May 1st.* Ice or 'sludge' usually begins to run in the river about the 1st of November, but has been noted in some years a fortnight earlier. The river generally freezes over before the end of November. Mr. Callbreath

* The season of 1887 was unprecedentedly late, the first canoe from the upper river reaching the coast only on May 18th.

states that the first sludge ice coming down from the smaller tributary mountain streams ceases to appear in the Stikine for a time after these are frozen over. As in the case of other rivers rising in the interior, the highest water occurs in the early summer, generally in June. Horses and mules find grazing on the Tahl-tan from April 20th, or May 1st to about December 1st, after which date they require some hay.

Discovery and Exploration of the Stikine.

Early notices of the river.

Though the position of the Stikine* is indicated on Vancouver's charts by the open channels of the river, and the shoals about its estuary are mapped, the existence of a large river was not recognized by that navigator, who visited this part of the coast in 1793. According to Mr. W. H. Dall,† the river was first found by the fur traders. "The sloop *Dragon*, Captain Cleveland, visited the Stikine delta in April, 1799,‡ and in the journal of the sloop *Eliza*,§ Captain Rowan, for the same year, we find the locality alluded to as 'Stikin'." It was, no doubt, visited as well by many of the trading vessels which about this time frequented the coast. In 1834 the Hudson Bay Company fitted out a vessel named the *Dryad* for the purpose of establishing a post and colony at the mouth of the Stikine, but the Russians being apprised of this circumstance sent two small armed vessels to the spot, and constructed a defensive work which they named Fort Dionysius, on the site of the present town of Wrangell. Finding themselves thus forestalled, the Company retired. This dispute was compromised in 1837, when an arrangement was made by which the Company leased for a term of years all that part of the Russian territory which now constitutes the "coast strip" of Alaska, and the "fort" was handed over to the Company, the British flag being hoisted under a salute of seven guns in June, 1840. In the same year, the post, which had been renamed Fort Stikine by Sir James Douglas, was attacked by the Indians, and in the following year a still more serious attack was threatened, and averted only by the timely arrival of Sir George Simpson, as recorded in his "Narrative of a Journey Round the World" (II, p. 181). In 1847, the coast Indians (Thlinkit) are stated to have attacked and taken possession of the fort. In the spring of 1840, the

Establishments of the Hudson Bay Co.

* The modes of rendering the native name of this river has been very varied, Mr. Dall enumerates *Stakeen*, *Stahkin*, *Stickeen*, *Stachin* and *Stikine*. (Pacific Coast Pilot, Alaska, Part I, 1883 p. 109; foot note.) The last mentioned has been generally employed by good authorities and is adopted here. Mr. J. W. McKay informs me that the name Stikine is a corruption of the native (Thlinkit) word *sta-hane*, meaning "the river," and equivalent to "the great river."

† U. S. Coast Pilot, Alaska, Part I, 1883, p. 110. From this work, and from Bancroft's History of the Pacific Coast, vol. xxxiii, several of the facts mentioned below are also derived.

‡ Cleveland's Voyages, Cambridge, Mass. 1842.

§ MS. in possession of Mr. Dall, but unpublished.

Hudson Bay Company established also a second fort on this part of the coast which was named Fort Durham. This fort was situated at a place named by the late Sir James Douglas, "Locality Inlet," about thirty miles southward from the mouth of Taku River and near the entrance of the Inlet of the same name, in sight of Douglas Island. It was abandoned in the spring of 1843, and is sometimes referred to as Taku Fort.

Dicovery of upper part of river.

Previous to this time, in 1834, Mr. J. McLeod, had in the interest of the Hudson Bay Company, reached the banks of the upper part of the Stikine, near Dease Lake, coming overland from the Mackenzie River. Subsequently, Mr. R. Campbell spent the winter of 1838-39 on Dease Lake, but established no fort on the Stikine.

Discovery of gold.

No further events of importance appear to have occurred in connection with the river till, in 1861, two miners named Choquette ("Buck") and Carpenter, discovered placer gold on its bars. In the following spring, some excitement being created by the announcement of this discovery, several prospecting parties were fitted out in Victoria, and a number of men passed the summer in mining on the river. In 1863, the Russian authorities, hearing of the discovery of gold, despatched the corvette *Rynda* to ascertain whether the mining was being carried on in Russian territory. A boat party from this vessel, under Lieutenant Pereleshin, ascended the river to a point a few miles above the Little Cañon, occupying May 23rd to June 1st on the expedition. Mr. W. P. Blake accompanied this party, and in addition to the sketch-map published by the Russians, his report on the Stikine, previously alluded to, is based on it.*

Hudson Bay Company's post.

A Hudson Bay post was established on the east side of the river in 1862 or 1863 and maintained till about 1874, when it was moved to the vicinity of Glenora, were it remained till 1878, when it was abandoned.

Telegraph exploration.

In 1866, explorations for the line of the Western Union or Collins' Telegraph Company were extended to the Stikine under Major Pope. These were continued in 1867 by Messrs. M. W. Byrnes, Vital Lafleur, W. McNeill and P. J. Leech, and embraced most of the principal tributaries of the river. The results of this work were not separately published, and the whole enterprise of which they were a part was, as is well known, abandoned. The sketch-maps then made were, however, partly embodied in the small map accompanying Mr. W. H. Dall's work on Alaska (1870), and with greater completeness in other subsequent maps of the region. The surveys made at this time, while doubtless sufficient for the object in view, and serving to

* Geographical Notes upon Russian American and the Stickeen River; Washington, 1868. Also, Am. Journ. Sci. and Arts, vol. xliv, 1867, p. 96.

represent the main features of the country traversed in a general way, leave much to be desired in the matter of accuracy.

In 1873, Messrs. Thibert and McCullough, travelling westward from the Mackenzie, discovered gold in the Cassiar region, and fell in with the miners already engaged on placer work on the Stikine in the autumn of that year. The subsequent history of the river depends on that of the Cassiar mining district, and need not be further followed in detail. Subsequent history of the Stikine.

Some years after the acquisition of Alaska by the United States, the Stikine came prominently into public notice for a time in connection with difficulties respecting territorial jurisdiction which occurred in regard to customs and other matters. A full account of these difficulties, together with a report by Mr. J. Hunter of his survey of the lower part of the river, made for the purpose of approximately determining the position of the line of boundary between Alaska and the province of British Columbia, is given in the Canadian Sessional Papers, Vol. XI, No. 11, 1878.*

A description of the Stikine is given in the U. S. Pacific Coast Pilot, previously quoted, as well as an itinerary of the river, but as no correct survey of the Stikine existed at the time (1883), the distances and details are only approximately correct.

Published Maps of the Stikine.

The following reference-list of published maps of the Stikine is based on that given by Mr. Dall in Appendix I to the Coast Pilot of Alaska, 1879.—

Russian Hydrographic Office chart No. 1396, Pacific Ocean on the North-west coast of America (published 1848). Also, Russian chart No. 1493-4 (published 1853), Alexander Archipelago. [These two charts, Mr. Dall informs me, show a part of the Stikine in such a way as to prove that it must have been surveyed.] Russian maps.

Plan of the Stikine River from observations by officers of the corvette *Rynda* in 1863. Russian Hydrographical Department, 1867.

Sketch-map of the Stickeen River from the mouth to the Little Cañon, W. P. Blake, *Op. supra cit.*, 1868. Blake's map.

Map of Cassiar District in Report of Minister of Mines of British Columbia, 1876. [This has remained the most complete map of the river up to the present time, and is a very praiseworthy sketch.] Wright's map.

Plan of Stachine (Stikine) River, by J. Hunter. [This, with other subsidiary maps, is contained in the Sessional Papers, Vol. XI, No. 11, 1878. It includes the lower part of the river only, but is from actual Hunter's map.

* See also Report by W. G. Morris, elsewhere referred to, p. 43 *et seq.*

survey and on a scale of 8000 feet=1 inch. It shows the provisional boundary line adopted without prejudice until the true line shall have been determined.]

Morris' map. Map showing boundary line in Morris' Report on Alaska. U. S. Senate, Ex. Doc. No. 59, 1879.

The river is shown on a small scale, according to the result of surveys here reported on, in a map accompanying a summary of the results of the expedition, in Science, Vol. IX, April 2, 1888.

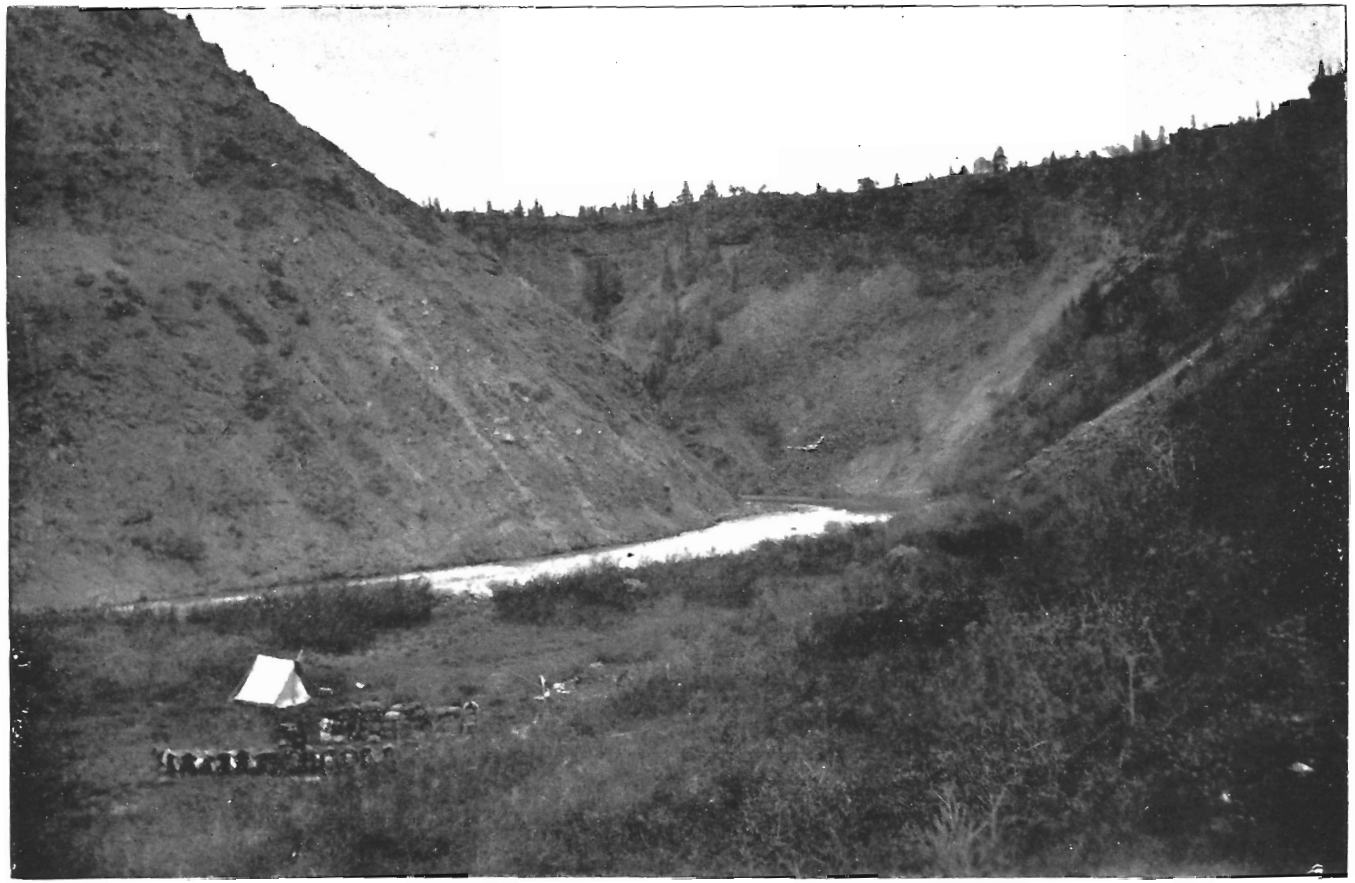
Cassiar Trail* (*Telegraph Creek to Dease Lake.*)

Route followed The trail from Telegraph Creek to the head of Dease Lake was opened by the Government of British Columbia in 1874. It has since been kept in a fair state of repair, and is a good route for pack animals. It follows the north side of the Stikine and Tanzilla valleys, and is sixty-two miles and a-half in total length As already mentioned, the same important valley which is occupied by the Stikine below Telegraph Creek, continues in a north-eastward direction to Dease Lake, the main stream of the Stikine entering it from the southward about midway between these two points.

Telegraph Creek to Tahl-tan. On leaving Telegraph Creek, the trail makes a steep ascent to the level of a broad terrace, and runs along at a considerable height above the river, and often at some distance from it, till it descends again, at eleven miles, to the valley of the Tahl-tan or First North Fork, near its mouth. The main valley of the Stikine is here about four miles in width, and is bordered by high hills and by mountains of rounded forms, those to the north often nearly bare, while those on the opposite side are generally either wooded or strewn, where fires have passed, with burnt logs. The river occupies a cañon, with precipitous banks often 300 feet in height, which has been cut in the bottom of this great valley. It is very rough and rapid, but there are no true falls. Terraces are well developed at several levels on both sides of the river, which is frequently bordered by vertical basaltic cliffs. The basalts have manifestly filled the bottom of the ancient valley in a series of nearly level flows, which have since been cut through by the present river, while the bordering hills are all composed of much older and probably Palæozoic rocks. A general summary of the geology of the country from Telegraph Creek to Dease Lake is given on a later page.

The country traversed by the trail between Telegraph Creek and the Tahl-tan is wooded only in patches, the trees being chiefly black pine (*Pinus Murrayana*) and aspen (*Populus tremuloides*), with occa-

* See note in Appendix II (p. 198) on the origin of the name Cassiar.



G. M. DAWSON, PHOTO., MAY 7', 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

TAHL-TAN VALLEY, AT TRAIL-CROSSING.

Bank on the right shews basalt, capping old gravel deposit. Hill on the left composed of older crystalline rocks.

sional specimens of white birch, and alder and willow in the hollows. The soil is reddish and rather sandy, and appears very dry, being but scantily clothed with thin, tufty grass and bear-berry (*Arctostaphylos uva-ursi*). The strawberry (*Fragaria Virginiana*) was abundant and in full flower on May 31st, while *Polemonium pulchellum* was also very conspicuous, and *Linnæa borealis*, *Echinospermum Redowskii* and *Arnica cordifolia* were also locally abundant. Thickets are composed principally of *Shepherdia Canadensis*, high-bush cranberry (*Viburnum pauciflorum*), roses, service-berry (*Amelanchier alnifolia*), red dog wood (*Cornus stolonifera*) and willows.

Indian village.

The Tahl-tan Indian village is seen near the trail, about a mile before the river of the same name is reached, but was at the time we passed quite deserted.

Tahl-tan River.

The Tahl-tan River is crossed near its mouth by a good bridge. It is a large and rapid stream, which rises about thirty miles to the north-westward. Its valley is narrow and almost cañon-like where it reaches the Stikine, and has cut through basalt flows and heavy underlying gravel deposits to a depth of about one hundred and fifty feet, though its right bank, just above the crossing, is composed of the older rocks. It is resorted to by the Indians for salmon fishing during a part of the summer, and there are several temporary houses and a number of graves. The angle between this river and the Stikine, on the right bank, shows three clearly defined, superposed, columnar basalt-flows. The opposite angle, up which the trail zig-zags, is in the form of a long, narrow point, the surface of which is extremely rough, being composed of large pieces of basalt lying in great confusion, with deep interspaces and crevices. This is generally known as the "lava bed," but its broken character appears to have been produced by the washing out of the underlying gravelly deposits, resulting in slides and irregular settlement of a once uniform basalt sheet. Notwithstanding its relatively recent appearance, the basalt here, as elsewhere along the Stikine, is of pre-glacial age, and was found, like the other basalt flows, to pass beneath the higher terraces. Gold mining was at one time carried on successfully for some miles up the Tahl-tan valley.

Sources of Tahl-tan

According to M. W. Byrnes, one of the Telegraph Company's explorers, the sources of the Tahl-tan are at a distance of about thirty miles from its confluence with the Stikine. It occupies a portion of an important valley which, still further to the north-westward, carries the upper branches of the Taku and the furthest sources of the Lewes River. The Indians travel along this valley, and it appears worthy of attention as a route from the navigable waters of the Stikine to the Yukon basin.

Tahl-tan to Tooya.

The distance from the Tahl-tan to the Tooya, or Second North Fork, is about six miles. For about half this distance, to Ward's house, (now, like other places of call along this route abandoned) the trail runs near the Stikine River, the immediate valley of which still continues to be occupied by basaltic flows. Above these, however, the sides of the valley are generally formed of very regular and high terraces, composed of horizontally stratified sands, gravels and earthy deposits, which though generally very fine, are rather silts than true clays. The gravels frequently include large boulders. At Ward's, the trail turns away from the river and cuts across a high point to the Tooya, the highest terrace-level crossed being about 1000 feet above the river. On these high terraces the vegetation was perceptibly less advanced than in the lower parts of the valley. Swampy spots are frequent, and the country, as we recede from the vicinity of the Coast Mountains, has evidently a somewhat more humid climate and is more subject to summer frosts. Potatoes and other crops are successfully grown at Ward's, situated on one of the lower terraces, but irrigation is there necessary.

Tooya valley.

The Tooya valley, where it is crossed by the trail, is a great gorge, about 600 feet in depth, cut out through the terrace deposits. The river, which is spanned by a small bridge, is a wild torrent—almost a series of cascades. Its scarped banks show a section of about 400 feet of the terrace deposits, which are of the character above noted, but include rough, bouldery and gravelly layers, and a number of large granite boulders occur in the bottom of the valley, resembling in their lithogical character the granites of the Coast Ranges.

Sources of Tooya.

Scarcely any authentic information is available regarding the headwaters of the Tooya, though these have been reached by prospectors from Dease Lake. A lake of considerable size is reported to exist on its upper part, as indicated in the accompanying map, and the volume of water in the river is such as to lead to the belief that it must drain a large area to the south of the Yukon watershed.

Plateau beyond Tooya.

About a mile beyond the Tooya, on the summit of a wide, undulating terrace, is Wilson's house. Here turnips and potatoes have been grown, but the potatoes do not fully mature. From Wilson's to Caribou Camp, about twelve miles, the trail crosses an extensive high terrace or plateau, with a nearly level or slightly undulating surface, which is generally wooded with aspen, black pine and white spruce of fair growth. A few very small streams, which flow toward the main valley, are crossed, but the river is generally some miles distant and scarcely visible from the trail. The Tooya valley is here said to run nearly parallel with the main valley of the Stikine and at no great distance from it, but is invisible from the trail. No mountains were

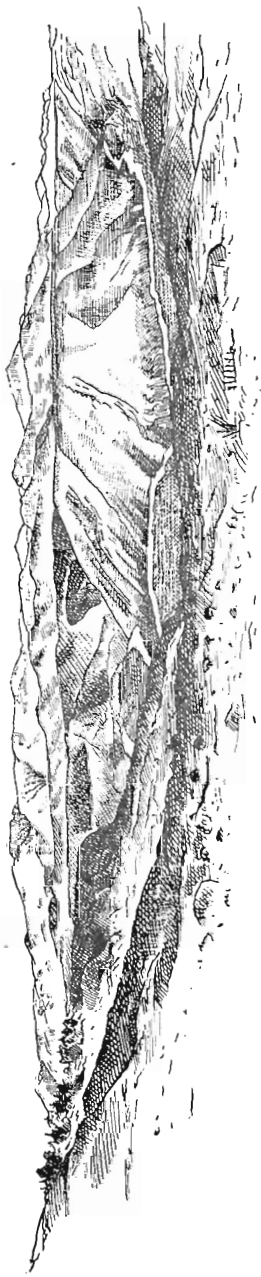


FIG. 2. VIEW OF THE TANZILLA RIVER, LOOKING SOUTH-EASTWARD FROM 'CARIBOU CAMP.'
Illustrating the character of the level terrace-country, based on stratified later-glacial deposits. (From sketch by J. McEvoy.)

here seen to the north-eastward, but high, rounded mountains, with broad, bare summits, continue to border the south-east side of the Stikine valley. About midway between Wilson's and Caribou Camp, the Stikine, or Too-dessa of the Tahl-tan Indians, coming from the southward, enters the main valley, cutting through the bordering mountains in a narrow cañon, which the Indians report impassable. Their route to the upper waters of the river crosses the mountains to the west of this cañon. They state that after again reaching the Stikine, above the cañon, they can ascend it in canoes without difficulty for a long distance.

Head of Stikine.

No rock exposures were seen along this part of the trail, and only occasional groups of boulders. The soil appears to be excellent, but the altitude is probably too great for the successful cultivation of any but the most hardy crops. The vegetation and appearance of the country afford evidence that the climate is still a rather dry one.

Tanzilla.

The trail reaches the edge of the valley of the Tanzilla, or Third North Fork, about a mile south-westward from Caribou Camp. This valley is cut out to a depth of 450 feet below the level of the plateau, and is about a mile in width from rim to rim. The sides show evidence of extensive landslips, both old and recent. The river is a comparatively small though swift and muddy stream, with an estimated width of 180 feet and depth of about three feet. No rocks are exposed in the valley, the entire depth of which appears to be excavated in bedded clays and silts, which weather to grey, earthy slopes. No true boulder-clay was seen, but the occasional presence of large granitic boulders, with the singularly contorted character of some of the clay-beds, appear to indicate the existence of floating ice in the body of water in which the deposits were originally laid down. The clays and silts are evidently the same with those seen in the Tooya, but here, so far as observed, want the rough bouldery and gravelly beds which are there intercalated, and which are doubtless connected with the entry of the former representative of the Tooya into the lake in which the silty deposits have been formed. Flat or lenticular calcareous nodules are abundant at certain horizons in both places, and are also reported to occur at some distance up the Tahl-tan, where the same silty deposit is probably continued. The level country based on these deposits has a width of several miles on both sides of this part of the Tanzilla.

Silt and clay terraces[1]

From Caribou Camp to the vicinity of Dease Lake, or for about twenty-six miles, the trail runs along the north-west side of the Tanzilla. The valley of the stream gradually loses its depth, owing to the fact that, while the grade of the stream is considerable, the terraces at its sides continue at about the same level. These consist, so far as can be seen, of similar silty and clayey materials, but the edges

Tanzilla valley.

of the terraces are less marked, and they show a tendency to merge into slopes, which rest upon the bases of the mountains bordering the valley. The mountains which extend to the south-east of the river here become higher than before, and take the form of a well-marked range, which is known to the Indians as *Ho-tai'-luh.** Swampy spots become frequent and the vegetation more alpine in character, with evidence of a considerably greater rainfall. The white spruce is relatively more abundant, and *Betula glandulosa* and *Ledum latifolium* were here met with for the first time. A great part of the forest all along this portion of the valley has been destroyed by fire. Rock is seen in place only on approaching the bases of the mountains.

Valley connecting Tanzilla with Dease Lake.

Opposite the head of Dease Lake, the Tanzilla turns off abruptly, and is seen to take its rise in a high range of mountains, holding much snow and running in a north-east and south-west bearing, at a distance of seven or eight miles. The main valley, which has heretofore been occupied by the river, turns northward, through a right-angle, and becomes continuous with that of Dease Lake. The distance from the head of the lake to the Tanzilla, at the nearest point, is about three miles, the level of the Tanzilla being somewhat lower than that of the lake. The height of land is about seventy feet above the lake, or 2730 feet above the sea, and constitutes the watershed between the Arctic and Pacific slopes.

Origin of the valley.

The part of the valley which connects the Tanzilla with Dease Lake is floored by terrace deposits, and is without doubt very deeply filled with such material, as no solid rock is seen in it. It has evidently been part of a through river-course of very ancient date, but in which direction the stream which originated the valley flowed, it is now difficult to surmise. It has, however, been again occupied by a river in comparatively recent post-glacial times, subsequently to the formation of the terrace deposits, as it is traversed by a well-marked river-bed, filled with rolled stones and gravels. This old channel appears to rise slightly toward Dease Lake, and there can be little doubt that the stream by which it was formed flowed out of the lake.

Geological Notes on the Cassiar trail.

Rocks chiefly Palæozoic.

Respecting the older rocks which characterize the greater part of the country between Telegraph Creek and Dease Lake, few details were noted, and no approach to a general section was obtained, as they are not usually exposed except along the bases of the mountains, which are, as a rule, at some distance from the route of travel. They

* The names of geographical features which have not been previously recognized, whether Indian names or names applied by myself, are throughout the descriptive portion of this report printed in italics, on the occasion of their first occurrence.

may be described as consisting of grey and greenish-grey quartzites and grauwackes, with a large proportion of altered volcanic materials, generally felspathic, but passing into diabases and becoming in some cases more or less schistose. Rocks originally of volcanic origin notably preponderate in the vicinity of Telegraph Creek, while near Dease Lake they are less abundant, and at about two miles from the lake, on the trail, massive grey fine-grained limestone occurs, in exposures which are nearly continuous for about a mile. None of the mountains in sight on either side of the valley are distinctly granitic, and rocks of this character were observed only in one locality, where they occupy a relatively small area.

Limestone.

Hornblende-rock and granite.

At about two miles along the trail to the south-west of the Tahl-tan, a dark, blackish-green, highly crystalline hornblende-rock occurs in considerable mass, and is much broken and shattered by a grey porphyritic and hornblendic granite, which appears to be of later date, and which may have a width of about two miles on the trail. In the bed of the Tooya River rocks differing in appearance from any seen elsewhere on this trail were found. They are reddish and purplish in colour, fine-grained, and in some beds slightly porphyritic, and appear to be chiefly felspatic in composition.* One of these is identical with a rock met with in the lower part of the bedded series, a short distance above "Grand Rapid," on the Stikine. No fossils were found in the limestones above alluded to, and the rocks, as a whole, can at present only be classed as Palæozoic, though showing many points in common with those of the Câche Creek group of southern British Columbia, which is believed to be, in great part at least, of Carboniferous age.

Purple felsites.

Basalts filling old river-valley

The pre-glacial age of the basaltic rocks is shown, as already noted, by their relation to the terraces of the valley, and also by the occurrence upon them of large granitic boulders, the transport of which must be attributed to glacial action. This is seen particularly in some places between Telegraph Creek and the Tahl-tan. The basaltic rocks, at the period of their eruption, have filled the old river-valley, and may very probably have at one time done so continuously from below Glenora to the Tooya, or perhaps considerably further. There is no reason to suppose that the basalts were erupted from a single volcanic centre, and indeed the existence of basaltic dykes cutting the older rocks at Telegraph Creek would appear to lead to an opposite conclusion. Subsequent to the period of basaltic eruption, the river, still flowing in the same great valley, has cut down through the basalts in several places, exposing sections of the gravel deposits of the ancient river. The new channel thus formed is not, however, coincident

* See Appendix V. (Cassiar Trail No. 4.)

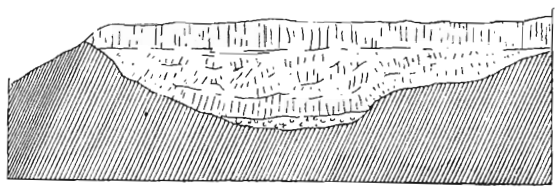


FIG. 3.—SECTION SHOWING OLD RIVER-CHANNEL CAPPED BY BASALTS. EAST BANK STIKINE RIVER BELOW TAHL-TAN.

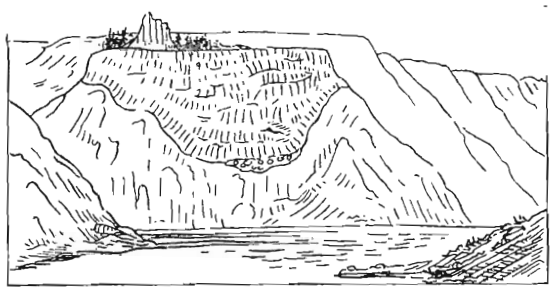


FIG. 4.—SECTION SHOWING OLD RIVER-CHANNEL FILLED WITH BASALT. MOUTH OF TAHL-TAN.

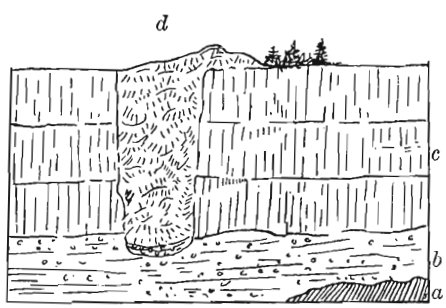


FIG. 5.—SECTION SHOWING RELATIONS OF BASALTS AND GRAVELS. STIKINE RIVER, EAST BANK, ABOVE TAHL-TAN.

a. Old basal rocks.
b. Old gravels.
c. Superposed basalt flows.
d. Basaltic filling of a later gorge.

with the old, but cuts across it at several points, and above Telegraph Creek, the excavation of the new bed has been carried to a depth estimated at from forty to seventy feet below the earlier one.

A few miles below Glenora, where the basalt filling of the old valley has been cut across, it seems, however, that the old river-bed is below the present water-level, indicating, in connection with the previous observation, that the grade of the original river was greater than that of the present.

Basalts near Tahl-tan.

Directly opposite the mouth of the Tahl-tan River, on the left bank of the Stikine, a good section of the old river-bed is exposed, in the truncated end of a point which forms a spur of the plateau to the south, the basalts filling it like a great ingot and resting, at the bottom, on the old gravels, at the sides, directly on the rocky banks of the old channel.

The angle between the Tahl-tan and the Stikine, on the upper side, has already been referred to in connection with the peculiarly disturbed character of the basalt layer by which it is capped. Beneath the basalt at this place is a great thickness (apparently not much less than one hundred feet) of well-rounded gravel and boulders. It is probable that this deposit does not reach to the water-level, but its disintegrated material has formed a slope which conceals any basis of old rocks which may be beneath it. The eruption of basalt has, moreover, not been confined to a single period, but must have occurred at several different times separated by rather wide intervals. The occurrence in some places of three or more superposed flows, shows this to have been the case, but a still more striking proof of the same fact is found in a section observed from a distance, on the left bank of the Stikine above the Tahl-tan. At this place a thick and apparently extensive deposit of gravels has been covered by three superposed basaltic flows. Through these, a narrow vertical-sided cañon has been cut by some tributary stream, which has even excavated a portion of the gravels beneath the lowest basalt. A fourth basaltic flow has then occurred, which has completely filled the cañon and partly overflowed on the surface of the highest of the three earlier basaltic layers.

Basalts of several dates.

Though the basalts of Tertiary age actually seen by me are confined to the Stikine valley, it is highly probable that further explorations will prove their occurrence in other valleys, and possibly also the existence of similar rocks, in the form of plateaux of some size, in the region east of the Coast Ranges.

Old Channel and gold placers.

The basaltic formation of this part of the Stikine has been described in some detail, on account of the importance which it possesses in respect to the distribution of gold. The gold along the Stikine was said by the miners to be "spotted," or irregular, in its occurrence, but the greater part of the "heavy" gold was found just along that

portion of the stream now characterized by the basalts, and it appears even possible to trace a connection between the richer bars which have been worked and those places in which the present river has cut through or followed the old basalt-protected channel. This being the case, it seems very desirable that the old channel should be fully prospected, which I cannot learn has ever been attempted. If gold should be found in it in paying quantity, it might easily be worked, and would give rise to a considerable renewal of activity in mining. It is not known to what extent similar conditions may occur up the Tahl-tan valley, where also remunerative bars were worked some years ago.

Superficial Deposits and Terraces.

Boulder-clay not observed.

No true boulder-clay was recognized either on the Lower Stikine or in the country between Telegraph Creek and Dease Lake; neither were any striated rock surfaces actually seen. The last-mentioned fact is to be attributed to the want of suitable localities for observation in the vicinity of the route followed and to the necessarily cursory character of the examination, as evidence of glaciation of a general character, shown in the rounding of rocky hillocks and the transport of large boulders, is abundant. The most characteristic later formation of the country between Telegraph Creek and Dease Lake, is the silty and clayey deposit which has already been referred to in several places. The whole of the great valley has evidently in later-glacial times been filled with this deposit, which must have been laid down in a comparatively tranquil lake-like body of water, into which coarser material was in some places washed by entering torrents, as in the case of the Tooya. It appears to me possible that this body of water was held in by means of glacier-ice accumulated on the Coast Ranges on one side and those of the Cassiar Mountains on the other, and the increased height of the terraces in the vicinity of Dease Lake, as compared with those near Telegraph Creek, may show that the terrace-deposits have been laid down near the front of a retreating glacier-mass, the water-level of the lake being reduced *pari passu*, with its recession. The highest terrace-level observed near the Tahl-tan, is at an approximate elevation of 1700 feet above the sea, while half way between the Tooya and Dease Lake the terraces run up to a height of about 2800 feet. At the head of the lake a well-marked terrace-edge was observed at 520 feet above the lake, or 3180 feet above the sea. The irregular surface of the same terrace sloped upward to a further height of about 100 feet, and granite boulders were found on the summit of a limestone hill 1000 feet above the lake, or 3660 feet above the sea. If the supposition of the considerable inland extension of the glaciers of the Coast Mountains at one epoch of the glacial period be

Thick silty and clayey deposits.

Heights of terraces.

correct (and it is strictly paralleled by similar circumstances in the more southern part of British Columbia), the greater part of the granitic erratics met with may probably have been derived from the Coast Ranges, though the Cassiar Mountains, and possibly other ranges in the region, are characterized by similar rocks.

Route for Waggon-road or Railway.

District naturally easy of access.

Dease Lake is the central point of the Cassiar district, and though, as shown by statistics subsequently quoted, the yield of gold has greatly fallen off since the palmy days of its first discovery, it is very probable that further placer mines of value may yet be found in this region, (of which a great part still remains to be carefully prospected) and there is every reason to believe that quartz mining and other industries will before long be developed on a considerable scale. Even at the present moment this district is more easily accessible than that of Cariboo, and when a waggon-road shall have been built from the head of navigation on the Stikine to Dease Lake, it should be easy to lay down goods at the latter point at very reasonable rates.

Route for waggon road.

The construction of a waggon-road, with moderately favorable grades, between Telegraph Creek and Dease Lake, would not be very difficult or expensive. The first ascent from Telegraph Creek is steep, but might easily be overcome. Between eight and ten miles from Telegraph Creek, or for a distance of about two miles, the road would have to follow a rough hill-side above the cañon, where some blasting and grading would be required. The descent to the Tahl-tan would entail some heavy side-hill cutting in rock and earth and a bridge would be necessary. The ascent and crossing of the "lava bed" would entail about a mile of rough work on the opposite side of the Tahl-tan, and should the line of the present trail be followed, a long and steep ascent, with grading in gravel and clay, would be required at Ward's, and again in descending to and ascending from the Tooya valley, but no rock work would be necessary. It seems quite probable, however, that a better route might be found for a road, at a lower level, from Ward's to the mouth of the Tooya, in following along the side of the main valley. In either case a good bridge would be required at the Tooya. Beyond this, all the way to Dease Lake, no further serious obstacle is met with. Portions of the route are clayey and swampy, and to render these easily passable, from eight to ten miles of corduroy in all would be required, for which suitable material could be obtained near by in all cases.

Railway route.

Should the construction of a railway be contemplated, the difficulties to be surmounted would be greater in proportion, particularly

between Telegraph Creek and the Tahl-tan, where the line would have to follow the side of the cañon, which is very rough and rocky. Beyond this point, so far as the valley could be seen from the trail, it presents no very serious impediments. Below Telegraph Creek, to Glenora, or a little further, a railway would involve some moderately heavy side-hill work; but further down the Stikine, to the sea, it might follow the river-flats at a nearly uniform level. The greatest difficulty to be apprehended on this part of the line would be that likely to arise in winter from the very heavy snow-fall on that part of the river below the Little Cañon.

It may be pointed out in this connexion that the survey of the Stikine and of the valley leading by the Tanzilla to Dease Lake shows that the route is an exceedingly direct one to Dease Lake, and that, taken in conjunction with the valleys of the Dease and Liard Rivers, it affords almost an air-line from the Pacific Coast to the great Mackenzie River. (See p. 19 B.)

Freight rates.

The present rates for goods, from Wrangell to Dease Lake are about as follows:—Wrangell to Telegraph Creek by steamer, 2½ cents per lb. Thence to Dease Lake by pack animals, 6 cents. Thence by lake to Laketon, ¾ to 1 cent. Total, about 9½ cents per lb., or $195 per ton. The result of such high prices is to discourage prospecting in the district and seriously to retard its further development.

Dease Lake.

Proceedings at Dease Lake.

We reached the head of Dease Lake on June 5th, and eventually left the lake on the morning of June 19th, spending thus thirteen days in all upon the lake. At the date of our arrival the lake, with the exception of a small area at its head, was still covered with the decayed but unbroken ice of the previous winter, and this did not finally break up and disappear till the 16th. Meanwhile, almost all our time and attention were devoted to sawing out boards and building three boats. It would have been impossible to have left sooner, even if we had had boats ready at the outlet of the lake, which had long been open, in consequence of the entire exhaustion of supplies in the district, from which it was necessary that we should depart provisioned for the greater part of the summer's work. As it was, our boats were finished a few hours before the final disruption of the ice, which occurred in the end with extraordinary rapidity, under the influence of a strong wind. It will easily be understood that we had but little time or opportunity for the examination of the surrounding country, which is nevertheless of considerable interest on account of the rich gold-producing character of some of the streams.

Opening and closing of lake.

The disappearance of the ice must always be late in this lake, in consequence of its high altitude, the want of any large entering streams and its contracted outlet. It was, however, in 1887 later than ever before known since mining operations began. The following dates, obtained from Mr. Robert Reid, of Laketon, are those of the opening and closing of the lake for the past few years.—

Year.	*Lake opened.*	*Lake closed.*
1882	June 9	December 5 or 6
1883	May 30 (Clear from end to end.)	December 5
1884	June 2	December 2
1885	June 3	December 1 (Frozen completely across.)
1886	June 5	December 16 (Crossing on 17th.)
1887	June 16	

Further particulars respecting the climate of Dease Lake will be found in Appendix VI.

Dease Lake.

Dease Lake has an elevation of 2660 feet above the sea, and lies nearly due north-and-south on the 130th meridian. It has a total length of twenty-four and a-third miles, with an average width of rather less than one mile, being somewhat narrower at the northern than at the southern end. Dease Creek, on the delta of which is situated Laketon, the chief place of the Cassiar district, enters on the west side at sixteen miles and three quarters from the head of the lake, and is the largest tributary stream. It is also the most important, as being that on which the richest of the gold deposits were discovered, and on which gold is still worked to a limited extent. A certain amount of business is still carried on here, and it is the head quarters of the present Gold Commissioner, Mr. Crimp. At the south end, or head of the lake, there are a few buildings, now virtually abandoned, and at Porter's Landing, on the west side of the lake near its north end, goods are landed for Thibert's Creek. The old Hudson Bay Post was situated about two miles from the lower end of the lake, on the east side. A small steamer was put upon the lake when the mines were in a flourishing condition, and is still employed in making occasional trips up or down the lake with supplies.

Mining camps.

Country surrounding the lake.

The country about the lake is everywhere wooded, though trees large enough for lumber are found only in sheltered valleys or on low land. It is not roughly mountainous, though several prominent summits occur. The most conspicuous of these lies four miles back from the lake, about half way between the head of the lake and Laketon. As I could not ascertain that this is recognized by any name, I propose

naming it *McLeod Mountain*, in honour of the discoverer of the lake. Its height is about 6300 feet. Between McLeod Mountain and Dease Creek is *Mount Sullivan*,* not so elevated as the last, but nearer the lake-shore and very conspicuous from it. On the opposite, or east side of the lake, a couple of miles back from the shore, is a group of rounded and wooded mountains, somewhat exceeding 1000 feet in height above the lake, or about 3800 above the sea. *Beady Mountain*, another notable landmark, is also on the east side of the lake, about three miles from its lower end and near the creek of the same name. Its height was not determined, but is less than that of McLeod Mountain. With the exception of these and some other nameless mountains, the country near the lake is merely hilly, or rises in long, light slopes from the shores to undulating wooded uplands, a few hundred feet only above it, which coalesce with the bases of the mountains. Only near the northern end of the lake do the mountains begin to crowd down more closely to the water's edge. The lake is shallow and marshy at both ends, but is elsewhere evidently very deep, though no soundings have been made in it. Mountains.

Rock-exposures are infrequent along the margin of the lake, which, when scarped, generally shows only stratified, sandy, clayey and gravelly terrace-deposits, like those seen on the trail to the south-eastward. None of these were recognized as true boulder-clay. The lake is probably held in at its northern end by the accumulated delta deposit of Thibert Creek.† It is much constricted, further up, by the similar deposit of Dease Creek, and has narrowly escaped being divided at this place into two lakes. It is rimmed round at its head by somewhat irregular terrace deposits, which have already been alluded to as filling the ancient valley which communicates with that of the Stikine. Superficial deposits.

The vegetation gives evidence of a greater rainfall and conditions more alpine and less favorable than those met with on the trail to the south-eastward, and sharply contrasting with that of Telegraph Creek and the Tahl-tan. The effect of the ice upon the lake in spring, in retarding the vegetation in its immediate vicinity, was extremely apparent. Agriculture can scarcely be regarded as practicable in this region, and the results of gardening, however carefully conducted, are small. Potatoes can be grown, but in some years they are much injured by frost, and carrots, lettuce, cabbage, cauliflowers and turnips may be made to afford a fair return. Vegetation and cultivation.

Such rock-exposures as could be reached near the shores of the lake were inspected, and the material brought down from the hills by sev- Rocks.

* So named for Mr. J. H. Sullivan, first Gold Commissioner of the district, lost in the wreck of the *Pacific* in 1875.

† A stream about fifty feet wide.

eral streams was examined, the evidence afforded being in favor of the belief that the whole country is underlain by Palæozoic strata resembling those described to the south-eastward. In addition to the limestone already noted as occurring at the head of the lake, there are grey and greenish rocks, representing altered materials of volcanic origin,* associated with leek-green serpentine, in which some minute veins of chrysotile or asbestos were noted. Besides these, and probably predominant as a whole in the valley of the lake, are argillite-schists, which vary from a black plumbaginous to a grey, finely micaceous character, and are often lustrous and not unfrequently highly calcareous. The rocks, as a whole, closely resemble those of parts of the gold bearing series of Cariboo district.

Dease Creek.

Dease Creek, is said to be about twelve miles in length and to rise in a lake about five miles long. It has cut a deep, narrow V-shaped valley through a series of terraces, which have evidently been formed at its mouth when the lake stood at various levels higher than the present. The ancient pre-glacial valley has, at the same later-glacial period, been filled with clayey and gravelly deposits, among which large and often glaciated boulders are common. These deposits frequently resemble boulder-clay, and are possibly entitled to be so called. The present valley has been cut down through them, and often to a considerable depth into the rock beneath them. The mining has occurred chiefly in the bed of the stream, along the surface of the solid rock, in the sides of the valley, and in various places in the gravel deposits which still remain; also at the head of the flat on which Laketon stands, where the stream issues from the narrow recent valley. Much quartz occurs in the wash of the stream, and the gold, being "coarse," is evidently of local origin and has been liberated by the disintegration of the rocks in the immediate vicinity of, if not entirely within, the actual drainage-area of the stream.

Gold Mining in Cassiar District.

Yield of gold.

The following table, based on the reports of the Minister of Mines of British Columbia, clearly illustrates the sudden rise and gradual decadence of the gold yield of Cassiar district.—

Estimated value of Gold produced by Cassiar District, from 1874 to 1887.

1873	Not known.
1874	$1,000,000
1875	830,000

* One of these, representing a numerous class having a more or less distinct schistose structure, is described in Appendix V. (Dease Lake, No. 8.)

1876	556,474
1877	499,830
1878	519,720
1879	405,200
1880	297,850
1881	198,900
1882	182,800
1883	119,000
1884	101,600
1885	50,600
1886	63,610
1887	60,485
Total	$4,886,069

No estimate has been formed for the yield of the mines in the first year of their operation (1873,) but as that for the following year appears probably to be overstated, it may, for the purpose of arriving at a general estimate of the whole, be assumed that the sum of one million includes both years. The value of the gold may be stated as from $16 to $17 per ounce, though that of Dease Creek is usually priced at about $15·50 only.

Sources of information on mining.

In the Report of Progress of the Geological Survey for 1886-87, I was enabled to give a general note on the various creeks worked for gold in Cassiar and on the Stikine.* The information there given was chiefly furnished by Mr. G. B. Wright. I am now able to add to this, particulars as to the actual condition of the workings in 1887. These were largely obtained through the kindness of Mr. J. S. Crimp, the present Gold Commissioner for Cassiar district, though facts were also gathered from several old miners who were among the first to enter the country. As explained on a previous page, my opportunities of personally investigating the Cassiar district were restricted by the necessity we were under of pushing on to our main field of exploration. Chiefly from the sources above-mentioned the following summary account of the different localities is derived.

Summary of Facts relating to Gold on the Stikine and various Creeks in the Cassiar District (1887).

Localities of gold mining.

Stikine River.—Gold discovered, 1861. Very fine gold can be found on almost all parts of the river, but very little profitable work was ever done below the mouth of the Clearwater. The rich ground may be said to have begun about nine miles below Glenora, and to have extended thence to the Grand Cañon, above Telegraph Creek. Here Sheck's or Shake's Bar, and Carpenter's, Fiddler's and Buck's

* *Op. cit.*, pp. 138-146.

Localities of gold mining, continued.

Bars were situated, the richest being between Glenora and Telegraph Creek, though gold was also worked in a few places in the Grand Cañon. With the exception of a few spots in the lower part of the cañon, below the Tahl-tan, and one nearly opposite Wilson's, all the gold was very fine. Coarse gold was also found on the lower part of the Tahl-tan, which proved quite profitable, and bars were worked for a distance of ten or fifteen miles up the river. Pellets supposed to be of silver but probably of arquerite or silver-amalgam were also found on the Tahl-tan. The bars on the Stikine at first averaged $3 to $10 a day to the hand, and as much as two to three ounces was sometimes obtained, but not more than $1 to $3 can now be got, and work has practically ceased. It is stated that none of the higher benches so far prospected will pay for hydraulic work, but it is doubtful whether these have been examined with sufficient care, as the area of such benches is very considerable.

Dease Creek.—The bed of this creek has been gone over several times, and is now nearly worked out. It formerly yielded $8 to $50 a day to the hand, and paid well from the head of the flat, at its mouth, for six miles up. Above this a few isolated good claims were found, particularly the Cariboo Company's claim, eight miles up, from which much heavy gold was obtained. This claim has been worked over four times. The best remaining claims are bench claims on the south side of the creek, some of these being upon an old high channel which yields well in places. Some hydraulic work on a small scale is being carried on. In 1886 there were sixteen whites and thirty-five Chinese at work, and the total amount produced was about $15,000. The gold is generally well water-worn and somewhat mixed in character, varying in value from $15·50 to $16 per ounce.

Thibert Creek.—The bed of this stream is also worked out. It paid for about six miles up from the mouth, yielding at about the same rate as the last. Bench claims are now being worked, two by the hydraulic method, the rest by tunnelling. An old high channel had also been found on the south side of this creek, upon which two claims are being worked, one paying very well. Yield in 1886, nearly the same with Dease Creek, about twenty-two whites and twenty-five Chinese being employed. Gold valued at $16 per ounce. On a tributary named Mosquito Creek very good prospects have lately been obtained,—as much as $40 to a six-foot set of timbers. Work is now going on here.

Defot Creek.—A tributary of Cañon Creek, on the same (west) side of Dease River with the last. It rises on a plateau high above the river, where great numbers of quartz reefs occur, and the gold found is quite rough and full of quartz. Large nuggets have been obtained, including one of fourteen ounces in weight. Some work is still in

progress, though the creek-bed is worked out. Gold worth $17 per ounce. Localities of gold mining. continued.

Cañon Creek.—No paying deposits found.

Cottonwood Creek.—This large stream heads in the same mountains with the last, but no paying deposits have been found upon it.

Beady Creek.—A little mining was done here in 1874 and 1875, but nothing of importance ever found.

Eagle River.—No mining ever developed.

McDame Creek.—Discovered 1874. The highest average daily yield varied from $6 to $100 to the hand when mining was at its best. Most of the gold was obtained in what appeared to be an old high-level channel, which crossed points of terraces or benches on both sides of the present stream. A very small proportion of the yield was from the stream-bed. Four or five Whites and forty Chinese are now at work here, the greater number of the Chinese being employed on wide flats, which occur about nine miles up the creek. Bench claims run for about seven miles up the creek or to Holloway's Bar. Gold worth from $17·75 to $18 per ounce.

Snow Creek, a tributary of the last.—The richest claim found in Cassiar was near the mouth of this creek, yielding for a week 300 ounces for six to eight men. Only two men now at work.

Quartz Creek, a branch of Trout Creek, which is also a tributary of McDame Creek. Good claims were worked here, yielding rough gold full of quartz. Much quartz in the vicinity. Two miners now at work.

Rosella Patterson and Dennis Creeks.—Yielded moderate amounts of gold, paying "wages," say, at $6 a day. Now abandoned.

The remaining creeks mentioned in the report cited, *viz.*, *Gold Creek*, *Slate Creek*, *Somer's Creek* or *First North Fork of McDame*, *Third North Fork of McDame*, *Spring Creek* and *Fall Creek*, are now abandoned, though several of them yielded a considerable amount of gold at one time.

Sayyea Creek. Near the head-waters of the Upper Liard, yielded excellent prospects, but has never been properly examined. The gold obtained was found in the benches, and some of it was very coarse. The creek yielded at the rate of $10·90 a day to the hand for a short time, to three miners who discovered it.

Walker Creek.—Said to be distant about seventy miles in an easterly direction from the mouth of McDame Creek. Some work has been done here, but no great quantity of gold obtained.

Black, Turnagain or "Muddy" River.—Reached by trail running easterly from a point opposite the mouth of McDame Creek, and said to be ninety miles distant. Fine gold stated to have been obtained to the value of $20 per day to the hand, and it is generally believed that coarse

gold may occur on its head-waters. In 1874 prospectors found streams about seventy miles south-east of Dease Lake, which are supposed to be tributaries of this river, and yielded $6 a day in coarse gold, but at the time this was considered too poor to work.

Frozen ground.

Considerable difficulties were experienced in mining operations in some parts of the Cassiar district on account of frozen ground, often met with below the wooded and mossy surface. It is on record that on Dease Creek, the ground continued to be frozen to the end of a tunnel driven in one hundred and fifty feet from the slope of the hill, and at a depth of forty feet from the surface. After the woods and moss had, however, been burnt off, little further complaint was heard of frozen ground.

Metalliferous veins.

Very little has yet been done in the way of prospecting for metalliferous veins in this district, but from what I have been able to learn it would well repay a thorough examination, and the comparative ease with which it may be reached from the coast, together with the facility it affords for the construction of a good road to the very centre of the district, should not be forgotten. A specimen of galena, holding a little copper and iron pyrites, from the "Acadia Claim," South Fork of McDame Creek, was given to me some years ago by Mr. J. W. McKay. This has since been assayed by Mr. C. Hoffmann, and proves to contain 75 ounces of silver to the ton of 2000 lbs. A piece of native copper, fifteen pounds in weight, was at one time found in Boulder Gulch, Thibert Creek.

Prospects of further placer mining.

Taking into consideration the great extent of generally auriferous country included in the Cassiar district, it must be conceded, that apart from the immediate vicinity of the well known productive camps, it has been very imperfectly prospected. A great part of the district has in fact merely been run over in search of rich diggings, the simplest and cheapest methods of prospecting only, having been employed in the quest. It is not improbable that additional rich creeks like those of the vicinity of Dease Lake, may yet be discovered elsewhere and it may be considered certain that these are great areas of poorer deposits which will pay to work with improved methods, and will eventually be utilized. It is also to be anticipated that "quartz mining" will ere long be inaugurated and will afford a more permanent basis of prosperity than alluvial mining, however rich.

Discovery and Exploration of Cassiar District.

Discovery.

The Cassiar district of the northern interior of British Columbia may be said to have been twice discovered, first by officers and employees of the Hudson Bay Company, and again, after a considerable interval, by the gold miners.

Exploration by McLeod.

The unsuccessful attempt made by the Hudson Bay Company in 1834, to reach the trade of the interior country west of the Rocky Mountains from the mouth of the Stikine, has already been noted. (p. 61 B). Efforts were at the same time being made to open up routes from the eastward. In the summer of 1834 Mr. J. McLeod, chief trader, was employed exploring the Liard River above Fort Halkett, and in endeavoring to discover some stream flowing to the westward. He found and named Dease Lake,* crossed to the head-waters of the Stikine, which he proposed to name the "Pelly River," and travelled westward in the valley apparently as far as the Tooya or Second North Fork. The Indian bridge (afterwards named Terror Bridge by Mr. R. Campbell), by which this river was crossed at the foot of "Thomas' Fall," was of such a character that neither McLeod nor any of his eight men dared to attempt it, and from this point he and his party retraced their steps.

McLeod's route and map.

The geographical information obtained by McLeod is incorporated in Arrowsmith's map of 1850, on which, however, the upper part of the Stikine, which McLeod had proposed to call the Pelly, is named "Frances River," and is placed much too far north and is not connected with the Stikine. The name Frances is still retained as an alternative one to "Stikeen" on the edition of 1854, though it has since fallen entirely into disuse. McLeod's route from the head of Dease Lake, as shown on these maps, crossed the Tanzilla within a few miles of the lake, and followed its left bank, recrossing before the main Stikine enters the valley, probably by an Indian suspension bridge, which is reported still to exist, within a mile or two of this point. On careful consideration of the facts there can scarcely be any doubt that the Tooya River was McLeod's furthest point, and the Indian bridge probably crossed it near the position of the present bridge, though it may have been at some point further up the stream which has not yet been mapped.

Second abortive expedition

In 1836, McLeod's successor at Fort Halkett was instructed to establish a post across the mountains and to extend the trade down the Stikine, or "Pelly," as it was then called from McLeod's naming. For this purpose he left Fort Halkett early in June, with a party of men and two large canoes, but the expedition entirely miscarried. The appearance, or reported appearance, of a large force of hostile Indians at Portage Brulé, ten miles above Fort Halkett, so alarmed the party that they turned back in great haste, abandoning their goods, and lost no time in running down stream to Fort Simpson.

* Dease Lake and River were so named by McLeod after Peter Warren Dease, the Arctic explorer.

Exploration by Campbell.

For most of the above particulars I am indebted to Mr. Robert Campbell, who was at the time of the return of the last-mentioned party in temporary charge of Fort Simpson. The news brought back by these expeditions was of a character to discourage further enterprises in the region, the extremely difficult and dangerous navigation of the Liard River, which constituted the avenue of approach from the Mackenzie, being an additional deterrent. In 1838, however, Mr. R. Campbell volunteered his services to establish a trading post at Dease Lake, and in the spring of that year succeeded in doing so. He was accompanied by a half-breed and two Indian lads only. After ascertaining that the "Pelly" of McLeod was identical with the Stikine, he returned to Dease Lake, where, to employ his own words, "we passed a winter of constant danger from the savage Russian [coast] Indians, and of much suffering from starvation. We were dependent for subsistance on what animals we could catch, and, failing that, on '*tripe de roche.*' We were at one time reduced to such dire straits that we were obliged to eat our parchment windows, and our last meal before abondoning Dease Lake, on 8th May, 1839, consisted of the lacing of our snow-shoes."* After being thus abandoned, the post was not again re-occupied. It had become unnecessary, owing to the leasing of the "coast strip" of Russian America by Sir George Simpson for the Company, in consequence of which the trade of the interior was entirely controlled on both sides by the Company.

Further history

From this time the country appears to have been practically forgotten for many years. The furs produced by it found their way, through the Coast Indians down the Stikine, by the Liard to the Hudson Bay posts on that stream, or across country southward to Fort Connelly (established by Douglas in 1826), on Bear Lake, at the head of the Skeena River. The exploration of the Telegraph Survey in 1866-67, has already been referred to. It did not extend inland as far as Dease Lake.

Gold discovery.

Such was the state of the Cassiar district when Messrs. Thibert and McCulloch, by the discovery of gold in 1872, brought about an entire change in its conditions. Henry Thibert, a French-Canadian, left the Red River country in 1869 on a hunting and respecting expedition to the west. In 1871 he met McCulloch, a Scotchman, and together they passed the winter near the abandoned site of Fort Halkett, on the Liard River, suffering no ordinary hardships from scarcity of food. Near this place, probably on what was known afterwards as McCulloch's Bar, gold was first found. In 1872 they reached Dease Lake, having been informed that it was a good locality for fish, with the intention

* The Discovery and Exploration of the Yucon (Pelly) River. Winnipeg, 1885.

of securing a sufficient supply for the ensuing winter. Being told, however, by the Indians, that white men were engaged in mining on the Stikine not far off, they crossed by the trail from the head of the lake and reached the mining camp of Buck's Bar. Early in 1873 they set out on their return to the original discovery of gold, but meeting with success on Thibert's Creek, at the lower end of the lake, they were deterred from going further and remained working there during the summer, being joined afterwards by thirteen other miners from the Stikine. Dease Creek was discovered during the same season, and Capt. W. Moore was among the first to begin work there. Thibert is still mining in Cassiar, but McCulloch lost his life some years since on a winter journey on the Stikine.

The subsequent history of Cassiar is that of a mining district.

Gold mining, 1874.

In 1874 the population, exclusive of Indians, was estimated to have reached 1500. The placers of McDame Creek were discovered. Miners descended the Liard a long distance, and worked McCulloch's Bar and other river-bars. Prospectors ascended the same river, and reported having been within sight of Frances Lake. The little town of Laketon was built at the mouth of Dease Creek, and beef cattle were for the first time brought across country from the Upper Fraser. The total yield of gold from the district (which, from a mining point of view, includes the Stikine) is roughly estimated to have been equal to $1,000,000.

1875.

In 1875 the population is estimated to have been 1081, and the yield of gold equalled about $830,000. Three hundred head of cattle were brought from the Fraser overland. This and the preceding season were the best years of the district. Of a small party which spent the winter of 1874-75 far up the Liard River, four died of scurvy. Prospecting was actively carried on in outlying regions, Sayyea Creek being discovered near the Liard head-waters, and the Frances River also apparently examined.

1876.

Owing to the flattering accounts sent out, a great influx of miners occurred in 1876, the population being at one time estimated at 2000. Profitable work could not, however, be found for so many men, and the yield of gold fell to $499,830. Walker Creek, said to be seventy to eighty miles east of McDame Creek, was discovered, but this stream never proved very remunerative. Defot Creek was also found, and in 1878 proved rich for a limited area.

Decline of gold mining.

Since this time the production of the district and the number of miners employed have gradually declined, and no important new creeks have been discovered, though reports to that effect have from time to time been circulated. The Black or Turnagain (Muddy) River is the most recent of these, some attention being drawn to it in 1886.

It appears, indeed, that after the first few years very little prospecting or exploring has been done at a distance from the main creeks, of which Dease, Thibert and McDame have throughout been the most important and permanently productive.

Dease River.

We left Dease Lake with quite a little flotilla, consisting of the three boats we had built, with an Osgood canvass boat, which it had been intended to keep in reserve, but which the amount of dead weight which we had to carry obliged us to press into the service. Besides myself, the party consisted of Messrs. McConnell and McEvoy, four white men, five Coast Indians and one Indian woman, the wife of the leading Indian boatman.

Cassiar Range. Though the region about Dease Lake is as a whole rather low, with isolated mountains and ridges here and there prominent, that to the east and north-east is very different, being studded with rugged mountains, and in effect constituting an important mountain range with north-west and south-east trend, and a transverse width of nearly fifty miles. This range appears to represent a continuation of that which in various maps has been named the Peak Mountains or Blue Mountains, but as its connection to the south-eastward is as yet quite uncertain, and as neither of these names possesses either a distinctive character or any special fitness, I believe it will be most appropriate and convenient to call the range the *Cassiar Range*, and shall accordingly so designate it.

Lower end of Dease Lake. Looking down the Dease River from Porter's Landing, near the north end of the lake, the view is one of the most picturesque possible, embracing a portion of the lake itself, bordered by the marshy flats of the mouth of Thibert Creek and bounded by the rugged and extremely varied forms of the eastern ridges of these mountains, towards which the Dease River flows, and through which it cuts in a direction almost directly transverse to the run of the range.

Three main courses of the Dease. The Dease River has, up to the present time, been very inaccurately represented upon the maps. My survey of the river, as shown on the accompanying map, proves that its course is somewhat remarkable. Disregarding minor flexures, which are numerous and sometimes involved, it may be described as following three principal directions.—From Dease Lake its general course is N. 56° E. for forty-seven miles, to a point near the valley of Rapid River. Here, before it has freed itself from the Cassiar Range, it turns nearly at a right-angle to a bearing of N. 15° W., which it maintains for thirty-one miles. Thence it again turns for a second time through a right-angle to a course of

N. 55° E., which it follows to its junction with the Liard. Its entire length, thus measured in three straight reaches, is one hundred and ten miles, but measured in straight lengths of one mile it is one hundred and twenty-seven miles, or, following all the sinuosities of the stream, one hundred and eighty miles.

Fall of the river, and current.

The height of Dease Lake, as previously stated, is 2660 feet, within small limits of error. That of the confluence of the Dease and Liard about 2100 feet. The last mentioned elevation is a fair approximation only, as no simultaneous barometer readings were available for purposes of comparison, and the weather during our stay at the forks was rather unsettled. The total fall of the river, according to these figures, is 560 feet, giving a slope of four feet to the mile for its entire length, which, judging from analogy with other western rivers, is about what might be expected from the appearance of the stream. The velocity of the current was estimated at about three miles an hour, as a general average, but there are several little rapids, as well as some rather long tranquil reaches.

Navigability of the river.

The river, from Dease Lake to the Liard, may easily be descended in two days, but the ascent is a comparatively slow process, depending much on the height of the water, and when the bars and beaches are not bare for tracking is a tedious affair. It is possible that the river might be navigated by small stern-wheel steamers of good power, as there are no insuperable obstacles, but doubtful whether such an enterprise would be a remunerative one, even if the traffic were to assume proportions much greater than at present. Such goods as are now required at McDame Creek (fifty-five and a-half miles below Dease Lake by the course of the stream) and at the little trading post at the mouth of the river, are easily taken down stream in large flat-bottomed boats, which go back light, by poling and tracking, without great difficulty. The boating on the river has been done principally by crews of Coast Indians, who are engaged and brought into the interior for the purpose.

Upper part of the river.

On leaving Dease Lake, the river is a small stream, estimated to average from 100 to 150 feet only in width, with a general middle depth of about three feet. It is extremely tortuous and rather swift, meandering in a wide, flat valley. At about eight miles from the lake, it may be said distinctly to enter the mountains, the valley at the same time gradually narrowing and becoming bordered by mountains from 4500 to 5000 feet in height, which, on the 19th of June, still bore much snow on their summits. At about thirteen miles from Dease Lake, it expands into a little lake about a mile and three-quarters in length, and between this and the mouth of Cottonwood Creek it flows through three more similar lake-like expansions, which are, respectively, a mile and a half, two miles and one mile in length. These are probably formed

in all cases by the partial blocking of the valley by *débris* brought in by tributary streams, of which Cottonwood Creek itself is the last and most important. These lakes constitute somewhat serious impediments to navigation, as they freeze over in the autumn long before the ice takes on the river, and remain frozen till late in the spring.

Small lakes.

The mountains by which the valley is hemmed in on both sides from *First Lake* to the Cottonwood are very rough and high, and chiefly, if not entirely, composed of granitoid rocks. About three miles and a-half north-west of *Second Lake* is a remarkable broken summit, with a height estimated at 7500 feet, which, from the peculiarity of its form, has been named *Anvil Mountain*. Running parallel with this and *Third Lake* is a straight, well-defined range, the higher peaks of which attain an equal elevation, and which, for the sake of distinction and in consequence of the long slopes of broken rocks which descend from it, has been indicated on the map as the *Skree Range*. It is probable that actual measurement will show that several of the peaks in this vicinity exceed 8000 feet. The vegetation was observed to be further advanced as soon as the Dease River was fairly entered, showing how great must be the effect of the ice which lingers on Dease Lake, in its immediate vicinity. There is also evidence of a less abundant rain-fall along the river.

Tributaries.

Dease River rapidly increases in size, and after the lake is left, soon doubles its volume, owing to the number of affluent streams, of which Cottonwood Creek is the first which may be called a river. This stream occupies an important valley, which may be observed to run for many miles in a north-westward direction, bordered by continuous high ranges. It is remarkable that no paying deposits of gold have ever been found either on this or on Eagle River, which enters the Dease from the south about four miles further down. Eagle River also flows between high mountains, and its valley appears to be parallel to, and analogous with, that occupied by Dease Lake. It is evidently the "Christie River" of McLeod,* but this name has entirely passed out of use, and it appears hopeless to endeavor to reinstate it. Cottonwood Creek is shown on Arrowsmith's maps, according to McLeod and Campbell, but is not named.

Terraces.

Rock exposures are unfrequent in the banks of the portion of Dease River above described, though stratified gravel deposits are often cut into. There is also a considerable development of terraces at high levels on the sides of some of the mountains, particularly in the part of the valley which runs along the base of the Skree Range. Well-

* I have endeavored in all cases to identify the original names given by the first explorers in this country, and to ascertain as well the native names of places, but where these have passed entirely out of use by the miners and traders now in the country, it becomes necessary to drop them, though in so doing the strict law of priority is, no doubt, transgressed.

marked terraces were here seen on the west side of the valley, at an estimated height of 2000 feet above the river, or about 4600 feet above the sea.

Cottonwood Creek to McDame.

Immediately below the mouth of Cottonwood Creek is the Cottonwood Rapid, in which the course of the river is impeded by a number of boulders. The rapid is not a formidable one, or at all dangerous to run, with ordinary care. The river below Cottonwood Creek runs nearly due east for about ten miles, with a rather strong current. It then turns more to the northward, and after making several large flexures, reaches Sylvester's Landing, at the mouth of McDame Creek, in about eight miles. In this reach the current is slack, and the river averages 300 feet in width. The flat land of the river-valley is rather wide in this part of its length, but the mountains to the north and south are high and bold, many of the summits ranging from 6000 to 7000 feet. The lower slopes of the mountains are usually light, and in general thickly wooded, but their higher parts are treeless, and from the quantity of snow borne by them in June, must retain some snow throughout the summer. Immediately opposite the mouth of McDame Creek is a remarkably prominent and abrupt rocky mountain, which it is proposed to name *Sylvester Peak*. It height was estimated at 7000 feet, but the circumstances did not admit of its measurement.

Sylvester's Landing.

Sylvester's Landing is the point of supply for the miners on McDame Creek, also a post for Indian trade, and there are here a few log-houses and store buildings. Mr. R. Sylvester has been resident here for a number of years, and readily gave us all the information and advice in his power. McDame Creek was discovered to be auriferous in 1874. It has since been constantly worked, and, with its tributaries, has yielded much gold, but is now believed to be nearly exhausted. Its valley is wide and important, running north-westward for about seven miles, and then turning nearly due west. At the angle thus formed a low, wide pass leads through the mountains to the north-eastward, where it connects with the valley of the Dease. The appearance of this pass, as seen from a distance, is such as to suggest that the Dease River itself may at some former period have flowed through it.

McDame Creek Mountains.

The mountains bordering McDame Creek, viewed from Sylvester's Landing, are singularly different from any before met with. They are evidently composed for the most part of limestone, and characterized by the occurrence of long, bare slopes of shattered rock-fragments. They are scarcely at all wooded, and in this respect resemble the bare limestone crests of parts of the Rocky Mountains in more southern latitudes.

Cultivation.

Potatoes and turnips of large size are grown every season without difficulty on McDame Creek.

Tributaries below McDame

Nine miles below Sylvester's, the Dease makes its great bend toward the north, the intervening portion of the river somewhat changing its character from that above described, rock exposures being comparatively frequent in its banks and bed, where they produce several little rapids. Four-mile Creek enters from the south at somewhat less than the specified distance below Sylvester's. It appears to be the "Stuart River" of McLeod, shown on Arrowsmith's map of 1850, but neither on this nor on that of 1854 is McDame Creek indicated. Sylvester's trail to Turnagain or Black River (Muddy River of miners) runs up this valley, and follows a tributary—Sheep Creek—to the south-eastward, passing near the base of *Sheep Mountain*, a high rugged peak estimated at 8000 feet, situated about five miles and a-half south of the Dease. The distance to the trading outpost on Turnagain River is estimated at ninety miles, but is probably less. Horses are employed in packing over the trail.

Trail to Black River.

Rapid River.

The valley of the Rapid River joins that of the Dease at its great bend, just alluded to, but the stream, running parallel with the Dease for some distance, enters it several miles lower down, and its actual confluence was not observed. Beyond the great bend the mountains near the river decrease rather notably in height and abruptness, and at the same time retreat from the vicinity of the river, the valley becoming very wide, and long, hummocky slopes, or groups of low hills, coming in between the river and the mountains.

Dry belt east of Cassiar Mountains.

The northerly course of the river here carries it very obliquely through the eastern portion of the Cassiar Range. The precipitation in this part of the valley is evidently inconsiderable. The quantity of snow resting upon the mountains was observed to be very small, and here Sylvester successfully winters his horses, without cutting hay or otherwise providing for them, the depth of snow in winter being so small that it does not seriously interfere with grazing. This favored district is, in fact, homologous with that in the vicinity of Telegraph Creek, being in the dry lee of the Cassiar Range, just as that is in a similar situation with respect to the Coast Mountains. Much of the valley, with the slopes of the hills, is open or partially wooded with groves of black pine (*P. Murrayana*) and aspen poplar. The grass has the tussocky bunch-grass character usually found in dry regions, and it is intermixed with the small sage (*Artemisia frigida*). The bear-berry (*Arctostaphlyos uva-ursi*) is not uncommon, and the strawberry and lupin (*Lupinus Nootkatensis*) were in flower. *Anemone patens* was here also observed for the first time, but long past flowering. Making allowance for the time occupied in reaching this place from Telegraph Creek, the progress of vegetation here was palpably less advanced, but the showing was still a remarkable one for the latitude, elevation and distance from the sea of the region.

Below the Rapid River the Dease changes its character considerably, becoming relatively wide, with numerous gravel-bars, and in some places many islands, with frequent "drift piles" or accumulations of timber. Terraces are well shown on the sides of the mountains and reach a height of about 2000 feet above the river. Dease below Rapid River.

A few miles before reaching the second great bend, a stream joins from the west, which has become known to the miners as French Creek, and is probably the "Detour River" of old maps. It rises on the north-east slope of the Cassiar Mountains, and is not large. French Creek.

The last main reach of the Dease is that which extends from the second great bend to its mouth, a distance of thirty-one miles in a direction of N. 55° E. Though the course of the river is far from being direct, the general bearing leaves the base of the Cassiar Range nearly at a right-angle. The country becomes low and uninteresting, and assumes a rather dreary aspect, being covered generally with forest of inferior growth, often degenerating into swamp on northern aspects, and with only occasional grassy openings on slopes with sunny exposures. In descending this part of the river, the mountains soon become invisible from the river-valley, which is bordered by undulating lowlands, or low diffuse hills which rise to a plateau at some miles distant, from 400 to 500 feet above the stream. Banks of frozen soil were seen in one or two places beneath a peaty or mossy covering. The climate is evidently somewhat more humid than before and less favorable to vegetation. The current of the river is rather swift, and there are two or three inconsiderable rapids, but none of importance till within about four miles of the mouth, where there are several strong rapids, which at certain stages of the water are reported to be dangerous, and in which all our boats shipped more or less water. Terraces, as much as 300 feet in height, approach the river in some places in this part of its course, and when cut into generally show stratified gravels which sometimes rest directly on low exposures of rock. Lower part of the Dease.

The larch (*Larix Americana*) was first seen five miles below the second great bend, and below this place becomes quite abundant in cold, swampy spots, where it grows with the black spruce (*Picea nigra.*) Larch.

Blue River (the "Caribou River" of Campbell) joins the Dease twelve miles below the second great bend. It is a stream fifty feet wide at the mouth, with clear water, and derives its supply from the north-eastern slopes of the Cassiar Range, to the north of French Creek. Blue River.

The "Lower Post," which is the furthest outwork of "civilization" or trade in this direction, is situated at the edge of a terrace forty "Lower Post."

feet in height on the left bank of the Liard, about half a mile above the mouth of the Dease. It is of a very unpretentious character, consisting of a few low log buildings, in the vicinity of which the woods have been entirely destroyed by fire.

The soil is poor near the post and the climate evidently unfavorable, but potatoes and turnips have been grown here in small patches.

Opening and closing of the river.

The Liard River is here said to open, as a rule, from the 1st to the 5th of May, though in 1887 this did not occur till the 18th of that month. In the autumn of 1886 it was frozen over on November 21st.

Mr. Egnell, in sole charge, received us on our arrival here with all distinction possible, displaying his Union Jack and firing a salute from his fowling piece. Before leaving we were indebted to him for many other courtesies, all of which are here gratefully acknowledged.

Geology of the Dease River.

Rocks west of granite range.

It would be impossible, without the expenditure of much time, to make anything like a complete geological section on the line of the Dease, in consequence of the infrequency of rock-exposures on the river itself and the distance and rough character of the bordering mountain-slopes. The main geological features are, however, sufficiently apparent. For about twelve miles below the lake the rocks composing the mountains seem to be referable to the same Palæozoic series, which has been described as occurring on Dease Lake, but the exposures examined appeared to be somewhat more highly altered, and in some cases to approach the character of crystalline schists. One bedded rock is probably a diabase, with somewhat lustrous division planes and kernels of epidote.

Granitic rocks of Cassiar Mountains.

Beyond the point above defined, at the first little lake, a granitic area is entered on, which may be regarded as constituting the axis of the Cassiar range, and which extends on the river to the mouth of the Cottonwood, constituting the entire Skroe Range, and apparently also Anvil Mountain and the surrounding high mountain region, with a tranverse width of about thirteen miles. The granite here seen differs somewhat from that found on the Stikine in being more highly quartzose and occasionally garnetiferous. Mica is present in great abundance, and is in some specimens black, in others of characteristic pale, silvery colours. The existence of distinctly gneissic rocks was not ascertained, but the lithological character of the series resembles that of the lowest rocks of Shuswap Lake and other districts in the interior of British Columbia to the south, which have been provisionally referred to the Archæan.

East edge of granites.

The valley of Cottonwood Creek appears to coincide with the north-eastern edge of the granites for a number of miles. The mountains to

the north of it, and extending eastward along the north side of the Dease, are evidently composed of stratified rocks, including important beds of limestone, the average dip being about N. 45° E. < 30°. The northern spur of the mountain which terminates the Skree Range, opposite the mouth of Cottonwood Creek, shows the overlap of the stratified rocks upon the granites at a considerable height above the river. The mountains which run southward on both sides of Eagle River valley seem to be also granitic for the most part, though a greenish-grey felsite was collected on the river from the northern spur of the mountain to the east of the valley.

Rocks of McDame Creek Mountains.

Little was ascertained respecting the rocks composing the mountains between Eagle River and Sylvester's Landing, but granite does not reappear in them. The range to the east of McDame Creek is largely composed of limestone, which, striking in a north-west and south-east direction, constitutes also the mountains on the south side of the Dease. The dip is generally westward, at varying angles, and the limestones are associated with reddish shales, and near the mouth of Rapid River were observed to be interbedded with dolomitic layers and calcareous schists. The total thickness of the strata brought to the surface along this part of the river must be very considerable. The lithological resemblance is close to the upper part of the Palæozoic section on the Bow Pass, including the Banff, Intermediate and Castle Mountain limestones of Mr. McConnell (Annual Report, 1886, part D). Limestones near the western or upper part of the river-section contain numerous obscure fossils, including brachiopods, corals, and apparently a sponge-like organism. I also satisfied myself of the occurrence of *Fusulina* on weathered surfaces, proving the Carboniferous age of the rocks in question. The pure limestones are usually grey and are not highly crystalline.

Fusulina.

The mountains bordering the valley in the north-and-south part of its course, between the first and second great bends, appear to be composed throughout of similar rocks, though those on the west side are much better exposed than those on the east.

Confused exposure.

Eleven miles south of the second great bend, on the right bank of the river, is a low, rocky cliff, about fifteen feet above the water, capped by about ten feet of bedded white silts. The rocks are blackish, sandy shales, rather hard in some places, carbonaceous, and holding a little impure lignite. They are extremely irregular in dip, and are broken and jumbled up with a hard, grey quartzite, which is seen in places as the underlying rock, but is even then singularly shattered. The aspect of the shales is that of those of the Tertiary rocks, and it is possible that this locality represents an old shore-line, but more probable that the rocks form part of an ancient slide, or are upon the line of disturbance of a fault.

Possibly Triassic rocks.

At the second great bend there are a few exposures of a peculiar character, consisting of regularly bedded, dark, calcareous, flaggy argillites, alternating with grey, flaggy and massive limestones. Lithologically, these much resemble the Triassic of the West Coast, but no fossils could be found, though carefully sought for, and the evidence is quite too imperfect for the reference of the beds. The limestone is rather cherty, and gives out a fetid odor on being struck. The beds, as a whole, appear to form a synclinal.

Schists and slates of lower river.

From the second great bend to the mouth of the Dease, the underlying rocks consist of grey and black schists, the former generally calc-schists, and the latter more or less highly carbonaceous. They are interbedded with thin limestones, which often weather brown. The calc-schists are frequently glossy, and in some places form very thin, paper-like layers. Some of these rocks closely resemble those met with at the "Grand Rapid" on the Stikine p. 55 B. The general strike is north-west by south-east, but the direction and angle of dip is very varied, and the beds are frequently much disturbed and twisted, and traversed by veins of quartz and calcite. There are probably frequent repetitions of the same horizon, but the general arrangement may be synclinal, the dark shales and schists occupying the higher position, and being most abundant about the middle of this length of the river-section. Graptolites were found in the dark shales, particularly at a locality in a north bend of the river, eleven miles westward in a direct line from the mouth, and in appearance the whole series is much like that of the Cambrian calc-schists and Cambro-Silurian graptolite-shales of the Kicking Horse (Wapta) valley, west of the summit, on the line of the Canadian Pacific Railway.

Comparision with rocks to south.

The general aspect and association of the rocks to the east of the granite axis of the Cassiar Range closely resembles that of the Rocky Mountains about the 51st parallel, but differs in the large proportion of metamorphic materials of volcanic origin, which, from the *débris* brought down by streams, must be even more abundant than the exposures along the river would indicate. This difference is paralleled by the similar change which is met with on the 51st degree of latitude, in passing from the Rocky Mountains proper to the interior plateau of British Columbia.

Note on graptolites by Prof. Lapworth.

A small collection of graptolites, made at the point above indicated, has been submitted by Mr. J. F. Whiteaves to Prof. Charles Lapworth, of Mason College, Birmingham, who has kindly examined them, and furnishes the following note.—

"The graptolites collected by Dr. Dawson from the Dease River are identical with those examined by me from the rocks of the Kicking Horse Pass, some time last year. The species I notice in the Dease River collection are :—

Diplograptus euglyphus (Lapworth).
Climacograptus, comp. *antiquus* (Lapworth).
Cryptograptus tricornis (Carruthers).
Glossograptus ciliatus (Emmons).
Didymograptus, comp. *sagittarius* (Hall).
New form allied to *Cœnograptus*.

Age of the fauna.

"The graptolite-bearing rocks are clearly of about middle Ordovician age. They contain forms which I would refer to the second or Black River Trenton period, *i.e.*, they are newer than the Point Levis series and older than the Hudson and Utica groups. The association of forms is such as we find in Britain and Western Europe, in the passage-beds between the Llandeilo and Caradoc limestones. The rocks in Canada and New York with which these Dease River beds may best be compared are the Marsouin beds of the St. Lawrence valley and the Norman's Kill beds of New York. The Dease River beds may, perhaps, be a little older than these.

"Mr. C. White described some graptolites from beds in the mountain region of the west, several years ago, which may belong to the same horizon as the Dease River zones, though they have a somewhat more recent aspect.

"The specific identification of the Dease River fossils I regard as provisional. While the species correspond broadly with those found in their eastern equivalents, they have certain peculiarities, which may, after further study or on the discovery of better or more perfect specimens, lead to their separation as distinct species or varieties.

"It is exceedingly interesting to find graptolites in a region so far removed from the Atlantic basin, and also to note that the typical association of Llandeilo-Bala genera and species is still retained practically unmodified."

Tertiary strata.

Overlying these old rocks, in several places at about eight miles from the mouth of the Dease, are shaly clays and coarse, soft sandstones, associated with which a thin bed of lignite was observed. These are evidently Tertiary, and referable to the series afterwards found more extensively developed on the Liard, above the mouth of the Dease. Some very obscure remains of leaves were noticed, but none were collected. The beds dip at various angles, sometimes as high as 15°, and thus appear to have been, to some extent, affected by flexure subsequent to their deposition. It is not improbable that a considerable part of the higher plateau by which the river is here bordered on both sides, is composed of these newer rocks resting upon the upturned edges of the schists.

Drift deposits and terraces.

Some notes respecting the superficial geology of the Dease have already been given in connection with the general description of the river. It now only remains to add the following general observations.

The scarped banks along the upper part of the river, to the first great bend, generally show stratified sands and gravels only, all or most of which may be classed as old river-gravels. Between the first and second great bends, well-bedded, yellowish-white silts appear and are frequently exposed. The bedding is sometimes inclined and large boulders are occasionally enveloped in the silts, which are in some places seen to rest upon and pass into true boulder-clay, while they are generally capped by a variable thickness of stratified gravels. The silts, occasionally, rest directly upon the underlying rocks, and in other places have been removed, so that the gravels lie upon the boulder-clay or upon the underlying rocks. Below the second great bend, the silts still occur, but are not so important, being largely replaced by stratified sands and gravels. The approximate level of the highest observed beds of the silt formation may be stated at 2400 feet above the sea. The highest observed terraces on the sides of the mountains have an estimated elevation of about 4600 feet. Glaciated rock-surfaces were observed in a single locality, a few miles below the mouth of McDame Creek. They appeared to indicate a flow of ice eastward or down the valley, but were not sufficiently distinct to afford completely satisfactory evidence on this point.

Upper Liard River.

Proceedings at mouth of Dease

We arrived at the little post at the mouth of the Dease on June 23rd, in rain, which continued during the whole of the next day, rendering it impossible to obtain observations, which were here necessary. On the morning of the 25th, however, I secured a fair series of observations, and having completed such arrangements as we had to make before entering the entirely untravelled country to the north, left the same afternoon. Mr. McConnell was here detached with two men and a boat for the examination of the Lower Liard. We had arranged that a couple of local Indians should accompany each party for the purpose of assisting at portages and acting as guides, but those who went with us deserted after a few days, and we afterwards learned that Mr. McConnell's Indians behaved in the same manner.

Country near the confluence.

The country about the confluence of the Dease and Liard is low and uniform, rising from the rivers in a series of more or less regular terraces, to a plateau 400 feet or more above the water-level, or approximately 2500 feet above the sea. The extent of this low country is considerable.

The name of the Liard River, or Rivière aux Liards, refers to the abundance of the cottonwood or poplar, and was no doubt originally given to its lower portion. This name has been corrupted to "Deloire," in which form it is generally in use by the miners of the Cassiar country. It is often spoken of as the West Branch by traders on the Mackenzie, and has also been named the Mountain River, and sometimes the Great Current River or Courant-fort. It is called Too-ti' by the Indians of the country along its upper part, while, according to Petitot, the Indians nearer the Mackenzie name it Eréttchichié and Thèttadéssè *

The name Liard.

The Liard River, though one of the principal affluents of the great Mackenzie, has remained up to the present time practically unknown, or at least undescribed, though sketched from observations by officers of the Hudson Bay Company on Arrowsmith's maps, and copied from those on other maps. It has long been in use as an avenue of communication by the Company, but since the abandonment of the posts to the west of the Rocky Mountains, its upper part has been traversed only at rare intervals, by a few prospectors and miners from the Cassiar district. With Mr. McConnell's work on the lower part of the river, and the examination of its upper part here reported on, we now have a survey extending from Fort Simpson, at its mouth, to one of its furthest sources, in Finlayson Lake.

Rivers hitherto unsurveyed.

This river and the Frances appear to have been ascended by McLeod, about 1834, as far as Simpson Lake, but in 1840 Mr. R. Campbell explored the same route to Frances and Finlayson Lakes (as subsequently mentioned in greater detail), and obtained the most accurate geographical information available to the present time. Sir J. Richardson, however, in his Arctic Searching Expedition (1851) gives such particulars of the Liard as he was able to gather from hearsay (Vol. I, p. 167; II, p. 203), and mentions having received in 1848, while on the Mackenzie, Honolulu papers of late date by this route from the Pacific. On the older maps, the Black or Turnagain River is designated as the main continuation of the Liard, but it is much smaller than the "North-west Branch" of these maps, to which the name is now applied. In the present report that part of this branch above the confluence of the Dease is, for purposes of description, distinguished as the Upper Liard.

Previous knowledge of the Liard.

The Upper Liard, just above the mouth of the Dease and opposite the post previously referred to, is 840 feet in width, and on the 24th of June 1887 was found to have a maximum velocity of 4·54 miles per hour. The river was not cross-sectioned, but, with an estimated depth of six feet for one-third of its width, the quantity of water car-

Size of the river.

* Bulletin de la Société de Géographie, vol. x, p. 152.

ried would amount to about 19,000 cubic feet per second.* This may be regarded as a rough approximation for the mean stage of the river, which, when in flood, probably carries at least double this volume of water. It is a turbid yellowish stream, and contrasts in this respect with the clearer water of the Dease, which river, at its confluence with the Liard, probably carries about half the volume of water above assigned to the latter.

Character of Liard and Frances Rivers.

From the mouth of the Dease River to the confluence of the Frances River, the general bearing of the Liard is nearly due north-west, the distance, in a straight line, being thirty-three miles, or following the course of the river, forty-five miles. The Frances River, which was followed from the last-named point, disregarding its minor flexures, has a nearly direct north-and-south course. A straight line drawn from the mouth of the Dease to the lower end of Frances Lake is ninety-four miles in length, but the distance between these points, following the flexures of the river, is one hundred and thirty-five miles. Almost every foot of this distance had to be made by poling or tracking against the rapid stream, and as our boats were heavily laden and not as well suited in build as they might have been for the work, the ascent to Frances Lake occupied twelve days, or an average distance of about eleven miles a day only. As the river was entirely unknown to us and some time was unavoidably lost in reconnoitering rapids and selecting portages, besides the delays incident to surveying work and geological examination, I believe, that with a good boat and crew, the ascent to the lake might be made in about half the above time at the same stage of water. In very high water it would be extremely difficult to pass through some parts of the cañons, while at exceptionally low stages of water, when it would be possible to substitute tracking for poling in many places, the distance might be accomplished in even less time.

Lower Cañon.

Six miles above the mouth of the Dease, by the course of the river, the entrance of the *Lower Cañon* is reached. The full height of the plateau through which the river here cuts, is about 500 feet, but banks of this height seldom abut directly on the river. The upper parts of these banks are composed of stratified sands and gravels, but the lower part of the gorge is cut through shaly and slaty rocks, which are perpendicular or form very steep slopes, averaging about a hundred feet in height. The cañon is three miles in length, and at high water it is said to be necessary to portage the whole of this distance. We were obliged to lighten the boats and make four small portages over rocky points, where the current was dangerously swift. The latitude,

* Estimated by approximate formula, Trautwine's Engineers' Pocket-book, 1882, p. 562. The depth above assigned to the river is probably too small.

observed at noon near the middle of the cañon, was 60° 01′ 06″. Finding that we were so near the northern boundary of British Columbia (Lat. 60°), we made a small cairn of stones on a prominent rocky point, in the centre of which a post was erected, on which the latitude was marked. The 60th parallel may be said to coincide almost exactly with the lower end of the cañon.

Rocks of Lower Cañon.

The rocks seen in the Lower Cañon resemble those described as characterizing the lower part of the Dease River and Dease Lake, being shales or schists, which in some places show slaty structure. They are generally dark with plumbaginous matter. With these are associated grey, somewhat glossy schists, and calcareous schists which pass in some places into pretty pure, thin-bedded limestones. Quartzites are also present, and all the rocks are occasionally locally silicified. The whole series is much disturbed and contorted, and is broken by innumerable small, irregular seams and veins of quartz and calcite, with some dolomite, though no well-marked or important lodes were seen. Galena is reported to have been found in some of the veins, and to have yielded a small return in silver on assay.

River from Cañon to Frances.

Above the Lower Cañon the river continues swift, the current averaging about four miles an hour, and much exceeding this rate in many reaches. It is wide and shallow, and in places becomes a complete maze of islands and gravelly, half-submerged bars, causing much difficulty and loss of time from the frequent necessity of crossing from one to another of these to avoid under-cut banks, with water too deep for poling. Our actual travelling time from the Dease to the mouth of the Frances, deducting all stoppages, was thirty-eight hours and a-quarter.

The river-valley averages about two miles in width, and is cut out to a depth of 300 feet or more in the plateau, which occasionally rises directly from the river-bank to its full height, though the stream is usually bordered by terraces of inferior height, alternating with low flats, which occupy the concave sides of the bends. The higher ground is generally wooded with spruce, while the black pine (*Pinus Murrayana*) is abundant on dry terraces, and groves of cottonwood of medium size often occur on the flats. Aspen poplar is not uncommon, and a few birch and larch trees were seen. Little of the timber is of useful size or quality. The dry bars and gravelly flats were, when we passed, gay with *Epilobium latifolium*, *Oxytropis campestris*, *O. Lamberti* and *Dryas Drummondii*, and the wild roses were rapidly coming into flower.

Rancheria River.

About midway between the Dease and Frances a small river enters from the south-westward, which has been called the Rancheria River, but of which I do not know the native name. It appears to debouch by several mouths when in flood, and apparently rises in the eastern

slopes of the Cassiar Range. A few miles above this, on the opposite side of the river, a small lake, reputed to be well stocked with fish, is reported. About seven miles below the mouth of the Frances, on the south west bank, is an old Indian camping place, which is said to be frequented at certain seasons by the Tahl-tan Indians for purposes of trade. It is reached by these people by some overland route which crosses the Cassiar Mountains to the north of the Dease River.

Confluence of Liard and Frances.

The Liard is full of islands at its confluence with the Frances, rendering it difficult to estimate the relative importance of the two streams, but they appeared to carry about an equal quantity of water. The Liard is, however, evidently more subject to freshets; Frances Lake doubtless serving to regulate the flow of the Frances River, the water of which is a clear, pale, amber color, and does not thoroughly mingle with the yellowish, turbid water of the Liard for some miles. Above the confluence, the Liard valley is seen to trend off in a south-westerly direction for ten miles or more, after which it again turns to the northwestward, and, from the scanty information available concerning it, seems to flow along the eastern side of the northern continuation of the Cassiar Range, from which it receives most of its water.

Sayyea Creek.

On comparing the statements of the few miners I have seen who have ascended this river, it appears that Sayyea Creek, which is an inconsiderable stream, flows in from the west about fifty-five miles above the mouth of the Frances. Good gold "prospects" were found on this creek in 1875, a number of pieces worth ten dollars having been obtained, but little work has ever been done. Of a party of miners who spent the winter of 1874-75 in its vicinity four died of scurvy. Of the other tributaries of the Liard, which must be numerous, I have been unable to ascertain anything authentic.

Names of Liard and Frances Rivers.

Respecting the names of the Liard and Frances rivers, it should be mentioned that Campbell called that which is now known as the Liard the "Bell River," after Mr. J. Bell, of the Hudson Bay Company. Under this designation it appears on Arrowsmith's map of 1854, the name Liard being applied to the branch now known as the Frances. Usage has, however, changed the first nomenclature, and it is undesirable to attempt to revert to the original names, as, irrespective of the question of relative size, the physical characteristics of the Liard below the confluence are undoubtedly continued on the west rather than on the east branch above that point. The Indian name of the Frances is identical with that of the Dease, being Too-tsho-tooa', or "Big Lake River."

Rocks above the Cañon.

Rocks like those of the Lower Cañon are seen at intervals for about two miles above its head, beyond which, for about three miles, stratified gravels and sands only appear in the banks. Six miles from the cañon

Tertiary clays of whitish and grey colours, and associated with impure lignite, are first met with, and these continue to appear here and there along the river as far as the Frances. The thickest bed of lignite observed was about three feet, four miles below the Frances. The lignite is generally impure and often very distinctly laminated. It resembles in character the lignites of the Miocene of British Columbia, and the associated clays and soft shales are similar in character to those of that formation. Numerous boulders of basalt are found along this part of the river, and the basalt was observed to form a mural cliff, at a height of about 300 feet above the river, at a place just below the mouth of the Rancheria River. This rock evidently overlies the lignite-bearing beds. The shaly clays and lignites show evidence of considerable disturbance, and dip in some places at rather high angles. This may be due to the action of old land-slides along the banks of the river, but appears to be rather too constant to be satisfactorily accounted for in this way.

Lignite.

Basalt.

Near the mouth of the Frances the white silts again become a prominent feature, though scarcely seen lower down the river. They overlie the Tertiary rocks and hold concretions of various forms here and there. They are capped by the usual stratified sands and gravels, which generally have a yellowish or rusty colour.

White silts.

The gravel bars and the shores of this part of the Liard are almost half composed of rolled quartz pebbles, which have evidently been derived from veins traversing relatively soft schistose rocks like those of the cañon. The great quantity of such vein material present in this district may be regarded as a favorable indication in respect to mineral development. Some small bars have paid to work along this part of the river, and gold is also found in some layers of the gravel deposit which overlies the older rocks along the cañon and above it, where "wages" at $4 a day can be made. The amount of cover which it soon becomes necessary to remove in following the paying layers, has prevented extensive mining, but probably these gravels might be advantageously worked as a whole, by sluicing or by the hydraulic method.

Gold.

No general view of the country can be obtained from the river, owing to woods and the depth of the valley, but from high points of banks above the river, near the Frances, a large area may be overlooked. Thus seen, the country is found to be a wide, rolling plateau, with an average elevation of about 500 feet above the river, or say 2700 feet above the sea. It rises here and there, however, in broad, rounded swells, or flat-topped higher plateaux with steep edges, and a considerable part of this higher ground is at an elevation of about 1000 feet above the river. The plateau is everywhere wooded, except

General appearance of the country.

where intersected by grassy or mossy swamps of small area. There is a large triangular region of country of this kind between the Upper Liard and Dease, which is bounded to the westward by the front of the Cassiar Range. Cassiar Range, the sharp, rocky peaks of which carry a considerable quantity of snow and run along the horizon line for many miles, but which, with the exception of a few outlying summits, is at a minimum distance of about twenty-five miles from the mouth of the Frances. The same low country runs in a north-north-westward direction, without apparent limit, forming the upper part of the Liard valley. To the Mountains to the east. eastward it is bounded, at a distance of about ten miles, by a comparatively low range of rounded mountains and hills, which, from the Indian name of one of its salient points to the northward, may be called the *Tses-ī-uh Range.* The part of this range nearest to the confluence of the Frances and Liard has an elevation estimated at about 3500 feet above the sea. Like other main features of the country, it runs in a north-north-west by south-south-east direction, but dies out completely before reaching the Upper Liard River, which, if continued, it would do at the Lower Cañon. It is probable, indeed, that the cañon is produced by the river cutting across the extension of the same Tertiary plateau. ridge of rocks which produces these hills. The general uniformity of the plateau appears to be largely due to the Tertiary rocks, which doubtless underlie almost its entire area. The appearance of some of the flat-topped hills above alluded to is suggestive of the occurrence of sheets of basalt overlying the softer rocks. The forms of the Tses-ī-uh Mountains show that they are not thus composed, but Tertiary rocks may again occur beyond them, in the valley of the McPherson or Highland River, which is not far off.

Frances River.

Mouth of Frances to Middle Cañon. The general direction of the Frances, for nine miles from its mouth, is north-north-west. It then bends to the north-eastward, and in four miles the lower end of the Middle Cañon is reached. For the first few miles above its mouth the Frances is extremely tortuous, so much so that the distance following the actual course of the river to the foot of the cañon is twenty-two miles. This river, like the Liard, was at a medium stage near the end of June, 1887. Marks along the banks showed that it had been about six feet higher in the spring, and that it had since been falling. Its average width in this part is about 600 feet, and the rate of the current, at the medium stage above referred to, about four miles and a-half an hour.

Terrace. The highest land immediately bordering on this part of the river is a terrace at a height of about 150 feet above it, the surface of which is

in some places composed of almost pure sand, upon which open woods of *Pinus Murrayana* grow. Larch was observed to be moderately abundant in damp, shady localities and the banks were in some places diversified with flowers, of which *Potentilla fruticosa* and *Primula mistassinica* were specially noted.

Exposures in the banks.

Numerous small exposures of Tertiary shales and clays, of grey, blackish and yellowish tints, occur along this part of the river. Lignite is strewn in great quantities over some of the bars, and though thin seams occur in places in the banks, it is probable that thicker ones exist in the bed of the river. The lignite often holds drops of fossil resin or amber. The Tertiary rocks are very generally covered by silts, like those already several times alluded to. In a bank near the mouth of the river, which gives a complete section from the top of the terrace above described, the lowest deposit consists of roughly stratified gravel and clay, with some glaciated boulders. This is followed by the silts, which are again in turn covered by stratified sands and gravels. The lowest deposit probably represents the boulder-clay, and resembles that of the Upper Pelly River, subsequently described.

Quartz is not so abundant a constituent of the gravel of the river-bars on this part of the Frances as it is on the Liard below, and no basalt blocks or boulders were observed here.

Middle Cañon.

The *Middle Cañon*, as it may be called for the purpose of distinguishing it, is about three miles in length, the river being hemmed in by broken, rocky cliffs of 200 to 300 feet in height for the greater part of this distance. We took our boats up along the south-east bank, making four short portages of part of the stuff, and two of both boats and load, across narrow, rocky points. One portage of greater length, on the opposite bank, would overcome all the really bad water, but the banks on that side are rougher, and the whole force of the current sets against the cliff in one place in a dangerous manner. The total fall in the cañon is estimated at about thirty feet.

This cañon is evidently produced by the southern extremity of a second range of mountains parallel to the Tses-ī-uh Mountains, but to the west of that range. This southern spur, though submerged in the Tertiary and drift materials by which the general surface of the country is covered, nevertheless presents a rocky barrier to the passage of the river, and in this place constitutes the eastern margin of the Tertiary basin, no beds referable to which are seen further up the Frances. The range of mountains here referred to may, for convenience, be named the *Simpson Mountains*.

Rocks of the Cañon.

The exposures in the lower part of this cañon show limestones, some of which are moderately pure, but others are nearly half composed of small, more or less rounded fragments of siliceous and schistose rocks.

These weather to rough surfaces, and have a very peculiar aspect, as an intense pressure appears to have flattened the contained fragments parallel to a single direction. These limestones are associated with several varieties of calc-schists, with hard, greyish-blue, cherty quartzite, with schistose breccia, which appears to have been originally of volcanic origin, and with some pretty evident volcanic agglomerate. Further up, the rocks have been completely shattered and variously changed in appearance by solfataric or some similar action, some parts being bleached, while others are reddened by the deposition of iron, forming cliffs of a remarkably varied appearance. The upper gate of the cañon is composed of white cliffs of marble and quartzite, all much shattered. The marble and limestones are in places associated with red shales, resembling those found in a similar association on the Dease, near the eastern edge of the Cassiar Range, and the rocks of this part of the section are probably like those, of Carboniferous age. Specimens of *Fusulina*, with polyzoa, etc., are found in some of the limestones on microscopical examination. Stratigraphically, the rocks seen in the sections are all much confused and broken, and the angles of dip are very varied, though the strike may, in a general way, be given as north-north-west. The Simpson Mountains which are upon this line of strike are doubtless composed of rocks of the same character.

Fusulina.

Above the Middle Cañon, the general course of the river is again north-north-westward for about twelve miles. It is here usually bordered by quite low land on both sides, and the valley between the southern end of the Simpson Mountains and northern part of the Tses-ī-uh Range is about three miles in width. The wide, uniform plateau country is now, however, left behind, and we enter a generally mountainous region, though the highest summits in this immediate vicinity scarcely exceed 3000 feet above the river. Their forms are rather rounded and flowing, and the slopes of those on the east bank are nearly bare of trees, while the opposite range is generally wooded, but evidently with trees of small growth. The river itself is wide and deep, with a rather slack current. A single exposure only, composed of grey-green, silvery schist, was seen along this part of the river.

Beginning of mountainous country.

Near the end of this reach of the river, two considerable streams enter on the west side, and on one or other of these, at no great distance from the river, Simpson Lake of McLeod and Campbell is situated. As the Indians who had accompanied us from the mouth of the Dease had deserted before we reached this place, I was unable to ascertain any definite particulars respecting the lake, though it is reported to be a good one for fish. The position of Simpson Lake, as indicated by broken lines on the map, must therefore be regarded as quite uncertain. The same doubt applies to the Indian names of

Simpson Lake.

several rivers tributary to the Frances above this point, for although one of the local Indians had made for us, upon a sheet of canvas used as a boat cover, an elaborate charcoal drawing of the whole system, it proved to be extremely difficult to recognize the features represented. The Indian map, such as it is, serves to show that the streams tributary to the Frances River rise in a number of lakes, some of which are reported to be of considerable size, and offer a most attractive field for further exploration. We were told, however, that none of the lakes in this region are equal in size to Frances Lake, for which we were heading, a statement borne out by the circumstance that both this and Dease Lake are known in their respective districts as Too-tsho, or "big lake," while the Frances and Dease rivers are, as already mentioned, both similarly named Too-tsho-tooa', or "big lake river." Tributaries of the Frances.

From the point just noted, the direction of the river changes to north-east, cutting across the direction of the Tses-ī-uh range, which terminates at the edge of the river in low, wooded hills. The current is moderately swift throughout, and in one place the river is bordered on both sides by low, rocky banks, but no rapids are met with. This we named the *False Cañon*. One or possibly two streams enter from a valley which runs to the east of the range just mentioned, but they are not of large size. Greyish-green, quartzose mica-schist and greenish silvery schists were seen in one or two places, and in the low rocky banks above alluded to, blackish argillites and grey quartzites, of a less altered appearance than usual, but from which no fossils were obtained, occur. False Cañon.

From the end of this reach the general course of the stream again becomes north-north-west for about thirteen miles, running for the greater part of this distance parallel to, and a mile or two miles from the base of a mountain range, which comes in to the east of the Tses-ī-uh Range. The country to the west of the river is here either flat or characterized merely by low, rounded and wooded hills for many miles back, the eye ranging across this country to the continuation of the Simpson Mountains, which, with generally rounded forms and no striking summits, reach elevations of 6000 to 6500 feet. These mountains do not form a strictly connected range, but appear rather as a series of mountainous areas, separated by wide, low passes. The Indian map above referred to shows three or four lakes in this region, supplying a stream named *Too-tshī-too-a*, which flows into the Frances, reaching it probably just above the Upper Cañon. None of these lakes were visible from any point reached by us. On the opposite side, one stream of considerable size joins the Frances. This is supposed to be the *Agū-zī-za* of the Indians, and, if so, is represented as rising in a chain of small lakes, some of which drain in an easterly direction River above False Cañon. Lakes.

to the Macpherson (*Eg-is-e-too'-a*) River. The valley occupied by these lakes is a travelled route employed by the Indians.

Granitic rocks.

The current is swifter in the upper than in the lower portion of this part of the Frances, and there are numerous islands in the river, but no rock-exposures occur. The mountains to the east of the river are high, but have blunt, rounded forms. Much bare rock shows in their sides, but there is no appearance of stratification, and this, with their form and color, and the great abundance of that material found in the streams in this vicinity, renders it nearly certain that they are composed of granite.

Character of the mountains.

The mountains so far met with in the vicinity of the Frances form rather isolated ranges or masses, which rise somewhat abruptly from generally low country, or are separated by wide valleys, the appearance being that of a mountain system partly buried in later deposits; though no Tertiary rocks, either in place or as loose fragments, are met with above the Middle Cañon. The granitic mountains last referred to form an outlying spur or buttress of the most important range of the district, the axis of which is here about twelve miles east of the river. This it is proposed to designate the *Too-tsho Range.** The southernmost high summit observed was named, from its form, *Tent Peak*. It is situated in latitude 60° 52′ 45″, and has an altitude of 7860 feet above the sea.

Upper Cañon.

The river next makes an abrupt turn to the west for four miles, a mile and a-quarter of this distance being occupied by a series of rapids, which are rocky and rather strong, and have a total fall of about thirty feet. The banks rise steeply from the river to heights of 100 to 200 feet, though the rocky cliffs along the water are of inconsiderable height, scarcely anywhere exceeding fifty feet. This place may be named the *Upper Cañon*, and is the last serious impediment to the navigation of the river. We found it necessary to make several short portages, but with a large boat and at a good stage of the river, it is probable that one portage of about 1000 feet in length, on the south bank, would overcome all the dangerous water, while the boat might be tracked up light. A stream, with moderate current at the mouth and about fifty feet wide, enters a short distance below the cañon, coming from the mountains to the north of Tent Peak. The rocks of

Rocks of Upper Cañon.

the Upper Cañon comprise black, glossy calc-schists, black quartzite or chert, bluish limestone, and some green-grey, silvery schist. Similar rocks are seen again a couple of miles up the river, above the cañon, where a rapid occurs. The dips are all low, and so far as observed, uniformly in a northerly direction. Some of the schists are highly

* From the native name of Frances Lake. I was unable to ascertain the Indian name of this range, if indeed it has any such.

silicified by action subsequent to their deposition, and parts of all the rocks, including the limestone, are reticulated with narrow quartz seams. Near the upper part of the cañon some hard conglomerates occur, holding schistose fragments, as well as limestone pebbles, in which crinoidal joints are observable. It is not improbable that two unconformable series of rocks occur here, but I was unable to find means of distinguishing them in the sections.*

Upper Cañon to Frances Lake.

From the Upper Cañon to Frances Lake, a distance of twenty-one miles and a-half in a straight line, the river maintains a northerly direction with considerable uniformity. It is deep, with a moderate current, for about eight miles, or to *Moose Island*, above which for ten miles the current is again swift, averaging from four and a-half miles to five miles an hour. It again becomes slack for a short distance below the lake. Some portions of this part of the river are much broken up by islands and gravel bars. The river-valley averages about ten miles in width, extending to the slopes of the Too-tsho Range on the east, and being bounded to the westward by a series of rounded mountains, which diverge to the northward from the direction of the first-mentioned range, and run to the west of Frances Lake. These I propose to name the *Campbell Mountains*, for Mr. R. Campbell, whose initial exploratary trip through this country for the Hudson Bay Company is elsewhere referred to at length.

Too-tsho Range

The valley is partly occupied by terrace-flats, and partly by wooded hills or ridges with rounded or flowing forms but which rise in some places to heights of several hundred feet. The Too-tsho Range is here very compact and regular, and runs due north-and-south, the higher summits reaching 6500 to 7000 feet, and carrying some snow, though nothing like true glacier-ice was anywhere seen. The lower slopes of the range toward the river-valley are singularly uniform and light. Two or three streams of some size enter the river from the eastward in this part of its course. All that could be gathered respecting these is shown on the map. The furthest north was named Tyer's River by Campbell, and is known to the Indians as *Pas-ka'*. The exact position of its mouth was not definitely ascertained.

Morainic ridges.

On approaching the lake, low ridges and irregular mounds begin to appear in the vicinity of the river, projecting through the lower terraces and suggesting the existence of morainic deposits. Large boulders also become abundant in the river-bed. No rock-exposures whatever were seen along this part of the river.

Travelling time on Frances River.

Our actual working time on Frances River, from its mouth to the lake, was sixty-seven hours and a-half. The difference of level between

* If so, the rocks here noted may represent the Cretaceous to which they are lithologically similar.

Frances Lake and the mouth of the Dease is 477 feet. By assigning ninety feet of this to the fall in the three cañons, and dividing the remainder by the total length of the river (less the aggregate length of the cañons), we obtain an average rate of descent very slightly exceeding three feet to the mile, which is about what might be anticipated from the current met with in the river, as compared to that of other streams in the district.

Frances Lake and Vicinity.

Frances Lake.

The elevation of Frances Lake above the sea, as determined by a series of barometer observations extending from the 8th to the 16th of July, is 2577 feet. Three miles from its lower end, the lake bifurcates, forming two approximately equal and nearly parallel arms, with lengths of about thirty miles. The two arms are about eight miles apart, and are separated by a group of low, rounded mountains, the culminating point of which, with an elevation of 5230 feet, was named Simpson's Tower by Campbell, the lake itself receiving its name at the same time in honour of Lady Simpson. The eastern side of its east arm is bordered by the Too-tsho Range or hills attached to it, while the country to the west of the west arm rises more gradually to the bases of the Campbell Mountains, some miles distant. Though so far referred to as a single lake, this body of water is in reality entitled to be considered as a group of lakes. The upper end of the west arm, with a length of five miles and a-half, is separated from the main portion of the same arm by a river-like constriction over a mile in length, while the east arm is entered by a narrow and inconspicuous opening with a strong current flowing out, and the real extent of this arm is seen only after passing, for about seven miles, through a series of irregular basins and small lake-like expansions connected by narrows, in which a very perceptible current is found. It appears best, however, to retain Campbell's original name for the whole body of water, rather than to multiply names for which there is no immediate call.

Character of its valley.

Except in its bifid form, for which there are several parallels, and which results merely from the convergence of two valleys of similar character, Frances Lake closely resembles a large number of lakes in the mountainous regions of British Columbia, and has the long narrow parallel-sided outline characteristic of lakes which occupy old valley-excavations, the drainage of which has become interrupted in various ways. In this case, as in a number of others, there can be little doubt, that the lake is held in by morainic accumulations. The great number of boulders near its outlet has already been referred to, and the lumpy, irregular mounds and ridges composed of detrital matter, on the lower

seven miles of the east arm, as well as on the corresponding portion of the west arm, appear without doubt to represent moraines in a more or less degraded condition. The average width of the upper portions of both arms, above these interruptions, is pretty uniformly maintained at about a mile and a-half, such irregularities as occur being produced by gravelly and sandy flats a few feet above the water-level, which have been formed at the mouths of entering streams. The extent and uniformity of these points, is such as to show that the lake must have remained, during a long period, approximately at its present level. The most important of these low points is that which separates the upper part of the west arm, already referred to, and is due to the Finlayson River.* The next is produced by a second stream which enters on the same side five miles and a-half below. This stream is somewhat smaller than the Finlayson, and is known to the Indians as the *Il-es-too'-a*.

Country surrounding the lake.

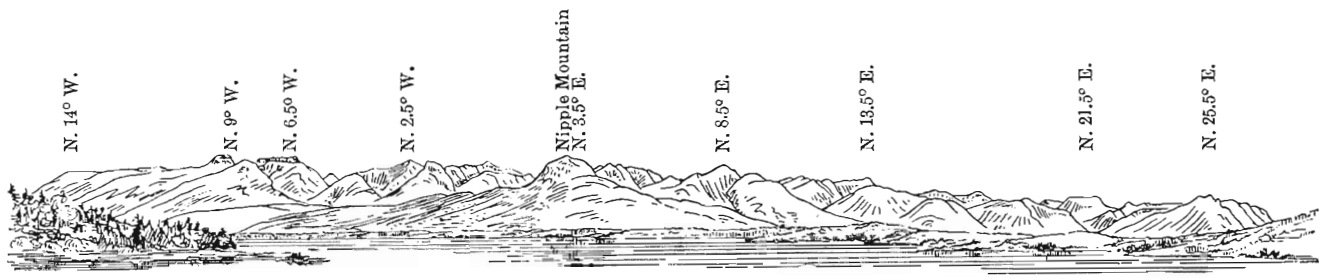
Except along the upper part of the eastern side of the east arm, the mountains do not slope down abruptly to the shores of the lake. Elsewhere, the lake is almost continuously bordered by a terrace-like plateau, which is widest to the west, and has an average elevation of about 300 feet. This resembles the low country found about Dease Lake, though even more uniform and less sloping in character, and is not far from the same actual elevation above the sea in both cases. The streams entering the lake generally cut down through the edges of this plateau-like margin, in deep narrow gorges, the sections in which show that it is composed largely of rock, though levelled up to some extent by the addition of superficial gravelly deposits. This fact appears to indicate that the lake or the drainage level of the country was maintained for a very prolonged period at or near the height of this plateau before the base-level of erosion was so lowered as to permit of the excavation of the lower valleys in which the lake now lies. There is, in addition to this, a second lower terrace, not so well marked, and not often of great width, at an elevation of ninety feet above the lake. This is seen on both arms, and is composed of gravel and other detrital deposits. It is specially conspicuous about the mouths of the entering streams, and marks a later stage at which the water of the lake stood, for a relatively short time, subsequent to the glacial period.

Origin of terraces.

Picturesque scenery.

Few lakes which I have seen surpass Frances Lake in natural beauty, and the scenery of the east arm, bordered on the east by the rugged masses of the Too-tsho Range, is singularly striking. The mountains of this range are very varied in form, and a number of points surpass 7000 feet in height, while one was found to attain an elevation of about

* So named by Campbell after Chief Factor Duncan Finlayson, afterwards a member of the H. B. Co. Board of Directors.



G. M. D. delt.

FIG. 6. OUTLINE SKETCH OF PART OF THE TOO-TSHO RANGE, FROM WEST SIDE OF FRANCES LAKE, AT ITS OUTLET.

(The figures placed above the various summits are true bearings.)

9000 feet. This is named *Mount Logan*, for the late Sir W. E. Logan. Heavy masses of snow rest in some of the valleys, but no true glaciers are produced, a fact indicating a comparatively small snow-fall. The broken outlines of this range contrast strongly with the rounded forms of the mountains to the west of the west arm, with which Simpson's Tower and associated hills, separating the two arms, also conform.

Terminations of the lake.

The west arm terminates in a nearly circular basin about a quarter of a mile in diameter, at one side of which a fair-sized river, easily navigable for boats, flows in. The east arm was not followed to its head, though its termination in low land was seen. Here also, according to Campbell's sketch, a considerable river, which he has named Thomas River, enters.

Upper parts of tributary valleys.

The two valleys, the lower parts of which are occupied by the east and west arms of the lake, run on far beyond the heads of these arms. Each of the rivers flowing in these valleys (according to the Indian sketch already referred to) eventually bifurcates, and all four streams thus formed rise in lakes. The river flowing into the head of the west arm is named *Yus-sez'-uh*, and the lake on its western branch is known as *Us-tas'-a-tsho*. No name was obtained for the lake on its eastern branch, which is evidently, however, Macpherson Lake of Campbell.

Henry Thibert, who made a prospecting expedition up the west arm of Frances Lake and far up the river in question, some years ago, has kindly supplied me with some notes on it. He estimated the river, from the head of the arm to Macpherson Lake, to be about thirty-six miles in length, while Macpherson Lake is ten miles long. The first distance was, however, intended to include the windings of the stream. He did not visit Us-tas'-a-tsho, which, however, from the termination tsho (=big) is probably large. Us-tas is the name of the mythical culture-hero of the Tinné. The Indian name of Thomas River is *Too-tlas'*, the lake in which its eastern branch rises being named *Tus-tles-to*, the source of its western branch *Tʻil-ē-i-tsho*. These lakes and connecting rivers are indicated by broken lines on the map, from Thibert's account and the Indian sketch of the country, combined with the observed positions of several of the mountain ranges.

Mountains to the north.

The mountains to the north in which these rivers rise, were too distant to enable us to fix them with any great accuracy from points occupied by us on Frances Lake, but the whole country in that direction, from such views as were obtained of it, appeared to be rugged and high. It was with great regret that we were obliged to abandon the idea of exploring these rivers further, but the summer was already so far advanced, that this was impracticable, in view of the journey still before us.

The water of Frances Lake is clear and of a pale, brownish tint, and the lake is evidently very deep in its upper portions, though rather

Rock exposures

shallow where encumbered by the morainic accumulations already alluded to. Rock exposures are, as a rule, quite unfrequent along its shores, which are generally composed of gravel and sand. At the time of our visit it was about six feet below its extreme high-water level, and it does not appear to be subject to very great fluctuations. Drift-wood is very abundant along some parts of the shores, particularly in the west arm, and it is probable that much of this is brought down by the river entering at the head of this arm. Lake-trout, white-fish, pike and suckers were found in the lake in considerable abundance.

Old Hudson Bay post.

The site of the old Hudson Bay post is just above the narrow entrance to the east arm, on the edge of the bank, facing westward. Though Mr. Campbell had given me an accurate description of its position, it was so completely overgrown with bushes and small trees, that it was discovered with difficulty. The outline of the old stockade, with bastions at the corners, is still visible, though all traces of the structure itself has disappeared. This post has been abandoned since 1851.

Forest.

All the lower country about Frances Lake is well wooded, and the mountains are also covered with forest, save where exceptionally steep and rocky, to a height of at least 1500 feet above the lake, while trees of smaller growth extend in the valleys considerably higher. The most abundant tree, here as elsewhere in the region, is the white spruce (*Picea alba*). It frequently attains a diameter of two feet, growing tall and straight on low ground and in sheltered places. The black spruce (*Picea nigra*) is also abundant. The larch (*Larix Americana*) is characteristic of damp, cool, northern slopes, and birch (*Betula papyrifera*) is moderately abundant, though not large. The shores, and particularly the delta-flats at the mouths of streams, are characterized by groves of cottonwood (probably all referable here to *Populus balsamifera*) and black pine (*Pinus Murrayana*).

Burnt country.

Large tracts of country have been burnt over, many years ago, and extensive recent fires have swept the western side of the upper part of the east arm. Where a second growth has had time to spring up, it consists generally of mixed spruce, aspen and birch. Alders are common, but scarcely arboreal, along the borders of the lake. In the middle of July thickets of wild roses were seen in many places in full bloom.

General aspect of country.

Taken as a whole, the growth of the forest and appearance of the country is remarkably pleasing, considering the high and northern position of the lake. The only characteristic difference of the woods here, as compared with those of the interior of British Columbia about the 54th parallel, is the great abundance and depth of the soft, mossy and lichenous floor which is everywhere found in them. The trees are also often well bearded with moss, affording evidence of a continuously

moist atmosphere, to be accounted for by the almost daily occurrence of light showers and the great prevalence of clouded skies, which was found throughout this part of the country. As before noted, however, the snow-fall cannot be great, nor is there any indication that the total annual precipitation is very considerable.

Geology of shores.

The infrequency of rock exposures along the shores rendered it difficult to obtain any connected idea of the geology of the lake, both arms of which appear, however, to occupy valleys excavated along the strike of comparatively soft black and greyish glossy schists, which are often calcareous and frequently interbedded with bluish limestone. In lithological appearance these rocks resemble those of the Cambro-Silurian, in which graptolites were found on Dease River, though no fossils were obtained here. The strike is parallel, so far as observed, to the directions of the arms, the prevailing dips being westward on the west arm, eastward on the east arm. The character of the harder and doubtless older rocks which occupy the centre of the anticlinal thus formed and compose Simpson's Tower and connected hills, was not ascertained.

Quartz veins numerous.

The high rugged central parts of the Too-tsho Range are composed largely or entirely of grey granite, pebbles and boulders of which are everywhere abundant, and particularly so along the beaches of the east arm. There is, too, a notable abundance of quartz along all the beaches of the lake, this material being derived from innumerable veins which traverse the schists in all directions, though most often found parallel to the bedding-planes, and generally assuming forms more or less lenticular. The largest of these are often several feet in width, and those seen in the cañon of the Finlayson, near its mouth, are of workable dimensions, if only moderately rich in gold. Specimens of quartz veins, containing some iron and copper pyrites, from the east side of the east arm about midway up it, were found to contain traces of gold on assay by Mr. Hoffmann.

Prospects for gold mining.

In general appearance the rocks of Frances Lake very closely resemble those from which the rich placer gold deposits of Dease Lake are derived, and they are probably of about the same age. Several "colours" to the pan were obtained from surface gravel at the mouth of Finlayson River, which struck me as specially promising in aspect and there seems to be no reason why some of the streams flowing across the schistose rocks into the lake or in its vicinity should not prove to be richly auriferous. This entire district well deserves careful prospecting. After my return to the coast, in the autumn, I ascertained from Charles Monroe that he and some other miners had actually done some prospecting in the vicinity of the lake at the time when the Cassiar mines were yielding largely, and the more enter-

prising men were scouring the country in search of new fields. He reached the lake from Cassiar by the same route we had followed. On comparing notes we found that he had worked for a short time at the mouth of the Finlayson, where he found the gravel to pay at the rate of from $8 to $9 a day.

Country between Frances Lake and Pelly River.

Proceedings at Frances Lake.

We reached Frances Lake an the morning of the 8th of July, and had we been able to find any local Indians to serve as guides and assist in carrying over our stuff, we should have proceeded at once to the best point for that purpose and continued our journey overland toward the Pelly. As it was, it became our first object to endeavour to find the trail used many years previously by the Hudson Bay Compay, of which a general description had been furnished by Mr. Campbell. This necessitated a careful examination of the west shore of the west arm to its head, which enabled us to identify, with tolerable certainty, the stream which Campbell had named the Finlayson. It was supposed that the Indians might have employed the same route in the periodical journeys which they were known to make from the Pelly down the Frances to the little trading post at the mouth of the Dease; but though the remains of an old log *câche* of the Hudson Bay Company were eventually found, together with the nails and iron work of a large boat which had evidently been burnt on the beach near it, no sign of a trail could be discovered. It thus appeared very doubtful whether we should be able to make our way across to the Pelly, with sufficient provisions and the necessary instruments for the continuation of our survey in the Yukon basin.

Search for Indians.

In order to exhaust the possibility of obtaining further assistance before making the attempt, I made a light trip in one of our boats round into the east arm, which was known to exist from Campbell's report, but the narrow entrance to which had not even been observed on our way up the lake. This also enabled me to sketch the east arm, but no Indians were found; in fact, we discovered traces of only a single camp which had been made during the same summer, most of the Indian signs being two or more years old.

Arrangements for journey to Pelly.

All that now remained to be done was to make the best of our own resources. We, therefore, went carefully over all our stuff, separating out everything which was not absolutely essential, and making up the remainder in packs, together with as much food as could be carried. This done, we stowed a great part of our camp equipage, together with some provisions, in a strong log *câche*, which was constructed for the purpose in the bay immediately south of the mouth of the Finlayson,

and moved round to the north side of the delta of that stream, to what we believed to be the best point from which to start. We then hauled out our two boats, and on the 17th and 18th of July carried our remaining stuff to a point some miles up the Finlayson and above the cañon and cascades, which render its lower part utterly impassable. Here we set up the Osgood canvas boat, which we had also carried over. Into this a portion of our stuff was put, and two of our Coast Indians were instructed to endeavor to track it up the shallow and winding stream, while the rest of the party found their way as best they could along the valley, with heavy packs. The walking was extremely fatiguing on account of the deep moss, alternating with brush and swamps, and as in addition, the weather was very warm and the mosquitoes innumerable, our rate of progress was slow. On arriving at the forks of the stream we unfortunately took the wrong branch for several miles, leading to some loss of time, but we eventually reached a lake which we recognized as Finlayson Lake, on July 24th. The canvas boat did not arrive till the evening of the next day, as great difficulty was met with in getting it up the shallow stream, which was badly blocked with fallen trees. In the meantime, observaations for latitude and time were taken, and a raft was constructed on which the stuff might be floated to the head of the lake, which lay in the general direction of our route.

Difficult land carriage.

The lake proved to be nine miles and a-half in length, and near its head we again found the ruins of a Hudson Bay *câche*, but no appearance of a trail. Having selected the most promising looking place from which to continue our journey, we took out the raft-sticks, in order that they might remain dry and serviceable for our Indians on their return, and made a second small *câche* of provisions. The Osgood boat being almost worn out by its hard usage on the Finlayson, and being besides quite too heavy to carry overland in addition to our other stuff, was also drawn up and abandoned.

Reach Finlayson Lake

Soon after leaving the lake we fell upon small streams which evidently drained toward the west, and about noon on the 29th of July we had the satisfaction of reaching the bank of the Pelly River. From this place our five Coast Indians were sent back with instructions to take back to Mr. Reed, at Dease Lake, the articles left in the *câche* on Frances Lake, and this duty, we subsequently learned, they faithfully performed.

Reach the Upper Pelly.

Having constructed a canoe from the canvas brought over for that purpose, we began the descent of the river on the 1st of August.

The above is a summary of our proceedings from Frances Lake to the Pelly. I now feel convinced, that if we had had Indian guides, we might in all probability have shortened the land carriage and possibly

Probable better route.

have found a travelled Indian trail, by following up the waters tributary to the west arm of Frances Lake. It remains to give some notes of the country actually traversed.

Mountains.

Though the region between Frances Lake and the Pelly may be described as a mountainous one, no very high summits were seen, the elevations being, as a rule, rounded and regular in outline, and forming broad, plateau-like areas above the timber-line in some places. The Too-tsho Mountains, which run along the east arm of Frances Lake nearly due north, appear to turn more to the westward beyond the head of the lake, but the line of travel followed toward the Pelly still diverged rapidly from this, the culminating range of the district, and the general direction of the principal ridges in the vicinity of the Finlayson River is not far from east-and-west.

General character of the country.

It is probable that the general character of the country here met with fairly represents that of a wide belt to the west of the Frances River and north of the Liard, including the Campbell and Simpson Mountains and their vicinity. The mountains are about equal in altitude to those last mentioned, averaging from 5000 to 6000 feet. The country is traversed by wide, wooded valleys, of which that occupied by the Finlayson is here the principal. The climate evidently becomes less moist as Frances Lake and the vicinity of the Too-tsho Mountains are left, and dry, gravelly terrace-flats, with *Pinus Murrayana*, are not uncommon on the upper part of the Finlayson. Larch was observed in places for about half the distance up the river toward Finlayson Lake, but was not seen further west. White spruce is still the most abundant tree, and grows as large as along Frances Lake. The black spruce also, however, occurs, and *Abies subalpina* becomes the common and characteristic tree near the upward limit of forest growth on the mountains, which here occurs at about 4200 feet. Grassy swamps are found in a number of places, and a good growth of grass is also met with, where areas have been denuded of forest by successive fires, so that should it ever become desirable to use horses on this portage, they might be maintained without difficulty.

Character of Finlayson River.

The lower part of the Finlayson for about four miles, near its mouth, forms a series of rapids and small cascades in a narrow, rocky gorge, making in this distance a total descent of 300 feet to the lake. Above this cañon it is rapid for several miles, with gravelly bars, and quite shallow, but further up it becomes a narrow and often deep stream, flowing between muddy or sandy banks. At twenty-two miles from its mouth it divides into two nearly equal branches, the northern of which comes from *McEvoy Lake*, the southern from Finlayson Lake. Each of these streams, at their confluence,

is from twenty-five to thirty feet in average width and about two feet deep. The northern branch, however, soon becomes shallow, rapid and stony, while that coming from Finlayson Lake is extremely crooked, winding in all directions in a flat valley about a mile in width, and is besides, as already mentioned, very badly blocked by fallen trees.

From the summit of an isolated, bare-topped hill, which occupies the angle between the two streams, and rises about 1200 above the valleys, an excellent view of the surrounding country was obtained. To the north-eastward, broken masses of high, rugged mountains, patched with snow, limit the horizon. These are evidently connected with the Too-tsho Range, but appear to form an irregular western spur, which is not continued to the west of north. The intervening district, as well as the whole country to the south, is occupied by bare-topped, rounded mountains and ridges of less elevation. Amid these hills the round or flat-bottomed valleys of the streams extend, showing here and there the paler green of a patch of meadow. The most remarkable feature is, however, a tract of low, level country, in which McEvoy Lake and the head of Finlayson Lake lie. This runs nearly due east-and-west, and appears to continue in the former direction till it intersects the northern continuation of the valley of the west arm of Frances Lake, and is also observable to the west of the head of Finlayson Lake. It is intersected throughout by numerous small lakes or ponds and swampy meadows. View from a mountain.

Finlayson Lake (*Tle-tlan'-a-tsoots* of the Indians) is nine miles and a-half in length and rather irregular in form. Its elevation above sea-level is 3105 feet, as determined by our barometer readings, and it may be regarded as occupying the summit of the watershed between the Mackenzie and the Yukon, as no stream of any importance enters it. The country about it is all rather low, but is diversified, to some extent, by wooded ridges and hills, which rise highest near its upper end. The water is apparently shallow throughout, and had, in consequence, a much higher temperature than that of Frances Lake. It is well stocked with white-fish and lake trout, and also, no doubt, with the other species found in Frances Lake. A dead amia, eighteen inches long, was also found on the shore. Character of Finlayson Lake

The immediate shores of the lake are generally quite low and often swampy, and the country is covered with small, poor timber, much of which has been killed by fire. A pretty well marked terrace, at 100 to 150 feet above the water, runs nearly all round the lake, and at the head are irregular, low, lumpy ridges and islands, which evidently represent moraine accumulations. No rock-exposures were anywhere seen along the lake-shore.

The watershed.

The distance from the head of the lake to the nearest point on the Pelly, in a straight line, is about fifteen miles, but the low tract of country already referred to runs some miles to the south of such a line for the greater part of the way. The actual watershed in this low country is probably not fifty feet above the lake, but there is no evidence that the lake ever discharges toward the Pelly. Its height above sea-level is about 3150 feet. Small streams rising to the west of the lake, flow together to form a respectable brook about half way across. This occupies a wide, terraced valley, the ridges bordering which gradually diverge as the Pelly is approached, and the river itself is bordered by undulating terrace-flats several miles in width.

Country west of Finlayson Lake

On ridges west of the head of Finlayson Lake *Abies subalpina* becomes moderately abundant, but the white and black spruce are still the characteristic trees, and the former is well grown in sheltered valleys. No larch or black pine were seen on this part of the portage. The western yellow pond-lily (*Nuphar polysepalum*) was observed in great abundance in a small inlet of Finlayson Lake, and on the hills beyond *Polymoneum pulchellum* and *Mertensia paniculata*, with *Potentilla fruticosa*, were noted as specially abundant flowering plants. The vegetation in the vicinity of the Pelly was much further advanced than any we had yet seen, and the climate of the valley is evidently more favorable than that of the watershed region. The soil of the river-terraces is a fine, silty material, which, judging from the luxuriance of plant growth, must be very fertile.

Geological notes.

In consequence of the width of the valleys and the mantle of drift deposits, few rock-exposures were met with along the whole route from Frances Lake to the Pelly, and those examined consisted wholly of schists or schistose argillites, associated with cherty quartzites in some places, and generally of blackish or grey colors. The gravel wash in the various smaller streams and the rock *débris* met with on slopes of hills and elsewhere, consisted also predominantly of similar materials, and it would appear that the whole of this country is underlain by rocks resembling those described on Frances Lake and part of the river of the same name. A reddish argillite was noted as locally abundant in some streams entering the Finlayson on the south. Pebbles and small boulders of grey granite are not uncommon, but all appear to have been transported from a distance. In addition to the rocks above described, the gravel beaches on Finlayson Lake show numerous fragments of grey-blue limestone, some of which contain obscure fossils. Green serpentine, like that of the vicinity of Dease Lake, and exhibiting minute veinlets of serpentine-asbestos, also a few pebbles of reddish serpentine, were also noted here, and fragments of a peculiar white quartz-porphyry are not uncommon. Large pieces of

Rocks of Finlayson Lake

the same stone were afterwards found on the hills to the west of the lake, but it was not anywhere seen in place. Quartz-vein-stuff is everywhere very abundant, and on the terrace overlooking the Finlayson, on the north side, three miles below the lake, a large mass of quartz occurs in place. The extent of this mass of quartz could not be ascertained, as it protruded from the soil only in isolated spots over an area several hundred feet in length and breadth. A few specimens were collected, but on assay proved to contain neither gold nor silver. Massive quartz.

One of the most notable features of this watershed region is the great quantity of detrital material or drift with which the whole is covered. On the lower part of the Finlayson, irregularly bedded, clayey, gravel deposits, containing large glaciated stones and resembling boulder clay, were seen; but elsewhere stratified gravels and sands are generally shown in any scarped banks which occur. Well rounded gravel was found scattered over the very summit of the isolated mountain at the forks of the Finlayson, above referred to, at a height of 4300 feet above the sea, the material being of varied origin and including granite. No distinct terraces were found on this mountain, but terraces were noted further down the valley on the slopes of higher hills, at a height equal to, or greater than, that of this place. The evidence appears to be conclusive that a body of water in later glacial times extended quite across the Pacific-Arctic watershed in this region, standing at a level more than 1000 feet above it. Glacial striation, in a bearing parallel to that of the valley, was noted on the surface of the quartz mass previously alluded to, but the direction of motion of the ice could not be determined. Superficial deposits of the watershed.

Upper Pelly River.

Our first camp on the Pelly was situated in lat. 61° 48′ 52″, long. 131° 01′ 06″, the height of the river being at this place, as approximately determined from the mean of a number of barometer observations, 2965 feet. The river is here 326 feet wide, with a current slightly exceeding two miles and a-half an hour, and a middle depth of seven feet. An approximate estimate of the discharge placed it at 4898 cubic feet per second. The river had evidently fallen very considerably since the early summer and was probably at or below its mean stage. The water is here nearly clear, with a light brownish tinge. From explorations made at the time of the existence of the Hudson Bay post, as well as from Indian report, the river is known to be navigable by boats for a considerable distance above this point, and to rise in two lakes, the position of which is approximately indicated on the map, according to Upper Pelly River.

Mr. Campbell's sketch. Our camp was about two miles above the mouth of the stream which has already been mentioned as rising on the portage near Finlayson Lake, at the angle between which and the Pelly the old post named "Pelly Banks" was situated. We saw no trace of the buildings which formerly existed, though the old site might, no doubt, have been determined by a little search, had we thought it worth while to devote the necessary time to it.

"Pelly Banks" to Hoole Cañon.

Appearance of the country.

From our initial point, above mentioned, to Hoole Cañon and Cañon, is a distance of thirty-one miles in a straight line, the direction of which is a few degrees north of west. The river, however, forms a wide curve to the south of this line, and is besides very tortuous in detail, the actual distance, following its course, being fifty miles. The main orographic river-valley is here not confined, as is so often the case, between parallel ranges of mountains. There is on the contrary a wide tract of irregularly hilly country, which is bounded to the south by a well-defined mountain range at a distance of ten to twelve miles. This range is crowned by a series of square-outlined pyramidal peaks, which are probably composed of stratified rocks. It is proposed to distinguish it as the *Pelly Range*. To the northward, no definite boundary to the low hilly region can be seen. The actual trough in which the river meanders, however, is scarcely more than a mile in average width, and is generally bordered by terraces a hundred feet or more in height.

Hoole River.

Thirty-three miles, by the course of the river, below our starting point, a tributary comes in from the mountains to the southward, about fifty feet wide by one deep, and very rapid. This is identified as Hoole River.* Its water is bluish in tint, and clearer than that of the Upper Pelly, which by this time has become slightly turbid from material derived from its soft, silty banks. The river, between our first camp and Hoole River, has a rather moderate current, scarcely exceeding four miles and a-half an hour, though with several little "riffles" or small rapids.

Rapid.

Just below the mouth of Hoole River is a rapid about 600 feet long, with a total fall estimated at about ten feet. There is an easy portage on the right or north bank, but a fair-sized boat might run through without danger at most stages of the water. As a precautionary measure, we lightened our canvas canoe, of the behavior of which

*So named by Mr. Campbell after his interpreter. Mr. Campbell, on his original sketch and on Arrowsmith's map, in the construction of which it was used, has named a number of the tributaries of the Pelly. It has been found difficult to identify some of these, but all have been placed on the accompanying map, after a careful comparison.

in bad water we had had at the time no experience. From this rapid to Hoole Cañon the water is swift, and there are several little rapids.

The banks and beaches of the Pelly above Hoole River, are generally silty or muddy, though the strength of the current is sufficient to produce well-washed gravel-bars in mid-stream. Below that point the banks and beaches are also as a rule gravelly, in conformity with the swifter flow of the stream.

Vegetation.

The banks along the south side of this part of the river, are for the most part densely wooded, and where shady and damp the growth of timber is small and scrubby, with much black spruce. The banks on the opposite side are very different in appearance. Those above Hoole River show numerous open, grassy patches, and below that place grassy slopes preponderate over the wooded area, the grass having the characteristic growth and dry, tufted appearance of "bunch-grass." The trees are similar to those found along the rivers previously described, except that *Pinus Murrayana* and larch do not occur, and but a single white birch was noted, near the mouth of Hoole River. Groves of cottonwood of medium size cover some of the flats. In one or two banks into which the river was cutting, and where the surface was covered with a dense, mossy growth, frozen soil was observed. The depth to which it extended could not be ascertained, as it went below the water-level of the stream.

Frozen soil.

Rocks represented.

Above the mouth of Hoole River the rock exposures are few and inconsiderable. Near the mouth of Campbell Creek a yellowish-weathering irregularly silicified dolomite was observed in several low outcrops, together with green-grey, slightly lustrous schists, and similar schists were seen in one or two other places on this part of the river. The composition of the gravel of the river-bars may be accepted as indicating in a general way the character of the formations of the drainage area of the upper river. These include fragments of schists, quartzites and argillites of the same kind as before described on the Frances, with grey, fine-grained limestone, some pieces of coarse white marble, and occasional small pebbles of the same peculiar quartz-porphyry seen on Finlayson Lake. There are also represented several varieties of granitoid rocks, the most abundant of which has a coarse gneissic lamination, with whitish or greenish mica and large, white, porphyritic felspar crystals, round which the layers of the rock bend. This peculiar granite or gneiss is probably derived from the head-waters of the main river, and often occurs in large boulders, which can scarcely have been carried by the stream, and have probably been transported during the glacial period.

Basaltic area. At the rapid at the mouth of Hoole River low bluffs of dark-brown basalt appear, and the same rock crops out in several places further down the river, extending probably to within two miles of Hoole Cañon, though the lower exposures have rather a dioritic appearance, somewhat different from those first noted. The horizontal extent of this local development of basalt is approximately indicated on the map, but as the country to the north is here all low, its limit in that direction is entirely hypothetical. This is probably the first occurrence of basalt on the river, as no basalt pebbles were seen above this place. The basalt is often amygdaloidal or vesicular, and contains chalcedony, calcite and some fibrous zeolite, but is scarcely at all columnar.

Scarped banks. Above the mouth of Hoole River, frequent scarped banks exhibit white or grey bedded silts, associated with or underlain by stratified gravels, with a dark-grey, earthy matrix. These latter deposits often hold large boulders, and observations made further down the river appear to show that they represent the boulder-clay.

Between Hoole River and the cañon, the silts are scarcely seen in the banks of the Pelly, being replaced by gravelly and coarse sandy deposits.

Hoole Cañon to Ross River.

Hoole Cañon. At Hoole Cañon, the river makes a knee-like bend to the north-eastward, and is constricted between rocky banks and cliffs about a hundred feet in height. These render it impracticable to use the line, and as the water is very rough and dangerous, it was found necessary to carry not only all our stuff, but the canoe as well, to the lower end of the cañon. The distance by the river is about three-quarters of a mile, by the portage half a mile, the highest point being one hundred feet above the river. The portage is on the south side of the river, and we found traces on it of skids which had been laid by the Hudson Bay Company many years ago, but no sign of its having been employed by the Indians, who in all this district generally travel by land, making rafts when they are obliged to cross any of the larger rivers.

Ross River. Sixteen miles and a-half below the cañon in a straight line, or twenty-three miles by the course of the Pelly, is the mouth of a river which is identified as the Ross River of Campbell.* This stream, which comes from the north-eastward, is to all appearance as nearly as possible equal in volume to the Pelly, having a width of 290 feet, with a current of four miles and a-half an hour. Its water is turbid and milky, and colder than that of the Pelly, leading to the belief that it is not derived from lakes like that stream, or that if lakes do

* So named after Chief Factor Donald Ross.

occur on its upper waters, they are much less in area than those of the Pelly. Its size would indicate that it may rise in the same distant range with the Pelly, but no long view was obtained up its valley, which is narrow and bordered by high, steep hills at its mouth. Midway between the cañon and the Ross, Ketza River,* a swift stream, about forty feet by one foot, joins from the south. Like other streams from that direction, it carries clear, blue, mountain water, and brings down quartzites, argillites and schists of the usual character, together with a great abundance of quartz-gravel. Character of county.

The Pelly, between the cañon and Ross River, is swift throughout, with numerous little rapids. To the south of the river there is still a wide extent of low, wooded country between it and the continuous range before referred to as the Pelly Mountains. To the north the view is more limited, particularly near the mouth of the Ross River, owing to the existence of a long, steep ridge, parallel to the course of the Pelly, and from 600 to 800 feet in height above it. The southern face of this ridge, which is cut through by the Ross River, is more than half, open grass land, and would afford excellent pasturage. Rocks.

The rocks of Hoole Cañon and its vicinity are chiefly white marble, associated and interbedded with grey and black cherty-looking quartzites, which are often thin-bedded and sometimes rather schistose, and precisely resemble the Câche Creek quartzites of southern British Columbia. Further down the river are occasional exposures of greenish and grey schists and schistose argillites. The rocks along this part of the Pelly strike nearly parallel to its main direction, or about north-west by south-east, and are either nearly vertical or have dips to the south-westward. Stratified gravels are seen in a few places in scarped banks, but silts are not here specially characteristic.

Ross River to Glenlyon River.

From the mouth of Ross River to the Glenlyon River, the general course of the Pelly is almost direct, on a bearing of N. 50° W., the distance being sixty-four miles. In consequence of the number of minor flexures in the stream, this is, however, increased by the river to eighty-two miles. Ten miles below the Ross, following the river, a stream, *Lapie River*,† sixty feet wide by one foot deep, and resembling in its general character and colour of water Hoole and Ketza rivers, comes in from the south. Twenty-three miles from the same point a smaller tributary joins from the north, which is supposed to be the Orchay of Lapie River. Orchay River.

* So named by Campbell, after one of his faithful Indian companions; not Kelzas, as shown on Arrowsmith's map of 1854.

† This stream was not named by Campbell. I call it Lapie River, after one of his Indians, he having given the name of the other (Ketza) to a neighboring tributary.

Campbell. This is about twenty feet wide by six inches deep, and carries clear, brownish water, doubtless derived from a lake or lakes. Ten miles further, on the same side, is a valley running to the north, which probably brings in a moderate sized stream. But this falls into a slough, behind islands, and was not seen.

Features of the country.

All the way from the Ross to the Glenlyon the Pelly is closely bordered on the north by ridges and hills of considerable height, which become mountains of 4000 to over 5000 feet before the last-mentioned stream is reached. These entirely preclude any outlook over the country on that side. To the south, the important and well-marked

Pelly Range.

Pelly Range is continued to a point opposite the Orchay River, where it appears to terminate in a group of mountains lower than those of its eastern part, but still from 5000 to 6000 feet in height. These are situated at a distance of about six miles back from the river, the intervening country being occupied by lower, wooded hills and broken country. The forms of the mountains are rather bold, consisting of steep crests and ridges, with intervening narrow, V-shaped gorges, and they appear to be grassed or covered with low, herbaceous growth, giving them a general greenish tint. There are few bare, rocky summits, and the whole appearance is that of a range shaped by normal processes of denudation from schistose or other crumbling rocks of a stratified character and nearly uniform hardness. They still carried a few patches of old snow on the 4th of August. The higher portions of this range to the eastward, present a rougher and almost serried outline, but there are not even there any exceptionally high points, and the slopes of the peaks are extremely uniform. Beyond the western termination of this range, for a distance of about twenty miles, no

Gap to the southward.

mountains were seen to the southward from the river-valley. From the fact that evidences of a more humid climate were found along the corresponding length of the river, it is highly probable that a somewhat important gap occurs in this direction, of sufficient width to admit the entrance of the moisture-bearing winds. The greater humidity of this part of the valley is particularly marked by the densely wooded character of the slopes on the north side of the river.

Beyond the gap above referred to, a low mountain-range appears on the south side of the river, not in line with that last described, but quite close to the river, which here, for a number of miles, flows in a valley between two mountain axes.

Notes on the river.

The Pelly, for rather more than half the distance between the Ross and Glenlyon, continues to be pretty swift, and is much divided among islands and gravel-bars; the remaining part is comparatively tranquil, with the exception of the rapids in the immediate vicinity of the Glenlyon. The forest growth throughout is much like that previously

described, save that the birch is now moderately abundant, and the black pine (*P. Murrayana*) appears, coming in first on dry northern slopes thirteen miles eastward from the Glenlyon. Cottonwood, aspen, alder, spruce and willows are the prevailing trees on the river-flats, which are usually about ten feet above low-water level. Frozen soil was again seen in several places along the shady side of this part of the river, extending from about eighteen inches below a mossy and peaty sod to the water-level, with a depth of ten feet or more. Some of these banks were being rapidly undercut by the water, which thaws the soil wherever it comes in contact with it, and causes large masses, with the superincumbent sod and trees, to fall into the stream. Black pine. Frozen soil.

The rapids above alluded to as near the Glenlyon are two in number. The first occurs in an S-shaped bend about two miles east of the Glenlyon; the second just below the mouth of that stream. The upper rapid is wide and rather shallow, with some rocky impediments. It is easily run with a canoe, but at low stages of the river, doubtfully passable for a steamer, unless of light draft. The current in the second rapid strikes full on the face of a rocky bank on the right of the river, and forms a heavy confused wash in consequence, but is otherwise unimpeded and deep. Rapids.

The rocks seen along the Pelly, between the Ross and Glenlyon, while resembling in a general way those previously described, differ in their greater alteration and in the evident importance in their composition of products originally of volcanic origin. The most abundant are blackish-grey and greenish quartzites and schists, often more or less micaceous, and in places passing into true mica-schists. Three and a-half miles west of the Ross River, on the left bank, are exposures of massive, dark, leek-green serpentine, associated with green serpentinous and quartzose schists, and a spotted white and green rock, which may be a much decomposed diabase or diorite. One portion of the bank shows at least a hundred feet in thickness of nearly pure serpentine, but no asbestos veins were seen here. Thirty-six miles west of the Ross a very peculiar purplish felsite was noted. It is schistose and slightly micaceous in the division planes, besides being porphyritic with irregular white felspar masses. Four miles east of the Glenlyon, a close-grained, banded, white-and-grey felsite occurs, in a much shattered exposure, and is probably a fine, altered volcanic ash. All these rocks evidently form members of a single series, and though with numerous local irregularities, strike in a general way parallel to the course of the river. The circumstances tend to show that they are on the whole stratigraphically higher than those seen further up the river, but it is not certain that the dips are normal. Geological features.

Laramie or Cretaceous rocks.

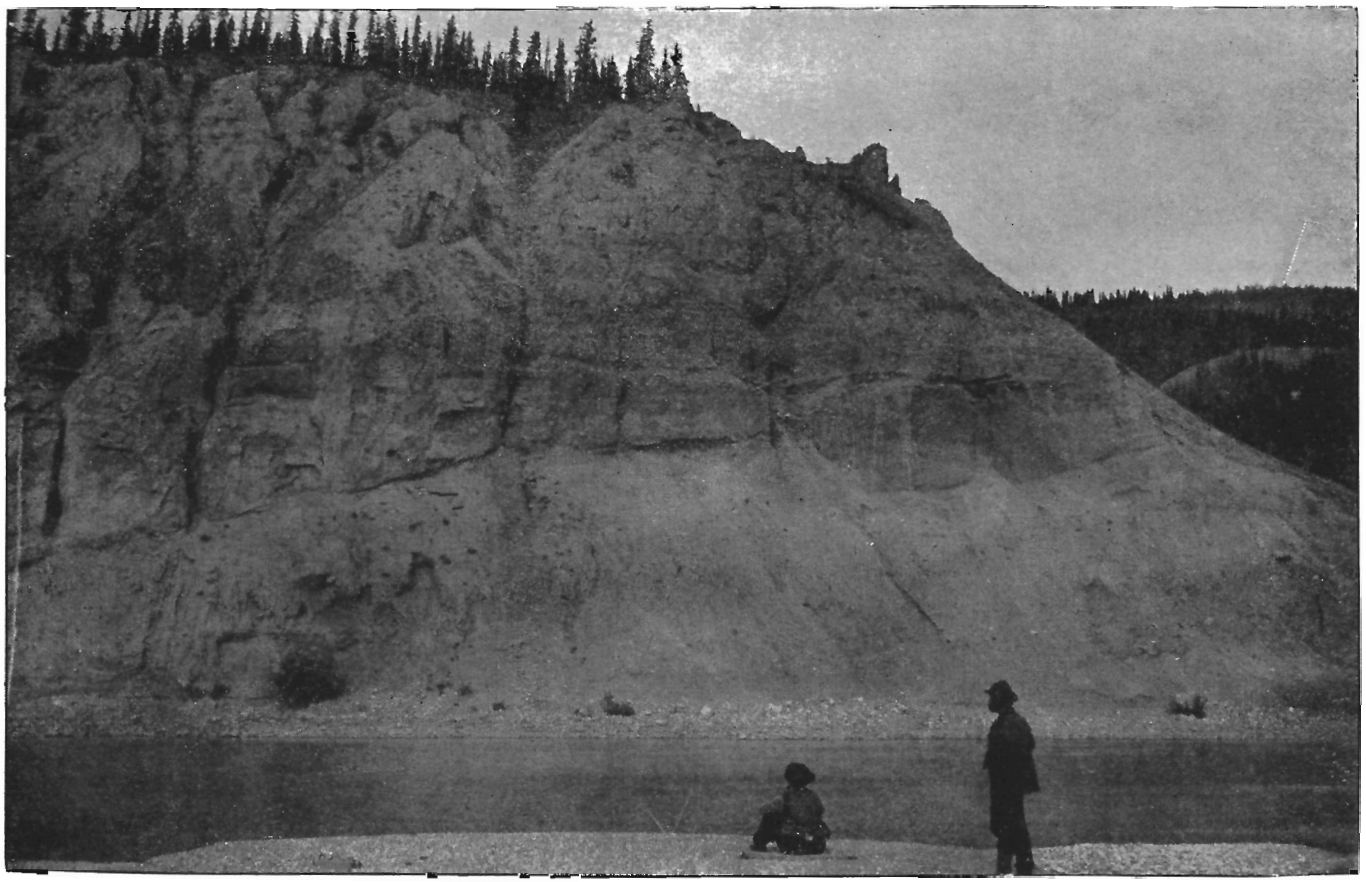
The most interesting fact developed on this part of the Pelly is, however, the occurrence of rocks of Laramie or Cretaceous age. These were noted in a single low exposure on the south side of the river, twenty-seven miles and a-half west of the mouth of Ross River. They consist of black carbonaceous or possibly plumbaginous shales, rather hard, and interbedded with grey-brown sandstones, the whole dipping nearly due south at an angle of forty-five degrees. But this single occurrence of rocks of this character was found, and no rocks are seen for several miles up or down the stream, so that the area characterized by the formation to which they belong is uncertain. Sir William Dawson writes as follows of the fossils obtained here:—"The few specimens examined are full of impressions of dicotyledonous leaves, much crushed and imperfect. One has the venation of *Corylus MacQuarrii* (Forbes). Another seems to be a *Juglans*, near to *J. acuminata* (Braun). Both of these species are said by Heer to occur at English Bay, Alaska, and also on Mackenzie River. The determinations cannot, however, be considered as certain."

Fossil plants.

Superficial deposits.

Fine sections of the drift deposits frequently occur along this part of the Pelly River, forming scarped banks from eighty to a hundred and fifty feet in height, and at times a quarter of a mile or more in length. The stratified gravels, with grey or brownish earthy matrix, which have previously been described, were seen just above the mouth of Ross River to be interbedded with and overlain by silts of the usual character. A few miles below the Ross they were first seen in association with indubitable boulder-clay, and thence down stream, the earthy or clayey gravels and boulder-clay form the lower portion of most of the scarps, being capped by bedded silts, which in some places are fifty feet in thickness. The stratified earthy gravels and boulder-clay are interchangeable and may be considered as constituting a single formation. These gravels are sometimes interbedded with rude layers of boulder-clay, while in other sections they occur in the bottom of the bank, with massive-looking boulder-clay above them, and in yet other instances these conditions are reversed, and the gravels pass above into the bedded silts, which everywhere constitute the upper member of the glacial series. When the matrix of the gravels becomes clayey, they closely resemble boulder-clay in composition, but do not often hold such large stones as the latter occasionally does. The stones of both the gravel and the boulder-clay are more or less completely water-rounded, and striated stones were seldom seen along the river. The gravels above referred to are quite distinct from the old river-valley gravels, which also occur at various levels, sometimes as the highest member of the section in scarped banks, in other cases forming the substratum of river-flats. With the appearance of

Peculiarities of boulder-clay



G. M. DAWSON, PHOTO., AUG. 4, 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

DRIFT BLUFF, UPPER PELLY RIVER, AT MOUTH OF LAPIE RIVER.

Lower part of bluff boulder-clay, irregularly overlain by earthy stratified gravels, these followed in ascending order by stratified silts.

the boulder-clay the scarped banks begin to assume a characteristically castellated appearance, standing often in series of nearly vertical buttresses and pillars, with deep intervening gullies.

Glenlyon River to Macmillan River.

For the purpose of description, the next convenient length of the Upper Pelly which may be taken, is that extending from the Glenlyon to the Macmillan River.* This again naturally sub-divides itself into two parts, the first with a general bearing of N. 53° W., twenty-eight miles and a half, in continuation of the general course of the upper river, the second about N. 77° W. thirty-three miles. The total distance, following the course of the river, from the Glenlyon to the Macmillan, is ninety-one miles. The tributary streams in this distance, again measuring by the course of the Pelly, down stream, are as follows:—Glenlyon River, forty feet by one foot. Eight miles and a-half below, stream on the north, sixty feet by six inches. Twelve miles, tributary from the south, twenty feet by three inches. Seventeen miles, on the south, dry torrent bed. Twenty miles and a-half, on the south, ten feet by three inches. Thirty miles on the north, thirty feet by six inches; the Earn River of Campbell. Forty-seven miles on the south, thirty feet by three inches; probably the Tummel River of Campbell. From this point to the Macmillan no tributary streams were observed, the country to the northward evidently draining toward the last-named stream, and that to the south, at no great distance, being in all probability within the drainage-basin of the Lewes. Tributary streams.

The above estimates of the sizes of the streams refer to the date at which we saw them, in August, when most appeared to be at or near their lowest stages. For about twenty miles below the Glenlyon River, the Pelly is more than usually free from abrupt bends, and few islands are met with. It is bordered to the south by a range of mountains, which may be named the *Glenlyon Mountains*, the highest points of which somewhat exceed five thousand feet. Lower irregular hills border the north bank, and these, as usual, show extensive grassy slopes on the southern exposures. At the distance just mentioned from the Glenlyon, the river turns abruptly to the northward, making an S-shaped bend, and cutting completely through the ridge which has previously bounded it on that side. After a sinuous course of about fifteen miles (about midway in which it receives the Earn River), to the north of the ridge, it turns again with equal abruptness to the southward, rounding the west point of the Glenlyon Mountains. The Detour.

* Of Campbell, named for Chief Factor Macmillan.

ridge, which here dies away. This peculiar flexure is distinguished on the map as *The Detour*. To the south of the ridge is a wide valley, which lies in the general direction of the river, and which, though now apparently floored by drift deposits, doubtless represents a pre-glacial valley of the Pelly. The distance from bend to bend of the river, through this disused valley, is eight miles and a-half, and the height of its floor above the water-level was estimated at about two hundred feet. As far as the lower end of The Detour the current is rather swift and there are a number of little riffles, some of which might be called rapids, though none are of a character to impede navigation.

Approach to Macmillan River.

From The Detour to the Macmillan, the Pelly has a current averaging not more than three miles an hour, though attaining four miles in a few places. The country begins to open out to a greater extent than found anywhere on the upper river, and is diversified only by comparatively low and irregular hills. About fifteen miles eastward of the Macmillan is a wide low gap opening to the north, by which the Indians evidently cross over to the valley of that river, as several large rafts were seen here on the north bank. Between this place and the mouth of the Macmillan, the river becomes again rather strictly confined between ranges of hills, but just below its confluence it turns sharply to the north and is broken up into several channels among a number of low, wooded islands.

Confluence of the rivers.

The Macmillan and the Pelly valleys coalesce at an acute angle at the western point of the range of hills which alone has separated them for some distance, and the two streams must run nearly parallel for many miles above their junction. The Macmillan is bordered to the north by a well defined range of low mountains, which continues to the westward for about ten miles as the bordering range of the united streams. At the confluence, the Pelly appeared evidently to be somewhat the larger river at the time of our visit, and it is probably so at all properly comparable stages of water. The inequality in size can not, however, be very great. The width of the Macmillan, just above its mouth, was found to be 455 feet, the rate of the current, which is greater than that of the Pelly at the same place, was 2·7 miles per hour. The Macmillan water is much more turbid than that of the Pelly, and of a yellowish colour. The temperature of both rivers was identical on the ninth of August, being 54° F. It may probably be assumed from this circumstance that the origin of the rivers is similar, and that the Macmillan, like the Pelly, rises in or flows through considerable lakes, in which the water is warmed to a like extent. The suspended matter of the Macmillan may be entirely due to the washing away of silty banks, which is the usual cause of the turbidity of streams in this district. The upper part of the Mac-

G. M. DAWSON, PHOTO., AUG. 8, 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL,

ON UPPER PELLY RIVER, NINETEEN MILES ABOVE MACMILLAN.

millan has never been explored, but its size would indicate that it may rise as far to the eastward as the Pelly, and probably, like it, in mountains representing the western ranges of the Rocky Mountains. We do not, however, know to what extent this river shares with the Stewart the drainage of the comparatively low country to the northward. I afterwards met a couple of miners (Messrs. Monroe & Langtry) who had ascended the Macmillan for several days in a boat, but not finding encouraging "prospects" had returned. They reported the existence of a large area of low land with good soil, and had met with no impediments to navigation as far as they had gone. Macmillan River.

Ten miles above the mouth of the Macmillan we encountered a couple of Indians, father and son, working their way up the Pelly with a small dug-out canoe. They were the first human beings we had met with in the country since leaving the mouth of the Dease River, forty-three days previously, but as we were totally unable to communicate with each other except by signs, it was impossible to obtain any definite information from them. They were evidently quite at a loss to know whence we had come, and evinced a peculiar interest in examining our little canvas canoe. Meet Indians.

The Glenlyon Range appears to be throughout granitic. Its base does not touch upon the river, but the general aspect and uniform grey colour of its higher parts is that of the granitic mountains of this region. Its composition is also indicated by the character of the material brought down by the Glenlyon River and other rapid streams which rise on its slopes or in its valleys. This is largely, and in some cases almost exclusively, composed of granite of very uniform lithological character, grey in colour and generally hornblendic. The same rock is met with in place on the Pelly, about half way from The Detour to the mouth of the Macmillan, beyond the termination of the range itself, but precisely in the continuation of the line of its axis.* The rocks exposed along the Pelly itself, between the mouth of the Glenlyon and the granitic exposure just alluded to, and which may be regarded as a whole as occupying the northern flank of this granitic range, are more varied in character than those met with on the upper part of the river. Nothing can be said as to their order of superposition, for while the river nearly follows the main direction of the strike, the locally observed attitudes of the strata of the several isolated places where they were noted are very irregular. This is particularly the case in the vicinity of The Detour. The rocks comprise greenish and blackish schists and schistose quartzites, of varied aspect, generally somewhat more altered in appearance than usual. These are interbedded at the east end of The Detour with finely-banded white Geological features.

* See Appendix V. (Upper Pelly, No. 53).

marble and quartzite; and at ten miles west of The Detour, are somewhat extensive exposures of blackish and bluish-grey, rather flaggy and little altered limestones, in which, however, no fossils could be found.

Second range of granite.

The range of hills which has been referred to as bordering the Pelly on the south, near the mouth of the Macmillan, is likewise composed of granite, which appears in several places on the river. This is of greyish and greenish-grey colours, and similar to that of the Glenlyon Range, though it apparently forms a distinct though parallel granitic axis. The rocks which immediately border this granitic axis to the north, though not seen in actual contact with the granite, have a more highly altered aspect than almost any of those seen further up the river, but the impression gathered from their examination is that they owe this alteration to the influence of the granite rather than that their character is an evidence of greater age. They comprise several varieties of rough, micaceous schists, which are highly quartzose, and evidently of clastic origin, as well as a much silicified, coarse grauwacke, and a pale-grey, speckled, silvery mica-schist, which breaks into thin laminæ. The last-mentioned rock is found on the north bank immediately below the Macmillan. Some distance further down, the river turns sharply to the south, and cuts across the whole width

Granite Cañon.

of the second granitic axis in *Granite Cañon*, presenting exposures of grey hornblendic granite for several miles, which, near the lower end of the cañon, becomes much shattered by jointage-planes.*

Drift deposits.

The drift deposits along the part of the river between the Glenlyon and Macmillan, resemble those previously described, the only marked change being in the substitution, in some sections to a considerable extent, of sands for the silts before so characteristic. Stratified clayey gravels and boulder-clay occur, with relations similar to those noted on the upper river, but in some sections gravels and sandy silts are interbedded, the bedding at times being flexuous, and even contorted in character. All these materials are below the ordinary valley-gravels and sands of post-glacial age.

Glacial striation.

Six miles below the Glenlyon, the first distinct case of glacial striation and ice-rounded rock-surfaces met with on the Pelly was noted, and below this place similar evidences were found in a number of localities. The direction of striation in all cases closely accords with that of the main depression of the river-valley, though cutting across it obliquely where it turns north towards the Macmillan. The form of the surfaces is such as to show that the sense of the movement of ice was westward or down stream.

---

* See Appendix V. (Upper Pelly, No. 57.)

Macmillan River to Lewes River.

From the mouth of the Macmillan to the confluence of the Upper Pelly and Lewes rivers is a distance, in a straight line with a general bearing a few degrees south of west, of forty-six miles. A considerable portion of this part of the river is, however, extremely tortuous, and in consequence no doubt of the generally low character of the country, its flexures are not merely short, sharp bends from side to side of a trough-like valley, like those usually met with further up, but lax irregular curves of greater dimensions. The distance from the Macmillan to the mouth of the Lewes measured along the course of the stream is seventy-four miles. Tortuous part of the river.

Four miles below the mouth of the Macmillan, on the north bank, is a small log-cabin, the first sign of habitation we had seen. We afterwards ascertained that two miners had lived here during the winter of 1886-87. At five miles and a-half below the Macmillan the Pelly was found to be 754 feet in width, with a current of 2·3 miles per hour; a few miles below this the river turns south-westward and then nearly due south, entering Granite Cañon at thirteen miles from the Macmillan. The rocks met with in the cañon have already been alluded to. The cañon is about four miles in length, with steep, rocky, scarped banks and cliffs, 200 to 250 feet in height. In the cañon are several little rapids, but the water is deep, and with the exception of some isolated rocks, the navigation would be quite safe for steamers, even at a low stage of water. As the river is much confined, however, it is probable that pretty rough water may be found here during floods. Just beyond the cañon, or sixteen miles and a-half below the Macmillan, a small stream, about ten feet by three inches, enters from the south-eastward. The bed is wide, and it appears at seasons of flood to become a formidable torrent. At thirty-six miles from the Macmillan another small stream was observed on the south side, but with this exception, the river receives no further tributaries before meeting the Lewes. Judging from Campbell's sketch, this otherwise insignificant stream must be that flowing from Tatlmain Lake, which was probably a source of supply of fish for Fort Selkirk while that post was maintained. Granite Cañon. Tatlmain Lake.

After passing the ridge which is cut through by Granite Cañon, the country on both sides of the river for about fifteen miles is quite low. No mountains or high hills are in sight on any bearing to the westward, and wide terraces run far back from the river at heights of 150 to 200 feet above it. These are often lightly wooded, largely with aspen, and are clothed with a good growth of grass presenting a very attractive appearance. The soil is good, and at the time of our Low country.

Appearance of the country.

visit the country was very dry. *Anemone patens* was seen here for the first time since reaching the Yukon basin, and *Elæagnus argentea* was also noted, both species characteristic of a rather dry climate. For the remaining distance to the mouth of the Lewes, the river is more closely bordered by low hills and ridges, which seldom exceed a height of 400 feet. At one place the stream is confined between high and somewhat rocky banks, but no rapid is met with. The southern slopes of the hills are generally open and grassy, and would afford excellent pasturage. The northern exposures are still pretty thickly wooded. Just above its confluence with the Lewes, the Pelly makes an abrupt turn to the south, and runs for several miles along the eastern base of a scarped cliff of basalt. From Granite Cañon to the confluence, the current scarcely exceeds two miles and a-half an hour.

Rock exposures

For a number of miles below Granite Cañon, no rocks are met with along the river, but lower down there are frequent exposures, extending for some miles, of highly crystalline schists, which strike nearly east-and-west, parallel to the main direction of the river, with general high northward dips. These rocks differ considerably from any before seen, including dark, wholly-crystalline schists, holding hornblende or hornblende and mica. With these are associated considerable exposures of a peculiar dark-green chlorite rock, containing large mica crystals.

This rock is interbedded with white, coarsely crystalline marble, in some places, and is quite evidently the alteration-product of some stratified material which has doubtless, however been of volcanic origin. Nine miles above the confluence, by the course of the river, a

Serpentine,

great mass of impure serpentine comes out on the bank, and six miles and a-half above the same place, grey granite of the usual character is again met with,* and appears to constitute the hills to the east of the river for the remaining few miles of its course.

Basalt bluffs.

The basalt, which forms a plateau from 200 to 250 feet in height in the angle to the west of the Pelly at its junction with the Lewes, consists of several superposed flows, not always distinctly separable at a distance. It forms a mural cliff, with a long talus of angular fragments sloping down to the river-level, and though not very distinctly columnar where it fronts on the Pelly, becomes so below the confluence. The rock is brown in colour and often vesicular.

Superficial deposits.

The bedded silts were seen above Granite Cañon, but are scarcely represented below it. Boulder-clay was noted in one place below the cañon, and the old stratified gravels in several places. The scarped banks along this lower part of the river are, however, chiefly composed

* See Appendix V. (Upper Pelly, No. 61.)

of well rolled valley- or river-gravels, which become much more important than before, and often constitute entire terraces up to forty feet in height.

A remarkable layer of fine white volcanic ash, which overlies the glacial deposits all along the Upper Pelly valley, as well as in that of the Lewes, has already been described on page 43 B. Volcanic ash.

General Notes on the Upper Pelly River.

The total length of the Upper Pelly, following the course of the river, from the point where we first reached it at the west end of Campbell's Portage to its confluence with the Lewes, is 320 miles. The elevation at the first-mentioned point is about 2965 feet, that at the confluence 1555 feet, giving a total fall of 1410 feet or 4·4 feet to the mile, a considerable portion of which, however, occurs in the numerous little rapids and riffles of its course. In Hoole Cañon the estimated fall is about twenty feet. Two hundred and eighteen islands were counted in the river, without including such gravel bars as are submerged at high water, and are consequently without vegetation. The general course of the river is remarkably direct, and it embraces two main directions, the first bearing N. 55° W., the second, N. 87° W. These are parallel to the principal orographic features respectively of the upper and lower parts of the country traversed, and appear to indicate the main slopes of the general surface of the region. Length and fall of the river

With the exception of Granite Cañon, where warping might have to be resorted to at one place, the river would be easily navigable for stern-wheel steamers as far up as the mouth of the Macmillan, and the latter stream is also navigable for a considerable though unknown distance. Above the Macmillan, I believe, no serious difficulty would be met with in taking a small stern-wheel steamer of good power up to the mouth of Ross River, and possibly as far as the foot of Hoole Cañon. A line might have to be carried ashore at a few of the stronger rapids, but the chief difficulty to be encountered would be from shoal water at low stages. Where the river is widely spread and swift, a depth of three feet could scarcely be found across some of the gravelly bars. The Ross River is a navigable stream at its mouth, but its upper part is quite unknown. Hoole Cañon is, of course, quite impassable for a steamer of any kind, and the rapid met with seventeen miles east of it, at the mouth of Hoole River, might prove to be a difficult one to surmount by warping, its fall being estimated at about eight feet. Above this point, the river is again, however, an easily navigable one Navigability.

for small steamers to the furthest point seen by us, and possibly as far as the lakes.*

Tributaries from the south.

All the streams and small rivers flowing into the Pelly from the south and rising in or beyond the Pelly and Glenlyon mountains, are notably swift, and most of them are evidently subject to heavy freshets.

Timber.

Some notes have already been given respecting the character of the timber along the Upper Pelly. On the lower part of the river there are numerous groves on or not far from the banks, with good spruce up to two feet in diameter. Spruce of the same size is found also on the whole upper part of the river, but is relatively less abundant there.

Quartz.

As in the case of the Upper Liard and Frances rivers, quartz derived from veins is an abundant constituent of the gravel-bars of the Pelly, and numerous small quartz veins were observed in the rocks in many places. Where the granites are approached, the veins are found to cut all the rocks except these, and it appears that the development of the quartz veins is due to the same period of disturbance which has given rise to the uplift of the granite axes or their extrusion.

Gold.

Small "colours" of gold may be found in almost any suitable locality along the river, and "heavy colours," in considerable number, were found by us as far up as the mouth of Hoole River, in the bottom of a gravel-bed there resting on the basalt. The river has been prospected to some extent by a few miners, but no mining of importance has yet been done on it. Thomas Boswell, whom we met on the Lewes, informed me that he had found and worked for a short time, a bar which paid at the rate of $18 per diem. This was on a tributary which, from his description, is probably identified as the Ross River. Two miners only, Messrs. Monroe and Langtry, were at work on this river in 1887, and their operations were confined to the part below Granite Cañon, where they made on a couple of bars from $10 to $20 per diem to the hand. The headwaters of the Macmillan and Ross, and those of the Pelly itself yet remain unprospected, as well as the very numerous tributary streams of these rivers, in some of which "coarse" gold may yet be found.

Coal.

From observations subsequently made on the Lewes, coal may be looked for in the Laramie or Cretaceous rocks near the river at the locality described on page 126 B.

* Dall, in his Alaska and its Resources, 1870, p. 278, gives a hypothetical itinerary of the Pelly River, making it head in Frances Lake. The Pelly, as shown on the map which accompanies the work, is evidently in part after Arrowsmith, and where it differs, (as in regard to the connection of Frances and Finlayson lakes with the Pelly), becomes misleading. It is difficult to understand why this part of Arrowsmith's map, bearing intrinsic evidence of proximate accuracy, should not have been followed throughout in the compilation of later maps, particularly as the Pelly had not been further explored since Campbell's time.

CONFLUENCE OF THE LEWES AND UPPER PELLY.

Comparison of the rivers.

The country about the confluence, is generally speaking low, with extensive terrace-flats running back to the bases of rounded hills and ridges, of which none in sight probably exceed 1000 feet above the river. The moderate current which has been described as characteristic of the Upper Pelly for some distance above the confluence, continues to its mouth, but the Lewes is much swifter, and though at the point of junction divided among wooded islands, is evidently the larger stream, carrying a volume of water considerably greater than that of the Pelly, though probably less than twice as great (p. 18 B). It does not, however, necessarily follow from this that the Lewes is to be considered the principal head stream or continuation of the Yukon. The question of nomenclature and that of the position of the furthest sources of the Yukon, have, however, been referred to at greater length in another portion of this report. (p. 14 B).

Temperature.

The water of the Lewes is of a bluish, slightly milky cast and is easily distinguished from the brownish muddy colour by which the Pelly is characterized below its junction with the Macmillan. The temperature of the water in both rivers was found to be practically identical, on the 17th and 18th of August, at 7 p.m., being 59° F.

Volume of united rivers.

The river below the confluence of the Pelly and Lewes averages about a quarter of a mile in width, and though its appearance is placid and there is no rough water, it is uniformly swift. An approximate cross-section made by Mr. Ogilvie showed the river to be, at the point in question, 25·76 chains wide, from bank to bank. Of this width about two-thirds had an average depth of ten feet, with a surface velocity of four miles and three-quarter an hour. The remaining third was occupied by shallow bars and slack water. Using the same formula as before (see p. 98 B) the volume of the flow is found to be approximately 66,955 cubic feet per second. Traces of the passage of flood-water in the preceding spring were found on the river-flat, about ten feet above the low-water level, which, with a velocity no greater than that above stated and assuming the banks to be vertical, would give a flood discharge of at least 167,400 cubic feet per second. It may be, however, that the water-marks observed were caused by the damming back of the river by an ice-gorge.

Ruins of Fort Selkirk.

The ruins of Fort Selkirk, formerly a post of the Hudson Bay Company, stand on a partly open flat, on the south side, at a short distance back from the river, and about a mile and a-half below the confluence of the Pelly and Lewes. One chimney, built of basalt blocks which must have been brought across the river, and cemented with clay which has been baked almost into brick by the combustion of the ruins of the fort,

still stands erect and uninjured. The lower part of a second is near it, and the fragments of several others strew the ground, which is partly overgrown by small aspens. These, and the traces of a couple of excavations which have probably been cellars, are all that now remain to mark the site of the buildings which were pillaged by Indians from the coast in 1852.

Discovery and Exploration of the Liard and Pelly.

Hudson Bay Company explorers.

Fort Selkirk, of which the ruins alone now exist, was at one time the most important post of the Hudson Bay Company to the west of the Rocky Mountains in the far north, and with the exception of Fort Yukon, it was the farthest permanent post ever maintained by the Company to the north-west. On previous pages of this report, frequent mention has been made of the former establishments of the Company in the Liard and Yukon region, and as Fort Selkirk is the last of these with which our route brought us in contact, a note as to the operations of the Hudson Bay Company may appropriately be given here. When we call to mind that our knowledge of the geography of the region described in preceding pages has been up to the present time almost wholly due to the explorations carried out by the officers of the Company in connection with these establishments, it becomes evident that the history of these explorations and the facts respecting the several posts are well worthy of record.

McLeod.

The circumstances attending the discovery of the Dease and Upper Stikine have already been given on page 83 B. Mr. J. McLeod, whose explorations in that quarter are there referred to, appears in the same year in which he reached the Stikine (1834), to have ascended the Liard as far as Simpson Lake, and to have brought back the information according to which the river was represented on Arrowsmith's map of 1850.

Campbell.

It was to the energy of Mr. Robert Campbell, however, that the exploration of the Upper Liard and Yukon is almost entirely due. The only published account of Mr. Campbell's work, so far as I know, is that which appeared in the Royal Reader, Fifth Book, Toronto, 1883, p. 435, and which was reprinted, with slight alterations at Winnipeg in 1885, as a small pamphlet entitled "Discovery and Exploration of the Youcon (Pelly) River." From this source and from additional facts furnished by Mr. Campbell in answer to questions addressed to him, as well as from allusions in the unpublished journals of Chief Factor James Anderson, which have kindly been placed at my disposal by his son, the following brief account is drawn up.—

After the abandonment of Dease Lake post in 1839, Mr. Campbell was, in the spring of 1840, commissioned by Sir George Simpson to

explore the "north branch" of the Liard to its source, and to cross the height-of-land in search of any river flowing to the westward, especially the head waters of the Colville, the mouth of which on the Arctic Ocean had recently been discovered by Messrs. Dease and Simpson.

Expedition to the Pelly.

Mr. Campbell writes:—"In pursuance of these instructions, I left Fort Halkett [on the Lower Liard] in May, with a canoe and seven men, among them my trusty Indians, Lapie and Kitza, and the interpreter, Hoole. After ascending the stream some hundreds of miles, far into the mountains, we entered a beautiful lake, which I named Frances Lake, in honor of Lady Simpson. * * * Leaving the canoe and part of the crew near the south-west [*sic*] extremity of this [the west] branch of the lake, I set out with three Indians and the interpreter. Shouldering our blankets and guns, we ascended the valley of a river, which we traced to its source in a lake ten miles long, which, with the river, I named Finlayson's Lake and River." From this point, Mr. Campbell struck across to the Pelly, which he then named in honor of Sir H. Pelly, a Governor of the Company.

"After reaching the actual bank of the river, we constructed a raft, on which we embarked and drifted down a few miles on the bosom of the stream, and at parting we cast in a sealed tin can, with memoranda of our discovery, the date, etc."

Establishment of Fort Frances

During Campbell's absence the remainder of the party built a house at the point between the two arms of the lake, which was then named "Glenlyon House," but was afterwards known as Frances Lake House or Fort Frances. Returning down the river, they met a trading outfit which had been despatched for them, at Fort Halkett, and turned back with it to Frances Lake, after sending out a report of their proceedings.

Exploration of the Pelly.

The Company now resolved to follow up those western discoveries, and in 1842 birch bark, for the construction of a large canoe to be used in exploring the Pelly, was sent up from Fort Liard. In the same year Fort Pelly Banks was constructed, or its construction begun, and early in June, 1843, Campbell left that place in the canoe which had been made, accompanied by Hoole, two French-Canadians and three Indians.

They saw only one family of Indians ("Knife Indians") till they reached the mouth of the river which Campbell called the Lewes. Here was a large camp of "Wood Indians," and these, after recovering from their surprise at the sight of the party, so discouraged Campbell's men by their stories of the number and ferocity of the people on the lower river, that he was obliged to turn back.

"Pelly Banks."

For some years afterwards the operations of the Company did not extend beyond "Pelly Banks," though during the summer, hunting

parties were sent down the Pelly to collect provisions, and in that way information was received respecting the river and the Indians inhabiting its vicinity.

Establishment of Fort Selkirk.

In the winter of 1847-48 boats were built at Pelly Banks, and early in June following Campbell set out to establish a fort at the confluence of the Pelly and Lewes rivers. This was named Fort Selkirk, and was at first situated on the extreme point of land between the two rivers, but this point being found subject to floods during the disruption of the ice, the post was in the spring of 1852 moved to a site a short way below the mouth of the Lewes, on the left bank. The inner work of the new buildings was still unfinished at the time of the Indian raid, noticed further on.

Exploration of Porcupine River.

Meanwhile an entry was being made into the Yukon basin from another direction. Mr. J. Bell had already in 1842 reached the Porcupine or Rat River, and had descended it for three days' journey. He was in 1846 in charge of the Hudson Bay post on Peel River, near the mouth of the Mackenzie, and was instructed again to cross the mountains and to further explore the Porcupine River. In pursuance of these instructions, he in that year reached the mouth of the Porcupine and saw the great river into which it flows, which the Indians informed him was named the Yukon. In 1847 Fort Yukon was established at the mouth of the Porcupine by Mr. A. H. Murray.

Identity of Pelly and Yukon shown.

It still remained, however, for Campbell, in 1850, to prove that the Pelly and Yukon were identical. This he did by descending the river from Fort Selkirk, to Fort Yukon, after which he ascended the Porcupine, crossed the mountain-portage, and returned to Fort Simpson by the Mackenzie.* One result of this journey was to show that the route from Fort Selkirk by way of the Porcupine River to the Mackenzie was preferable to that originally discovered. The navigation of the Liard was both arduous and dangerous and several lives had been lost in boating on that stream. Added to this was the length of the land transport from Frances Lake to the Upper Pelly and the fact that great difficulty had been found in maintaining the posts in that district.

---

* Mr. Campbell states that when again on his way down the river from Fort Selkirk to Fort Yukon, in 1851, he found that a great number of the Indians had been carried off during the previous winter by some virulent disease.

He has further informed me, in answer to my enquiries on the subject, that the Stewart River was so named after his "dear and gallant friend and assistant-clerk, James G. Stewart, son of the late Hon. John Stewart, of Quebec." Stewart was sent out in the winter of 1849 to follow the Indian hunters in quest of meat. He found them some distance north of this river, which he crossed on the ice.

White River, Mr. Campbell named on account of its milky color. Of the other streams entering between Forts Selkirk and Yukon he says, "Antoine River" was named after the interpreter at one time at Fort Yukon, a son of his interpreter Hoole; "Forcier River," after his guide, Baptiste Forcier; "Lolique River," for Forcier's wife; and "Ayonie's River," below the White River, was named after the natives of that quarter.

In 1849, the post at Pelly Banks, with the exception of the men's house, was accidently burnt. In 1850 it was finally abandoned, and in the spring of 1851 Fort Frances was likewise abandoned.* The abandonment of these posts was not due to any hostility of the natives, who were on the contrary most friendly, but in consequence of the circumstances above noted, and the fact that while these establishments were very expensive to maintain, they merely bought furs which would otherwise have been carried by the Indians themselves to other posts, if these particular, and to them more convenient ones, had not been in existence. Abandonment of posts.

The several ruined chimneys of Fort Selkirk still to be seen, with other traces on the ground, are in themselves evidence of the important dimensions and careful construction of this post. The establishment consisted, I believe, in 1852, of one senior and one junior clerk and eight men. The existence of this post in the centre of the inland or "Wood Indian" country had, however, very seriously interfered with a lucrative and usurious trade which the Chilkoot and Chilkat Indians of Lynn Canal, on the coast, had long been accustomed to carry on with these people; acting as intermediaries between them and the white traders on the Pacific and holding the passes at the head-waters of the Lewes with all the spirit of robber barons of old. In 1852, rumours were current that these people meditated a raid upon the post, in consequence of which the friendly local Indians staid by it nearly all summer, of their own accord. It so happened, however, that they absented themselves for a couple of days and at that unlucky moment the Coast Indians arrived. The post was unguarded by a stockade and yielding to sheer force of numbers the occupants were expelled and the place was pillaged, on the 21st August. Two days afterward Campbell, having found the local Indians, returned with them and surrounded the post, but the robbers had flown. Being now without means of support for the winter, Campbell set off down stream to meet Mr. Stewart and the men who were on the way back from Fort Yukon. He met them at the mouth of White River and after turning them back with instructions to arrange for wintering at Fort Yukon, set out himself in a small canoe up the Pelly River, crossed to Frances Lake, descended the Liard and arrived at Fort Simpson with the tidings of the disaster, amid drifting ice, on the 21st of October. Irruption of the Chilkoots. Campbell's journey of 1852.

Being anxious to obtain Sir George Simpson's permission to re-establish Fort Selkirk, Campbell waited only till the river froze, when he left Fort Simpson on snow-shoes and travelled overland to Crow Wing in Minnesota, where he arrived on the 13th of March. On the

* Forts Frances and Pelly Banks are erroneously stated in Dall's Alaska and its Resources, to have been burnt and pillaged, p. 115, foot-note and p. 508.

18th of April he reached London but was unable to obtain from the directors of the company the permission he desired. A short account of this remarkable journey appeared in the Perthshire Advertiser and Inverness Courier, but I do not know the precise date of the publication.

News from Fort Selkirk.

In the autumn of 1853, one of Campbell's hunters arrived at Fort Halkett on the Lower Liard by way of the Pelly and Frances. This is the last traverse of Campbell's Portage of which I can find any record, though it may doubtless have been used by the Indians subsequently. From this man it was learnt that the buildings at Fort Selkirk had been all but demolished by the local Indians for the purpose of getting the iron-work and the nails. He also stated that the Chilkats, being unable to carry away all their plunder in the preceding year, had taken merely the guns, powder and tobacco. They had câched the heavier goods, which were afterwards found and appropriated by the local or wood Indians. At a later date the ruins of the post must have been burnt, as their present appearance indicates.*

The United States and Fort Yukon.

Fort Yukon, at the mouth of the Porcupine, was continuously maintained till 1869, when the Hudson Bay Company was expelled by the United States Government as represented by Capt. Charles W. Raymond, Corps of Engineers, U. S. Army; he having ascertained by astronomical observations that the post was situated to the west of the 141st meridian. He describes his proceedings as follows.—"On the 9th of August, at 12 m., I notified the representative of the Hudson Bay Company that the station is in the territory of the United States; that the introduction of trading goods, or any trade by foreigners with the natives, is illegal, and must cease; and that the Hudson Bay Company must vacate the buildings as soon as practicable. I then took possession of the buildings and raised the flag of the United States over the fort." † The fort was afterwards abandoned and allowed to go to ruin.

Pioneers of the Hudson Bay Company.

The utmost credit must be accorded to the pioneers of the Hudson Bay Company for the enterprise displayed by them in carrying their trade into the Yukon basin in the face of difficulties so great and at such an immense distance from their base of supplies. To explorations of this kind performed in the service of commerce, unostentatiously and as matters of simple duty by such men as Mackenzie, Fraser, Thompson and Campbell, we owe the discovery of our great north-west country. Their journeys were not marked by incidents of conflict or bloodshed, but were accomplished on the contrary with the

* Of Reid House, shown on Arrowsmith's map of 1854, near the Stewart River and to the north of Fort Selkirk, I have been unable to learn anything. Mr. Campbell never heard of it, and if it had any existence it was probably a temporary outpost of Fort Yukon.

† Report of a Reconnaissance of the Yukon River, 1871, p. 16.

friendly assistance and co-operation of the natives. Less resolute men would scarcely have entertained the idea of utilizing, as an avenue of trade, a river so perilous of navigation as the Liard had proved to be when explored. So long, however, as this appeared to be the most practicable route to the country beyond the mountains, its abandonment was not even contemplated. Neither distance nor danger appear to have been taken into account, and in spite of every obstacle a way was opened and a series of posts established extending from Fort Simpson, on the Mackenzie to Fort Yukon. Fort Simpson may itself be regarded, even at the present day, as a post very far removed from the borders of civilization, but this further route, which nearly half a century ago became familiar to the Company's voyageurs, stretched out beyond it for over a thousand miles. Mr. James Anderson, in 1853, writes thus of the Liard River: "You can hardly conceive the intense horror the men have to go up to Frances Lake. They invariably on re-hiring endeavour to be exempted from the West Branch [Liard]. The number of deaths which have occurred there is fourteen, viz. three in connection with Dease Lake and eleven in connection with Frances Lake and Pelly Banks, of these last three died from starvation and eight from drowning." Dangers of the Liard.

At the time of the establishment of Forts Yukon and Selkirk, and for many years afterwards, the "returns" from these furthest stations reached the market only after seven years, the course of trade being as follows: *Goods.*—1st year, reach York Factory; 2nd year, Norway House; 3rd year, Peel River, and were hauled during the winter across the mountains to La Pierre's House, 4th year, reach Fort Yukon. *Returns.*—5th year, reach La Pierre's House and are hauled across to Peel River; 6th year, reach depot at Fort Simpson; 7th year reach market. The "returns."

Lewes River.

Our proceedings at the mouth of Lewes River and our meeting there with Mr. Ogilvie have already been noted. We finally left the confluence and began the ascent of the Lewes on the 18th of August, and arrived at Lake Lindeman, where the portage to the coast begins, on September 16th. We were during this time on the one travelled route of the country, and every few days fell in with small parties of miners, generally on their way out, up the river. A few men were still found working on bars, and six or eight passed down stream with the purpose of wintering at or near Forty-mile Creek. Meeting with Mr. Ogilvie.

Though my own observations did not extend below the mouth of the Lewes, Mr. W. Ogilvie sent out by the last party of miners met by

him on their way to the coast, a small collection of rocks from places further down the river, as far as Forty-mile Creek. The general character of these has already been noted in the introductory part of this report (p. 34 B). They are not further described here, as they will be referred to by Mr. McConnell in connection with his geological examination of the portion of the river from which they were derived.

Discovery of the Lewes.

The Lewes River * was discovered and named by Mr. Campbell in 1842, as already stated. It is indicated in an approximate manner, according to information supplied by this gentleman, on Arrowsmith's map of 1854. Mr. Campbell informs me that he was well aware of the existence at its head of a portage to the sea by which the Chilkat Indians came inland to trade. This route he had the intention of exploring, but the question of supplies and other difficulties prevented him from doing so. Communication was occasionally had by this route with the Hudson Bay steamer which traded along the coast, and it was thus that the Honolulu paper mentioned as received in 1848 by Sir. J. Richardson, on the Mackenzie, was sent inland. Such communication was, however, only accomplished by travelling parties of Indians.

First exploration.

In 1867, Frank E. Ketchum, of St. John, New Brunswick, and Michael Labarge, of Montreal, explorers in the employ of the Western Union Telegraph Company, ascended the Pelly or Yukon from Fort Yukon to the mouth of the Lewes, returning down the river. In the same year, Michael Byrnes, also an explorer of the Telegraph Company, reached the Hotolinqu (of Telegraph Survey map, not the river subsequently so called by miners) which is now known to be one of the furthest if not the most remote source of the Lewes. This he did from the direction of the Stikine, but was recalled before he had, by descending the river, proved its relation to the Lewes. †

Incursion of miners.

As elsewhere stated, in connection with the history of gold mining in the Yukon basin, (p. 178 B) the head-waters of the Lewes River were first reached from the head of Lynn Canal about 1878. Between the date of the explorations of the Telegraph Company and this time, the Lewes may have been visited by traders ascending from the Lower Yukon, but of this we have no record. Previous to 1883, however, the river and some of its tributaries had become well known to a number

* So named by Campbell after Chief Factor, John Lee Lewes.

The name of the Lewes given to me by the Tagish Indians was Ta-hī-ne-wat (=Big Salmon River) but I am doubtful whether this applies to the whole stream or to some special part of it.

† See Dall's Alaska, p. 277. A statement in a subsequent paragraph on the same page would appear to indicate that Messrs. Ketchum and Labarge reached Lake Labarge of later maps, but I can find nothing to bear this out. Whymper, in his travels in Alaska and on the Yukon (p. 229) also limits their journey at Fort Selkirk. Dall in consequence of the imperfection of the map of the Telegraph Survey with which he was supplied, in his work and on the map accompanying it, continues the head-waters of the Taku River into the Hotolinqu River, making them tributary to the Lewes, but in an addendum, at the end of the book, notes and corrects this error.

of miners and prospectors, and when Lieut. Schwatka, in the last mentioned year, crossed the Chilkoot Pass and descended the Lewes, he merely followed in their footsteps. To Lieut. Schwatka is, however, due the credit of having made the first survey of the river, a survey which Mr. Ogilvie's work of 1887, has proved to be a reasonably accurate one, in so far as its main features are concerned. This being the case it would be an ungracious task to criticise in detail, either Lieut. Schwatka's map or the various accounts which he has given of his journey. As, however, he is not sparing in his condemnation of the inaccuracy of the compilers of the maps made before the results of his journey were available, I need have no hesitation in stating my belief, that his desire to affirm that he had started at the source of the Yukon and followed it to its mouth, caused him to fail to observe that Lake Lindeman is not even on the main source of the Lewes, and to change the name of the Lewes which had already appeared on the maps for about thirty years to that of Yukon, a quite arbitrary and unjustifiable proceeding. (See p. 16 B.) In addition to this he has completely ignored the names of many places already well known to miners, throughout the country, substituting others of his own invention, some of which even differ in the different versions of the map of his route which he has published. Strict justice might demand the exclusion of all these new names on the definitive maps now published, but to avoid an appearance of arbitrary action in the matter, and more especially in view of the scientific eminence of some of the names which he has selected, it has been decided to retain as many as possible of these.

Surveys by Schwatka.

While the general course of the Upper Pelly is remarkably straight, that of the Lewes makes several important and well marked bends and is besides interrupted by lakes and otherwise irregular. These irregularities are to be accounted for by the fact that the Lewes, instead of following a direction parallel with the main orographic features of the country, runs for a considerable part of its course diagonally across the principal ridges and valleys.

Pelly and Lewes contrasted.

In describing the Lewes and the main geological features met with along it, the site of Fort Selkirk is taken as an initial point and the distances are given as measured on the map, up the mid-channel of the river. The distances thus arrived at will not be found to correspond exactly with those given by Mr. Ogilvie in his preliminary account of his survey of the river,* Mr. Ogilvie's distances being those instrumentally measured from station to station of his survey.

Distances.

* Contained in the Annual Report of the Department of the Interior for 1887. See also Report of Proceedings of Association of Dominion Land Surveyors, 1888, p. 61.

Fort Selkirk to Rink Rapid.

Character of the river.

From the site of Fort Selkirk to Rink or Five-finger Rapid, the course of the river is nearly straight, the bearing being about S. 50° W. and the distance, measured by the stream, fifty-five miles. The current of this part of the river is swift throughout, averaging about four miles and a-half an hour and seldom being under four miles. At a point six miles below Rink Rapid, where the course of the river was uninterrupted by islands and its velocity and width about normal, the rate of flow was found to be 4·8 miles per hour, the width 732 feet. There are numerous islands, which differ from most of those met with on the Pelly in frequently occupying positions in mid-channel instead of being merely portions of river-flats cut off by lateral sloughs. A few miles above the mouth of the Lewes, these islands are particularly numerous, for a distance of about five miles, and the total width of the stream from bank to bank, is increased to nearly a mile. This group has been named Ingersoll Islands by Schwatka.

Terraces.

The terraces and flats immediately bordering the river, are at first quite low, but in ascending, increase in height till they stand often at 100 to 200 feet above it before reaching Rink Rapid. They are for the most part composed of rolled river- or valley-gravels like those of the Pelly at a similar distance above the confluence. Boulder-clay first occurs in the scarped banks about six miles below Rink Rapid.

Character of the valley.

The river-valley is generally wide and somewhat ill defined, the ridges and low hills bounding it seldom exceeding 1000 feet in height. Near the mouth of the river these are irregularly disposed, but further up, those on the north-east bank become more uniform and run parallel to the stream like the hills on that part of the Pelly near the Macmillan. In a few places the slopes of the hills run down to the water's edge, and it is generally only at such points that rock exposures occur. Hooche-koo Bluff is situated thirty-five miles above the old fort, on the north-east bank, and is formed by the abrupt face of an isolated hill, against which the river washes. With the exception of Tatshun River, a mile and a-half below Rink Rapid, the tributaries of this part of the Lewes are merely small brooks. This stream is about 30 feet wide by 6 inches deep, with clear brownish water.

Rink Rapid.

Two miles below Rink Rapid, the Lewes makes a right-angled bend to the south-westward. The rapid itself is caused by the occurrence of several bold rocky islands which obstruct the river, and is only a few yards in length, where the water flows swiftly between them. The channels are deep and unobstructed, and at low stages of water might, I believe, be ascended by a steamer of good power even without the assistance of warping. At high-water this rapid would, of course, be

more formidable, as the velocity of the stream would be increased. It is pretty evident that a fall has at one time existed here, but the barrier of conglomerate which has produced it has now been cut completely through by the river. Below the main rapid there is a second "riffle" or minor rapid which appears to be somewhat stony, but which would not be a serious impediment to a properly constructed steamer.

Fine country.

The general appearance of the country along this part of the river is pleasing and resembles that of the corresponding part of the Pelly. It is usually wooded, but the southern exposures of some of the hills are partly open, and dry, grass-covered terrace-flats are frequent. The trees are of the same species before mentioned and birch is moderately abundant. *Elæagnus argentea* was noted on dry banks.

Geology.

On this part of the Lewes, rock-exposures are unfrequent and it is consequently impossible to give any connected account of the geology. About five miles above the old fort, on the west bank, are outcrops of basalt, which appear to indicate an outlying patch of this rock. Just below these on the river, is a dark greenish rock which seems to be a bedded diorite and to have a high south-west dip. On the other side of the basalt, a massive, coarsely crystalline, black, hornblende-rock occurs, which is followed by hornblendic granite. The granite, in some places, contains large porphyritic crystals of pink felspar, in addition to the more abundant white triclinic felspars. It continues for some miles, near the Ingersoll Islands, and probably connects with the exposures on the Pelly to the north-east. The few exposures examined between the granite and Hoo-che-koo Bluff, consist of greenish and greenish-grey rocks, being altered volcanic materials, probably with the lithological composition of diabase. In one place a distinct volcanic agglomerate was seen.

Hoo-chee-koo Bluff.

Hoo-chee-koo Bluff consists of a grey, slightly porphyritic, felspathic rock which is apparently interbedded with a fine-grained, nearly black argillite, but the rocks are everywhere very much fractured and jointed. The south end of the bluff shows a pretty evident, altered agglomerate of a similar felspathic material. The jointage planes often contain seams of calcite and show copper-staining. Specimens of the copper-stained portions of the rock proved, on assay by Mr. Hoffmann, to contain minute traces of gold, with ·088 oz. of silver to the ton.

The rocks along the Lewes so far described, with the exception of the granites, may be referred to the Palæozoic.

Rocks above Hoo-chee-koo.

For about twelve miles above the Hoo-chee-koo Bluff no rocks were seen, after which, for eight miles, or to Rink Rapid, there are frequent exposures of rocks of a different series, of much less altered appearance and all probably referable to the Cretaceous. These include coarse, hard, dark grauwacke-sandstones, with softer shaly sandstones, passing

Cretaceous rocks.

into dark sandy shales, all more or less calcareous. Just below Rink Rapid, on the south-east bank, are brownish evidently tufaceous rocks, the materials of which also, however, include well-rounded quartz pebbles. These pass by easy stages into grauwacke-sandstones and are interbedded with coarse conglomerates containing pebbles of granite and of greenish altered volcanic rocks, like those of the older series seen lower down the river. Carbonaceous streaks and pieces of dark-coloured fossil wood are included in some of the beds; and a couple of layers two to three feet thick, were observed, which are so carbonaceous that they might almost be called coal. The dip is here N. 20°, W. $<$ 40°, but elsewhere in this vicinity is varied and confused.

Conglomerates and sandstones.

The rock of the islands and banks of the actual rapid is coarse conglomerate which often contains boulders of granite up to eighteen inches in diameter and is interstratified with irregular beds of yellowish sandstone, the appearance of the conglomerate being much like that of the conglomerate of Jackass Mountain on the Fraser River, though somewhat less altered. Immediately above the rapid, on the south-east side of the river, grey and blackish shales, with thin beds of sandstone and of limestone, appear from below the conglomerates. These were found to contain fossils in considerable abundance, though representing but a few species.

Cretaceous fossils.

The fossils have been examined by Mr. Whiteaves, who states that of four determinable species, all but one appear to be new, but that the occurrence of a *Schlœnbachia* apparently identical with a species from the lower part of the section in the Queen Charlotte Islands, would seem to show that the rocks may be of corresponding age, or about the lower part of the Middle Cretaceous.

The species are as follows :—*

Discina pileolus, N. sp.
Cyprina Yukonensis, N. sp.
Schlœnbachia (*propinqua?* var.) *borealis.*
Estheria bellula, N. sp.

Fossil plants.

Sir J. Wm. Dawson has examined the fossil woods found at the same place, and writes of them as follows :—"Two species of fossil coniferous wood. One of these shows large wood-cells with one to two rows of discs and long narrow medullary rays. It is not improbably the wood of a species of *Sequoia*. The other has thick-walled wood-cells with one row of discs and spiral lines, the medullery rays being short and few celled. It has the characters of a taxine wood, and is not unlike that of *Salisburia*. Another specimen from this place is a small and badly preserved branchlet, with short and apparently thick curved

* To be described and figured in Part II. Contributions to Canadian Palæontology.

subulate leaves. It is probably coniferous, and it is not unlike *Sequoia ambigua* and *S. concinna*, of Heer, from the Cretaceous of Greenland. It is, however, quite obscure, and might be a species of the Mesozoic genus *Pachyhyllum*."

Gravels of the Lewes.

The constituents of the gravel found along the Lewes River differ considerably in appearance from those of the Pelly gravels. Granite of various kinds is abundant, and there is a notable profusion and variety of green and greyish-green altered rocks of volcanic origin in association with which are found occasional pebbles of more or less pure jade, which appear to pass by insensible gradations into green rocks of the kind above mentioned. Quartz vein-stuff is much less important as a constituent of the river-gravels than it is on the Upper Pelly, Upper Liard and other streams to the eastward.

Rink Rapid to Little Salmon River.

From Rink Rapid to the mouth of the Nordenskiöld, the general bearing of the river is nearly due south, the distance in a straight line being twelve miles. From this point the general bearing is about south-east for eighteen miles and a-half, when it turns abruptly to a north-east direction round Eagle's Nest Rock, and in five miles reaches the mouth of the Little Salmon River. The total distance from Rink Rapid to the last-named place, measured by the stream, is fifty-three miles, though the through distance, on a straight line (which would have a south-east bearing) drawn between the two terminal points is twenty-seven and a-half miles only.

Nordenskiöld River.

The Nordenskiöld is a small swift river with clear bluish water, which enters the Lewes on the west side. It was estimated as eighty feet wide by six inches deep, a couple of hundred yards above its mouth, on the 23rd of August, when it was evidently near its lowest stage. Its valley is not a wide or important one, it being in fact difficult to decide from which direction the stream comes a few miles back from the Lewes. The Little Salmon (or Daly, as re-christened by Schwatka) joins the Lewes on the opposite side, and was estimated to carry about twice as much water as the Nordenskiöld. It is about one hundred feet wide with an average depth of three feet. The water is clear and brownish in tint, and the current not rapid at the mouth.

Lewes valley.

The valley of the Lewes, between Rink Rapid and the Little Salmon River, is in general somewhat irregular and not very wide, but a few miles before reaching the Little Salmon, the river turns into a wide valley which runs north-east and south-west and appears to be continuous with that of the Little Salmon in the first mentioned direction. The hills, in the vicinity of the river, seldom exceed 800 feet in height, till near the Little Salmon, when they attain 1000 or possibly 1500 feet.

No mountains are in sight from this part of the river. Terraces rising to 200 feet are frequent and often run back at about that level to the bases of the hills. Near the mouth of the Nordenskiöld, the river is extremely crooked, and the current is everywhere swift. The southern slopes of the hills and terraces are generally in large part open and grassy, no difference such as might indicate a climate more humid than that of the region about old Fort Selkirk being met with. Several magpies were seen, for the first time, on this part of the river.

Gold bars. The first spot observed by us in ascending the river where bars have been worked for gold, is situated six miles above the Nordenskiöld.

Thick Cretaceous series. The rocks along this portion of the river, like those last described, belong to the Cretaceous series, but their attitudes are too varied to enable anything like a complete section to be gained from the isolated exposures met with, though the impression was received that the total thickness represented must be very great. The rocks consist generally of sandstones, grauwackes, coarse grits and conglomerate which not unfrequently have a general reddish appearance on weathering, probably in consequence of local dolomitization. A few localities, however, show features worthy of special mention.

Beds of coal. One of these is found five miles and a-half above Rink Rapid, where a high bluff shows a series principally composed of sandstones, shales and shaly clays, poorly exposed in consequence of the sliding character of the bank, which is being washed away by the river at its base. These have a south-eastward dip, at low angles, and the thickness of beds represented must be several hundred feet. This exposure includes, within sixty feet of the base of the bluff, at least three coaly beds, of which the lowest is about three feet thick. This and the other beds contain some good looking coal, of which a thickness of about a foot sometimes occurs, but the greater part of the material is so sandy and impure as to be useless. The highest of these beds is underlain by a layer of dull purplish-grey, finely granular and porphyritic trachyte from six to eight feet in thickness, and evidently representing a contemporaneous flow of volcanic matter. Its upper surface is somewhat broken up and mixed with carbonaceous matter, and passes into black, carbonaceous sandstone, about a foot thick, above which is the upper impure coal before referred to, overlain by shales and sandstones of the ordinary character.

Wide synclinal The condition of all the beds in this vicinity is remarkably unaltered, as compared with those seen lower down the river, and would appear to show that if (as assumed) they form a connected series, these represent its upper part. The dip of these beds, taken in connection with that of those near Tantalus Butte and the horizontal appearance of the strata in the hills to the south-westward, indicates the existence

of a synclinal five or six miles in width, running in a south-west by north-east direction. The relatively high position of these beds is further shown by the occurrence, about two miles further up the river, of fossil plants referable to the Laramie. These were found in a hard, white, shaly rock, which has apparently been permeated by waters charged with silica about the time of its formation. Sir J. Wm. Dawson states that the following species are represented :—

Fossil plants.

Taxodium Tinajorum, Heer.
Glyptostrobus Europæus, Heer.
Sequoia Langsdorffi, Heer (doubtful).

The thin coal-seams here actually seen cannot be considered as of economic value, but are important as indicating the existence of a coal-bearing horizon which may prove to contain thicker beds elsewhere and might become an important point in connection with the navigation of the river. The coal has been examined by Mr. G. C. Hoffmann who describes it as a lignite-coal, with the following composition.—

Composition of coal.

Hygroscopic water	6·03
Volatile combustible matter	36·92
Fixed Carbon	49·03
Ash	8·02
	100·00

About a mile below Eagle's Nest Rock, are exposures of coarse conglomerate, with inter-bedded sandstones precisely like those of Rink Rapid. The included stones are well rounded, and often a foot in diameter, and consist of granites and various green and grey hard, altered, volcanic rocks. This is probably the same conglomerate bed with that of the rapid. The dip here is N. 13° W. $< 40°$.

Conglomerate.

Frequent exposures of true boulder-clay occur along this part of the river, particularly above the Nordenskiöld, where they often form castellated bluffs, in consequence of their considerable induration. The boulder-clay generally shows traces of bedding more or less distinct, and is sometimes very stony and includes large boulders, a few of which were observed to be striated. The pebbles are, as a rule, well rounded and even superficially polished. Clayey gravels with silty layers are in places associated with the boulder-clay in the manner already described on the Pelly. In some places the boulder-clay also appears to be overlain by silty deposits, but on the Lewes thus far up, these are not extensive or well marked.

Drift deposits.

Little Salmon to Big Salmon River.

The river and its valley.

From the Little Salmon to the mouth of the Big Salmon River or D'Abbadie, the general bearing of the Lewes is about east-south-east, and the sinuosities of the river are not nearly so great as in the portion last described. The distance by the stream between these tributaries is thirty-four miles. A considerable portion of this part of the river is not so swift as usual, and for eight or ten miles, midway between the Little and Big Salmon rivers, both the river and its valley are more than usually narrowed. Beyond this, the valley begins to widen rapidly and for some miles before the mouth of the Big Salmon is reached, is notably wide, between the bases of the limiting hills. At the mouth of the Big Salmon, the Lewes turns abruptly to the south, while the main valley is continued in a south-easterly direction, becoming there the valley of the Big Salmon. From the confluence of the rivers, the main valley can be seen running on for a distance of about fifteen miles, bordered by low hills to the northward, and by higher hills to the south. These last are the Seminow Mountains of Schwatka. The Lewes cuts through this range, which is continued also for some miles westward, forming the south-west side of the Lewes valley. The hills are rounded in form and wooded, and rise to heights of 1500 to 2000 feet above the river.

Geological features.

Few rock-exposures occur along this part of the Lewes, and in consequence, nothing very definite can be said as to its geological structure. Thirteen miles above the Little Salmon, greenish, grauwacke-sandstones, and green, highly calcareous conglomerates were found, the latter containing pebbles of limestone or marble, granite, various schistose rocks and green altered volcanic rocks. The greater part of the hills in this vicinity seemed to be composed of similar materials, which are evidently newer than the altered volcanic series, and therefore in all probability Mesozoic, and very possibly even Cretaceous. For some distance below the Big Salmon, numerous fragments of lignite-coal and of soft, shaly materials, like those previously described as occurring with the coal, are found on the bars, but cease to appear above the confluence of the Big Salmon, leading to the belief that Cretaceous or Laramie rocks attain a considerable development in the valley of that stream. It would require, however, a detailed survey to separate the various formations in this region, and the result of such an examination would probably be to place in the Mesozoic series a much larger area than would, at first sight, appear probable. At the mouth of the Big Salmon a grey-green, crystalline rock which is apparently a diorite, occurs. It appears to be bedded, and dips southward at an angle of 25°.

Nine miles below the Big Salmon is the first extensive display met with on the Lewes of the bedded silty deposits. Scarped banks and cliffs one hundred feet in height are here composed of these white silts with some interstratified sands and gravels. The silts contain numerous nodular layers and sheets of calcareous concretionary matter, and are hard and fine-grained toward the base, where they may be seen, in some places, resting on boulder-clay. Bedded silts.

Several bars which had been worked on for gold were seen along this part of the Lewes. Gold.

Big Salmon River.

The Big Salmon* has been re-named by Schwatka, the D'Abbadie River, a name which has the merit of being more distinctive than that previously in use, but the miners who (with the exception of the Indians) alone travel through the country, refuse to know it by any but the old name. It is much more important than any of the tributaries joining the Lewes further down, being 347 feet wide, with a depth of five feet for about one-third of its width, and a current of about two miles an hour. The water is clear and of a bluer tint than that of the Little Salmon, and the discharge was estimated at 2726 cubic feet per second, when probably rather below its mean stage. It might, no doubt, be navigated by a small stern-wheel steamer for many miles. Appearance of the river.

I was afterward so fortunate as to meet a party of four miners who had spent a part of the summer of 1887 in prospecting this stream, and from one of them, Mr. John McCormack, obtained some particulars respecting it, together with a sketch of its course. Thirty-two miles from the Lewes, the Big Salmon is said to be joined by a smaller stream, which McCormack calls the North Fork. For about a mile and a-half below, and a short distance above the mouth of this branch, the river is very rocky and rapid. Half a mile above it there is an Indian salmon-fishing place. For some distance beyond this the river is sluggish, and at sixty-six miles from the Lewes, the South Fork branches off. This fork occupies a wide valley and comes from the south-eastward. Above it the water is swifter and the valley of the river is narrow, with high mountains on both sides, but particularly on the north. Granite and mica-schist were seen along this part of the river. At a supposed distance of one hundred and five miles from the Lewes, another stream joins from the south-east, and this also occupies an important valley, though not so wide as that of the South Fork. Above this point the river turns to a northerly bearing for about fifteen miles, the current being, in general, slack. It then reverts to an easterly bearing, and Notes on upper part of river.

* Ta-tlin-hī-nī of the Tagish.

Lakes at head of river.

after passing a rapid, at one place, Island Lake is reached at 190 miles from the Lewes. This lake is four miles long, and has two arms at its upper end, from the southern of which a river leads, in eight miles, to a second lake two miles and a-half long. A stretch of river, a mile and a-half long, joins this to the highest lake, which McCormack named Quiet Lake, and of which he estimates the length at twenty-four miles. At the outlet of the lake is an Indian fishing place. The country to the south of these lakes is mountainous, granite being a common rock, and several streams run from these mountains into Quiet Lake. The north-east side of the lake is bordered by lower ridges, and from its head, McCormack travelled about eight miles, through a low country, to the bank of the Tes-lin-too, which he found here flowing from north to south.*

Gold.

These miners found "fine" gold all along the river, but no good paying bars. They were in search of "coarse" gold, but did not discover any. A small specimen of pyrites and quartz, from veins met with on one of the streams flowing into Quiet Lake, given to me by Mr. McCormack, was found by Mr. Hoffmann to contain very distinct traces of gold with a trace of silver.

Salmon.

According to the Indians, the salmon run up this river to its source, and the same is reported of the Little Salmon and the Tes-lin-too.

Big Salmon River to Tes-lin-too.

The river and river-valley.

As already noted, the bearing of the Lewes becomes nearly due south, at the mouth of the Big Salmon. Though crooked in detail, it preserves this general bearing to the mouth of the Tes-lin-too, a distance by the river of thirty-one miles. Both the valley and the river itself are unusually narrow where the Seminow Hills are cut through, the width of the range being about five miles, and the river continues narrow and deep, with a swift current, beyond this point, though, the valley widens and permits the stream to resume its flexuous character. The actual width of the river, at a point nine miles below the mouth of the Tes-lin-too, was ascertained to be 483 feet, the current being at the rate of 4·84 miles per hour. These figures may be taken as representing the general character of this part of the stream. A short distance south of this point, the river again begins to widen and to resume its usual aspect. The hills bounding the valley on the south of the Seminow range seldom exceed a height of 800 feet till the vicinity of the confluence of the Tes-lin-too and Lewes is reached, when they gradually increase to 1000 or 1500 feet.

* The above estimates of distance are probably all in excess, and include the minor sinuosities of the stream. The actual distances from point to point are shown on the map as well as it has been possible to estimate them.

A number of auriferous gravel-bars have been worked along this part of the Lewes, including Cassiar Bar, which has so far proved the richest on the river. Limited areas of the river-flats have also been worked over, where the alluvial cover is not too deep. Cassiar bar.

The valley near the mouth of the Tes-lin-too is again narrower than usual, singularly so for the point of confluence of two important rivers. The valley of the Tes-lin-too is evidently the main orographic depression which continues that occupied by the Lewes below the confluence. The Lewes flows in through a narrow gap, closely bordered by high hills and nearly at right angles to the lower course of the river. On the map accompanying Lieut. Schwatka's report, the width of the Tes-lin-too is shown as about half that of the Lewes, the actual fact being precisely the reverse and all the main features of the lower river being contained by the Tes-lin-too; while the other branch, both in its irregular mode of entry, the nature of its banks, the colour of its water and its very rapid current, presents, at first sight, all the appearance of a tributary stream of new character. To such an extent is this difference observable, that Mr. Ogilvie and the members of his party, as well as most of the miners on the river, were of the opinion that the Tes-lin-too actually carries much the greater volume of water. As this appeared to be a question of some importance, we stopped a day at the confluence for the purpose of investigating it, cross-sectioning each river and ascertaining the rate of the current at distances of about half a mile from the junction, where the circumstances were favourable. It was thus ascertained that the rivers possess the following dimensions:— Lewes and Tes-lin-too compared. Volumes of rivers.

	Lewes.	Tes-lin-too.
Mean width	420 feet.	575 feet.
Maximum depth (near left bank)	12 " (near right bank)	18 feet 4 inches.
Sectional area	3015 "	3809 feet.
Maximum velocity	5·68 miles pr. hr.	2·88 miles pr. hr.
Discharge per second	18,664 cubic feet.	11,436 cubic feet.

In connection with these measurements it may be stated that the Lewes showed evidence of having risen about a foot above its lowest summer level, while the Tes-lin-too was probably near its lowest summer stage.* If we subtract the volume of water represented by this extra foot in depth, the discharge of the Lewes at the summer low-water stage may be approximately stated at 15,600 cubic feet. The water of the Lewes has a blue, slightly opalescent colour, much resembling that of the Rhone where it issues from the Lake of Geneva, while that of the Tes-lin-too is brownish and somewhat turbid. The temperatures of the Lewes and Tes-lin-too were respectively 54° and 53·5° F. on the evening Water of the two rivers.

* All the rivers in this country reach their actual minimum toward the end of the winter.

of August 31st. A considerable part of the water of the former stream must be derived from the glaciers and snows of the Coast Ranges, but the existence of large lakes on both streams doubtless accounts for their proximate equality in temperature.

Rocks. From the few exposures which occur on that part of the Lewes which cuts across the Seminow Hills, the range would appear to be composed of greenish, altered volcanic rocks, probably diabase, interbedded with grey or whitish marble. Rocks of this character are those which have supplied the material for the conglomerates described before (p. 146 B) and are evidently much older than these and doubtless referable to the Palæozoic. At another place, south of the Seminow Hills, felsite, schistose diabase and dark fractured argillite were noted in association, and at about a mile and a-half below the Tes-lin-too, purplish and greenish amygdaloid, with calcareous filling, was seen. The exposures on this part of the river are few and unconnected and that last mentioned shows less sign of alteration than usual, and may be referable to a period newer than the Palæozoic.

Drift deposits. Clayey and earthy gravels, like those often associated with the boulder-clay, were noted in some places along this part of the Lewes. These are overlain by nearly white, bedded silts, which often form entire banks of considerable height. A mile and a-half below the mouth of the Tes-lin-too, the first glaciated rock-surfaces seen in ascending the Lewes, were noted. The direction of glaciation is N. 4°, E. The glaciation is here well preserved on surfaces a few feet above the river, and consists of wide, shallow, straight grooves and flutings, quite evidently the work of a glacier.

Tes-lin-too or Newberry River.

Notes on the river. The Tes-lin-too River is named the Newberry or Tess-el-heena* on Schwatka's map, and is evidently the same which is sketched on the U. S. Coast Survey map of Alaska, etc., (1884) as the Nas-a-thane. By the miners who pass along the Lewes, it is known as the Hootalinkwa or Hotalinqu, in consequence, as it proves, of a misapprehension. The Hotilinqu, which has appeared on the maps for many years, was traversed in its upper part by Byrnes in the course of his exploration already mentioned. I have ascertained that one or more of the miners who first descended the Lewes knew Byrnes and were familiar with his work, and, naturally enough, on finding this

* This is doubtless a version of Tes-lin-hī-nī, *hīn* (or in combination *hī-nī*) being Tagish for river. Tes-lin-too is the name given to me by the Tagish Indians, the termination being the Tinné equivalent for *hīn*. This is, however, not the only case of such use of Tinné words by the Tagish. Nas-a-thane is doubtless Nī-sutlīn or Nī-sutlīn-hī-nī, the name of the river above the great lake. Krause names this river, on an Indian sketch attached to his map, Tis-lin-hin.

river, they jumped to the conclusion that it was the Hotalinqu of which he had told them.

River not yet mapped.

This river still remains to be explored and mapped, and as it drains a country with a rather dry climate, the area of its basin is probably very considerable. It has been prospected to some extent by a few miners, but it is difficult, from the accounts which they are able to give, to ascertain much of a definite character respecting it. At the mouth of the river we met Mr. T. Boswell and two other miners who had spent most of the summer on it, and from Boswell's description, together with sketches subsequently obtained from Indians, the following notes are drawn up.

Tes-lin Lake.

The general tread of the Tes-lin-too appears to be south-eastward, and Boswell estimates its length, to the great lake, at one hundred miles. There are no rapids or falls in this distance, but the water for sixty or seventy miles from the mouth is moderately swift, the remaining distance to the lake being quite slack. The lake is represented as being at least one hundred miles in length, but accounts differ as to the existence of a large tributary river at its head, some affirming that there is merely a small unimportant stream. Be that as it may, the main continuation of the Tes-lin-too is found at the head of an arm ten or twelve miles long, on the east side of the lake.

The upper river

This river, known to the Tagish Indians as Ni-sutlīn-hī-nī, must come from a north-easterly direction in the first instance, and it is represented as circling completely round the head of the Big Salmon River and rising between that river and the Upper Pelly. At a distance variously estimated at from eighty to one hundred and twenty miles from its mouth (and said by the Indians to be two days travel down stream), the river forks, the west fork being the larger and that of which the course has just been described. The east fork is swift and full of rapids and rises in a mountainous country, which no doubt represents a portion of the northern continuation of the Cassiar Range. The Indians travel several days up this fork and then cross mountains to tributaries of the Upper Liard and descend by these to the little trading post at the confluence of the Liard and Dease. Between the mouth of the main river and the forks above mentioned, the navigation is fairly good and no heavy rapids occur.

Features near the lake.

The great lake above mentioned, into which the Ni-sutlīn-hī-nī discharges, is said by the Indians to be the largest known to them. It is named Tes-lin by the Tagish Indians, and is bordered to the westward, at a distance of several miles, by a high range of mountains, while a similar range, but of inferior height, runs along its east side and, further north, separates the Tes-lin-too from the Big Salmon. Near the head of the lake is an Indian trail by which, it is said, the head

Pass to Taku.

of canoe navigation on the Taku River may be reached in two long days packing. Enquiry seems to show that the distance from point to point by this trail is about sixty miles, and that it crosses a range of mountains, but not at such a height as to pass entirely out of the timber. It is stated that a miner named Mike Powers, with eight or nine other men, crossed from the Taku to the lake in 1876 or 1877. These men built three boats on the lake, but do not appear to have done much prospecting and came out by the same route by which they had entered.

Gold.

There are two Indian salmon-fishing stations on the Ni-sutlīn-hī-nī above Tes-lin Lake. Mr. Boswell and his partners found fine gold all along the Tes-lin-too and also on the Ni-sutlīn-hī-nī. They worked in different places along the river and appear to have done fairly well.

Tes-lin-too to Lake Labarge.

From the mouth of the Tes-lin-too or Newberry to the lower end of Lake Labarge the distance by the Lewes is twenty-seven miles and a-half. The river is very crooked and for the first six or seven miles very rapid, averaging probably six miles an hour. Large boulders occur in its bed in some places, but it is believed that a stern-wheel steamer of good power might ascend without difficulty. The current becomes slack three or four miles before reaching the lake. The river does not follow any well marked or important valley, but an irregular depression among lumpy inconsequent hills, none of which probably rise over 1000 feet above it. No rocks were found exposed on the river, but some of the hills are evidently composed in large part of pale, grey limestone. Scarped banks, about a hundred feet high, show boulder-clay overlain by white silts, which on the lower part of this reach of the river form about one-third of the height of the bank. The lakes above evidently prevent the occurrence of heavy floods on this part of the river, the sod coming down quite to the edge of the water in a manner not found on the lower part of the Lewes or on the Tes-lin-too where seen near the mouth.

Lake Labarge.

Nomenclature of the lake.

This lake, through which the Lewes River flows, is undoubtedly that named for Mike Labarge on the older maps, though Schwatka names it Kluk-tas-si which is, no doubt, an attempt at its Tagish Indian name Tloo-tat-sai'.. Krause calls it Tahiniwūd, which is evidently the name given to me as that of the Lewes River. (See p. 142 B).

The lake is a little over thirty-one miles in length. It lies nearly north-and-south, but is somewhat irregular in outline and does not present the parallel-sided form and constant width of most of the mountain lakes. About six miles of its lower end averages two miles and a-half in width. It then maintains a pretty constant width of a mile and a-half, for nine miles, after which it again increases in size and attains a width of five miles near Richtofen Island. (Named Richtofen rocks and shown as a peninsula on Schwatka's map). Its elevation above sea-level is approximately 2100 feet. It appears to maintain its level pretty constantly, the total rise and fall as indicated by the shores being about four feet only. It was about a foot above its low-water stage at the time we passed early in September. Size of the lake.

The lake is bordered nearly everywhere by hilly or mountainous country, but two important valleys occur which require special mention. The first of these evidently forms the continuation of the hollow occupied by the lake itself, and runs on from its north or lower end in a north-westward direction, while the river, where it leaves the lake, turns to the north-east and breaks through the ranges of hills on that side. The greater part of this valley, which I propose to name the *Ogilvie valley*, appears to drain from the lake in a north-westerly direction and probably to White River, as it is seen to be blocked by terrace-flats about 200 feet above the lake, at a distance of a few miles from it. The second valley begins in a tract of low land to the west of Richtofen Island and runs parallel to the first, being like it, one of the main orographic valleys of the region. A small river appears to enter the lake from this valley. The mountains on the south-west side form a well characterized range, but appear scarcely to exceed 2500 feet in height above the lake. They carried, however, some patches of old snow, the first seen by us since leaving the upper part of the Pelly River. Country about the lake.

The hills along the lower part of the lake on the east side are quite remarkable in their abrupt forms and have white limestone summits. They rise from 300 to 1000 feet above the lake and no higher mountains were seen behind them. Further up the lake, on the same side, similar limestone mountains attain a height of about 2000 feet at a short distance back, but are not so remarkable in form. On the west side of the lake, north of the Richtofen valley, the hills slope gradually back from the shore and in a few places reach a height of probably 2000 feet above it, at some miles inland. The outlines of these hills are monotonous and they are wooded nearly to the summits. South of the Richtofen valley the *Miner's Range* * approaches the lake at an oblique angle, but decreasing in altitude. The mountains forming this range are more varied in form than those just described. Mountains.

* I name this for the miners met by us along the river, good fellows all of them.

Survey of the shores.

Mr. Ogilvie's measured line was carried down from point to point along the west shore of the lake, a few points only having been fixed on the east shore by triangulation. In order to complete the outline of the lake I decided to make a track-survey of the east shore, connecting this by bearings with known points on Ogilvie's survey. We had not time to circumnavigate the lake and nothing was known to point out one side as better than the other for the purpose of geological examination. The lake is reputed to be a very stormy one, the prevailing winds being from the south in summer, and often so strong that miners have been detained in camp for many days. We lost almost the whole of one day, owing to wind, on our way up the lake.

Climate.

Though local evidence of a more humid climate was noted on the Lewes near the Seminow Hills, these are soon lost after passing that range, and along Lake Labarge, southern slopes of terraces and hills are often grassy and open. *Anemone patens* was noted as abundant in many places.

Two series of rocks.

The rocks bordering the east side of Lake Labarge evidently represent two distinct series, of which the older is for the most part composed of grey limestone; which, in some places, nearly approaches marble but in others becomes rather flaggy and argillaceous. Resting unconformably on this, is a series composed of conglomerates, which pass into hard grey and greenish grauwacke-sandstones, and hard, dark, calcareous shales which occasionally become nearly black, impure, flaggy limestone. The two series are folded together, the strike of both being north-north-west and meeting the shore of the lake very obliquely. The direction of dip is generally westward at high angles or vertical. The conglomerates are chiefly composed of greenish, grey and purplish altered volcanic rocks, together with limestone of various kinds, and the same constituents in a more comminuted form enter into the composition of the grauwackes. At a point opposite Richtofen Island, black, argillaceous and calcareous beds are charged with numerous angular fragments of the older limestones, the occurrence of which and of the pebbles of altered volcanic rocks elsewhere associated with the limestones, constitute the evidence of unconformity, as the two series are too closely folded together to admit the observation of an angular unconformity. The good exposures found along this shore of the lake are important as indicating the intimate manner in which the rocks of differing age are associated in this region. They show that their separation on the map can be accomplished only by means of a detailed survey. No characteristic fossils were found in the older limestone series which may, however, be regarded from analogy as probably of Carboniferous age. The newer series is evidently Cretaceous and very probably of the horizon of Series C., the Lower Shales and Sandstones of the Queen Charlotte Islands. A few fossils were obtained at the point

already referred to, opposite Richtofen Island, on which Mr. J. F. Whiteaves supplies the following note.—

"The fossils collected at this locality appear to be somewhat as follows, though they have only been subjected, so far, to a preliminary and by no means exhaustive examination. 1. A single specimen of a small sponge, and, (2.) several badly preserved corals, one with compound and very slender corallites. 3. Several small lamellibranchs apparently referable to three genera, two of which are represented by mere fragments, while the other may be a form of *Pleuromya lævigata*. 4. A mould of part of a spiral gasteropod, which may be referable to *Nerinæa* or to the genus *Pseudomelania* of Pictet and Campiche. 5. A piece of a phragmocone of a small belemnite. Cretaceous fossils.

"These fossils, though somewhat obscure, appear to be of Cretaceous age and possibly of about the horizon of Series C., of the Queen Charlotte Islands."

Of the rocks on the opposite or west side of the lake nothing certain can be said. Limestone is, however, not a prominent feature in the hills near the lake, though apparent in some of those seen behind the first range. It is not improbable that the Mesozoic rocks are here more extensively developed.

Terraces were noted on the lower part of the lake at about 200 feet above it and at various lower levels, and near the head of the lake they were seen at an elevation estimated as being at least 400 feet above it. The rocks along the lake-shore frequently show glaciated surfaces, the bearing being in general parallel to that of the lake and the sense of the movement of ice from south to north. The limestone hills are channelled, planed and fluted along their sides and over their summits in such a way as to indicate the former existence of very heavy ice pressure. Two miles from the lower end of the lake, at the water-level, the glaciation points directly down the valley through which the river now runs, or N. 24° E., while two miles further on, the summit of a limestone hill 300 feet high is crossed by heavy glaciation running N. 8° W. The latter may be accepted as that of the main direction of motion, the divergence met with being not greater than that frequently found in tracing the course of the ice of the former Strait-of-Georgia glacier on the coast, where it has passed over rugged country,* and it would appear that in this case the main mass of ice moved into the wide Ogilvie valley, while part of the lower portion of the mass was pressed through the smaller valley by which the lake itself now discharges. Where the limestone hills have recently been stripped of their covering of soil, the sloping glaciated surfaces are still so smooth that it is difficult to walk over them. Terraces. Glaciation.

* See Annual Report Geol. Sur. Can., 1886, p. 100 B.

Origin of the lake.

No definite indication of the mode of origin of the lake was obtained. The observation just cited shows that the valley through which it now discharges existed in glacial times, but it may probably have been of less importance and it is not impossible that before the glacial period the river flowed out by the Ogilvie valley which may since have become blocked by morainic or other drift deposits.

Lake Labarge to Tahk-heena River.

The valley.

Beyond the head of Lake Labarge, the valley of the Lewes continues equally wide, and runs in a general southward direction like that of the lake. At the head of the lake, the valley is occupied by swampy flats nearly at the water-level and by low terrace-flats, which, where cut in the river banks, are seen to be composed of stratified fine sands, which are often iron-stained and a few miles up the river are found to rest upon the white silts, showing that they are valley deposits of post-glacial date. The limestone range which has bordered the east side of Lake Labarge, runs on in a southward direction, forming the east side of the wide valley. Eleven miles and a-half from the head of the lake the Tahk-heena River flows in from the west, making a right angle with the main river and at thirteen miles further (still measuring along the river), the foot of White Horse Rapid is reached. The current of the Lewes is rather slack for eleven miles from the lake, and the bed and banks are clayey or sandy. Above this point, the river becomes swift, averaging about four miles an hour, and gravel banks and bars re-appear. For about two miles below the White Horse Rapid, the current is very swift, and though the latter may be designated as the head of possible steamer navigation, it would scarcely pay to endeavour to force a steamer up to th every foot of the rapid.* No rock exposures what ever were seen along this part of the Lewes, the scarped banks, which are often a hundred feet in height, consisting almost entirely of white silts with a widely undulated bedding.

The river.

Tahk-heena River.

Size of the river.

The Tahk-heena† River is a considerable stream and is wide and slack at its confluence with the Lewes. At about 200 yards from the Lewes, where it has attained its normal size, it was ascertained to be 237 feet wide, with a depth of ten feet for about one-third of this width,

* Several small stern-wheel steamers have, for some years, ascended each summer the Lower Yukon, in Alaska, but so far as I know, none of these have yet gone further up than the mouth of the Stewart; it would, however, be quite practicable to ascend to the point here indicated.

† Named the Yukon at its outflow from "west Kussooā Lake" at its head, on Krause's map. The orthography of the published maps is here retained. The name would probably be more correctly rendered Ta-hī-nī.

and a current estimated at two miles an hour. The discharge may be roughly estimated at 3600 cubic feet per second, and appeared to be about half that of the Lewes above the junction or one-third of that below the confluence. The hills which border the south side of this river at its mouth, rise to high rugged mountains at about fifteen miles to the west, and these have the appearance of being largely composed of granite. The water of this river is very turbid as compared with that of the Lewes, and the temperature of both rivers was found to be 52° F. on the 6th of September.

Upper part of the river.

The principal sources of the Tahk-heena are shown by Dr. A. Krause's exploration to be at a distance of forty to fifty miles from the head of the west branch of Lynn Canal, and the river was formerly much employed by the Chilkat Indians, whose chief place is on that arm, as a means of reaching the interior. It is not used by the miners, and now only to a small extent by the Indians themselves, on account of the long and difficult carriage from the sea to its head, but the lake at the head of the river once reached, the voyage down stream is reported to be easier than that by the main river, the rapids being less serious. A sketch of the course of the Tahk-heena River, probably based on Indian accounts, is given on map No. 20 which accompanies the U. S. Coast Survey Report for 1867. This sketch has, however, not been employed on the map of of 1884, it being probably supposed at that time that the Indian information on which it had been drawn referred to the upper part of the Lewes.

The Cañon.

White Horse Rapid.

The White Horse Rapid and Miles Cañon form together the most formidable obstacle to the use of the Lewes as a route into the interior, constituting an interruption to navigation of two and three-quarter miles in total length. White Horse Rapid is three-eights of a mile long.* The worst rapid is at the lower end of the White Horse, where the river scarcely exceeds a hundred feet in width, with low basaltic banks, and the force of the water is very great. In the upper part of the White Horse, the water flows between low basalt cliffs scarcely exceeding twenty feet in height, but sufficient to render tracking precarious and difficult, while the occurrence of numerous rocks in mid-channel makes the rapid dangerous to run. The portage is on the west bank and it is usual to carry both boats and cargo over it.

Between the White Horse and the foot of the cañon the river is very swift, and at one place, a mile above the former and three-quarters of a mile below the latter, the set of the stream is so strong round a rocky

* The distances here given are those measured by Mr. Ogilvie.

point as to render it advisable to make an additional short portage of 130 feet. A third portage of five-eights of a mile is necessary at Miles Cañon. This portage is on the east bank, and at the lower end, a very steep ascent has first to be overcome. Here a sort of extemporized windlass has been rigged up by the miners for the purpose of hauling up their boats. The cañon is cut through a horizontal, or nearly horizontal, flow of basalt and is not more than about a hundred feet in width, with vertical cliffs averaging about fifty feet, and never exceeding one hundred feet, at the sides. It opens out into a species of basin in the middle, but the river is elsewhere inaccessible from the banks. Terraced hills rise above the basalt walls on each side of the valley, but are particularly abrupt on the west bank. The river flows through the cañon with great velocity, but is unimpeded in its course, and it is therefore not very risky to run with a good boat. The White Horse Rapid is, however, much more dangerous, and though some of the miners have run through it—generally accidently—it should not be attempted.

The cañon.

Basaltic rocks. The basaltic rocks of the rapid and cañon are not seen for any distance above or below these points, and appear to represent a local effusion of no great area, which is probably confined to the bottom of the valley. A second wide valley runs behind *Cañon Hill*, to the east, and it is possible that this may represent a pre-glacial channel of the river. The basalt is itself evidently older than the glacial deposits. It is grey in colour and often vesicular, the cavities being in some places filled by a radiating zeolitic mineral.

Miles Cañon to Lake Marsh.

Lewes River and valley. The great structural valley which is occupied by Lake Labarge and by the river above it up to this point, runs on above the cañon as a wide, important depression, bearing nearly due south, and appears to be uninterrupted till it joins the lower end of Bennett Lake, thirty-two miles distant. The course of the river, however, diverges to the south-east, in which direction also a wide valley runs, and in twenty-three miles (following the stream) the lower end of Lake Marsh is reached. This valley, though extensive between its limiting slopes, is not regularly bounded by parallel ranges, like that first mentioned. The current of the river to within five or six miles of the lake is moderate, not exceeding three miles an hour, and the immediate river-trough is narrow, being rather closely bordered by terraces of a hundred feet or more in height. Above this point, to the lake, the current is quite slack; the terraces gradually retreat toward the bases of the hills, and wide, swampy flats occur. The water above the cañon is quite clear and

blue, showing that its turbidity further down is entirely due to the washing away and falling in of the high banks of silt. The turbidity of the Tahk-heena is probably also due to the same cause.

Anemone patens and *Elæagnus argentea* are common on dry banks, and slopes covered with bunch-grass and *Artemisia frigida* still occur, evidencing a dry climate. The black pine (*Pinus Murrayana*) is now very abundant, much more so than on the lower river, and it was here observed that this tree began to assume a more branching and less rigid form than it has to the north. Large numbers of salmon were found dead or dying along the banks for a few miles above the cañon, and the grass along the shores was trodden down by bears attracted here by this circumstance. No salmon were found so far up as Lake Marsh, and the Indians state that this is their limit. It would appear that after their long journey from the sea, those which get so far, exhaust their last remaining strength in ascending the cañon. Vegetation. Salmon.

There are some very fine exposures of stratified white silts, often interbedded with sands, along this part of the river, but no boulder-clay was seen; neither are there any exposures of rock in place. Basalt is seldom found as a constituent of the gravels above the cañon, and then only in small pebbles. Rounded pieces of greenish, jade-like rocks and impure jades, which were abundant below the Tes-lin-too, here again become common. White silts. Jade.

Lake Marsh.

Lake Marsh, so named by Schwatka, in honour of Prof. O. C. Marsh, is known to the miners as "Mud Lake." It is twenty miles in length, with an average width of about two miles, pretty uniformly maintained. The valley of which this lake occupies the centre, is notably wide, and the country in the immediate vicinity of the lake is quite low, consisting of terrace-flats, or low rounded or wooded hills and ridges. Conspicuous mountain summits, however, occur at a distance of some miles inland on both sides of the lake. A moderately well defined range, of which Michie Mountain* 5540 feet in height is the most elevated point, bounds the view on the east side of the lake, from which it diverges in a south-easterly direction. To the west is an irregular and broken mass of mountains in which several notable gaps occur and which occupy the country between Lake Marsh and the Watson valley, previously referred to. The highest points of these, *Mounts Lorne* and *Lansdowne*, were ascertained to have approximate elevations of 6400 and 6140 feet respectively. The diversified forms of the mountains in view from this lake render it particularly picturesque, Situation of Lake Marsh. Mountains.

* So named by Schwatka.

and at the time of our visit, on the 10th and 11th of September, the autumn tints of the aspens and other deciduous trees and shrubs, mingled with the sombre greens of the spruces and pines, added to its beauty.

The lake and its tributaries.

The shores of the lake are generally rather shoal, and in some places the beach-gravel was found to rest on mud or clay, but these peculiarities are not so striking in themselves as to warrant the application of the name "Mud Lake." The mouth of the M'Clintock River, which enters the lower end of the lake from an important valley, was not examined closely. It appeared, however, to be a small stream, and the greater part of the country to the east of the lake probably drains to the Tes-lin-too. A second stream joins the lake at the south-east angle at its head.

Track-survey.

As in the case of Lake Labarge, Mr. Ogilvie's measured line was here carried along the west shore and in order to complete the outline of the lake, I travelled up the opposite side, making a track-survey of it, which has been embodied on the map.

Rocks.

The rocks seen at the lower end of Lake Marsh, and on the island, may be taken as representing the composition of the range which borders the Lewes on the north-east for some distance below. They consist of greenish and purplish altered volcanic materials, probably all diabase in composition, and are bedded, the strike being approximately parallel to the run of the range just mentioned.* Further up the lake on the same side, similar rocks were noted in several places, together with some which might be taken to represent the grauwacke-sandstones of the newer series described on Lake Labarge. The higher mountains off to the eastward appear to be, at least in part, composed of limestone. At the head of the lake are considerable exposures of black and dark-grey, hard, slaty argillites, finely cleaved and traversed by numerous small quartz veins. The strike of the cleavage is S. 30° E., with a high easterly dip.

Glaciation.

The rock surfaces along the lake are heavily glaciated, the direction being, in general, parallel to that of the main valley. The evidence is such as to show, however, that at least the subjacent part of the ice of the former great glacier, bifurcated at the north end of the lake, one branch taking the valley of the Lewes, the other that of the M'Clintock River. In the same way, at the south end of the lake, a great part of the ice has been delivered through the wide valley which comes from the south-east between *Jubilee Mountain*† and *Mount White*.‡

* See Appendix V. (Lake Marsh, No. 86) for note on one of these rocks.

† 1887 being the year of Her Majesty's jubilee.

‡ So named in honor of the late Hon. Thos. White, to whose initiative the despatch of the expedition to which this report refers was largely due.

Tagish, Bennett and Lindeman Lakes.

The upper end of Lake Marsh is connected with Tagish Lake by a wide tranquil reach of river five miles in length. The current is here very slack, and the depth, according to Ogilvie, from six to twelve feet. The river is bordered by low terraces, which are particularly wide on the west side, and are covered with open woods, chiefly consisting of white spruce and cottonwood. To the east, the long irregular ridges and slopes which culminate in Jubilee Mountain begin to rise a short distance back from the river. A mile above Lake Marsh, on the east bank of the river, are two roughly built houses belonging to the Tagish Indians. These are the only permanent houses seen along the whole course of the Lewes, and here the Tagish people who roam over this part of the country, reside during the winter months. Connecting river. Indian names.

From the description just given, it will be seen that the navigation, by steamers, from the head of the cañon through Lake Marsh and to Tagish Lake would offer no difficulties, while the tranquil character of the connecting river between the two lakes last mentioned, is such as to practically render Lake Marsh the lower portion of an extensive system of still-water navigation which includes not only Tagish Lake but also Lake Nares, Lake Bennett and possibly other connected waters and which will prove of the greatest utility at no distant date in facilitating the opening up and development of the mineral resources of the tract of country in their vicinity. Navigable waters.

The through distance, from the lower end of Lake Marsh to the head of Lake Bennett, measured along the central line of the various lakes and connecting waters, is about seventy miles, made up as follows.—

Marsh Lake	20	miles.
River	5	"
Tagish Lake	16·6	"
Lake Nares	2·7	"
Bennett Lake	25·8	"
Total	70·1	

The still-water navigation, however, includes also the West Arm of Bennett Lake, about twelve miles; Windy Arm of Tagish Lake, eleven miles; Tako Arm of same lake, (of which some notes are given below) at least twenty miles; making a grand total of at least one hundred and thirteen miles.

Taken as a whole, these lakes constitute a singularly picturesque region, abounding in striking points of view and in landscapes pleasing in their variety, or grand and impressive in their combination of rugged mountain forms. Scenery.

Height above sea-level.

The elevation of this remarkable system of lakes above the level of the sea, as approximately ascertained by the mean of about eighteen barometric observations extending over several days, (all taken in triplicate on as many different aneroids,) is 2150 feet. The mean of the barometer readings was compared with that of those taken during the same days at Haines' mission, on Lynn Canal, and the resulting height as above given, is probably a near approach to the truth.

Position relatively to Coast Ranges.

The inner or north-eastern edge of the Coast Ranges is not here very well defined, but Tagish and Bennett Lakes, with their several arms, may be described as lying upon this border and as in part penetrating the outskirts of the range. The lower part of Tagish Lake occupies the continuation of the same wide valley in which Lake Marsh lies, and the valley of the Tako Arm may also be included as a part of the same depression. To the west of this, the upper part of Tagish Lake and Bennett Lake must be considered as lying among the mountains of the Coast Ranges, and the height as well as the abrupt and rugged character of the mountains increase in that direction, their slopes and summits holding large areas of permanent snow, even late in the summer.

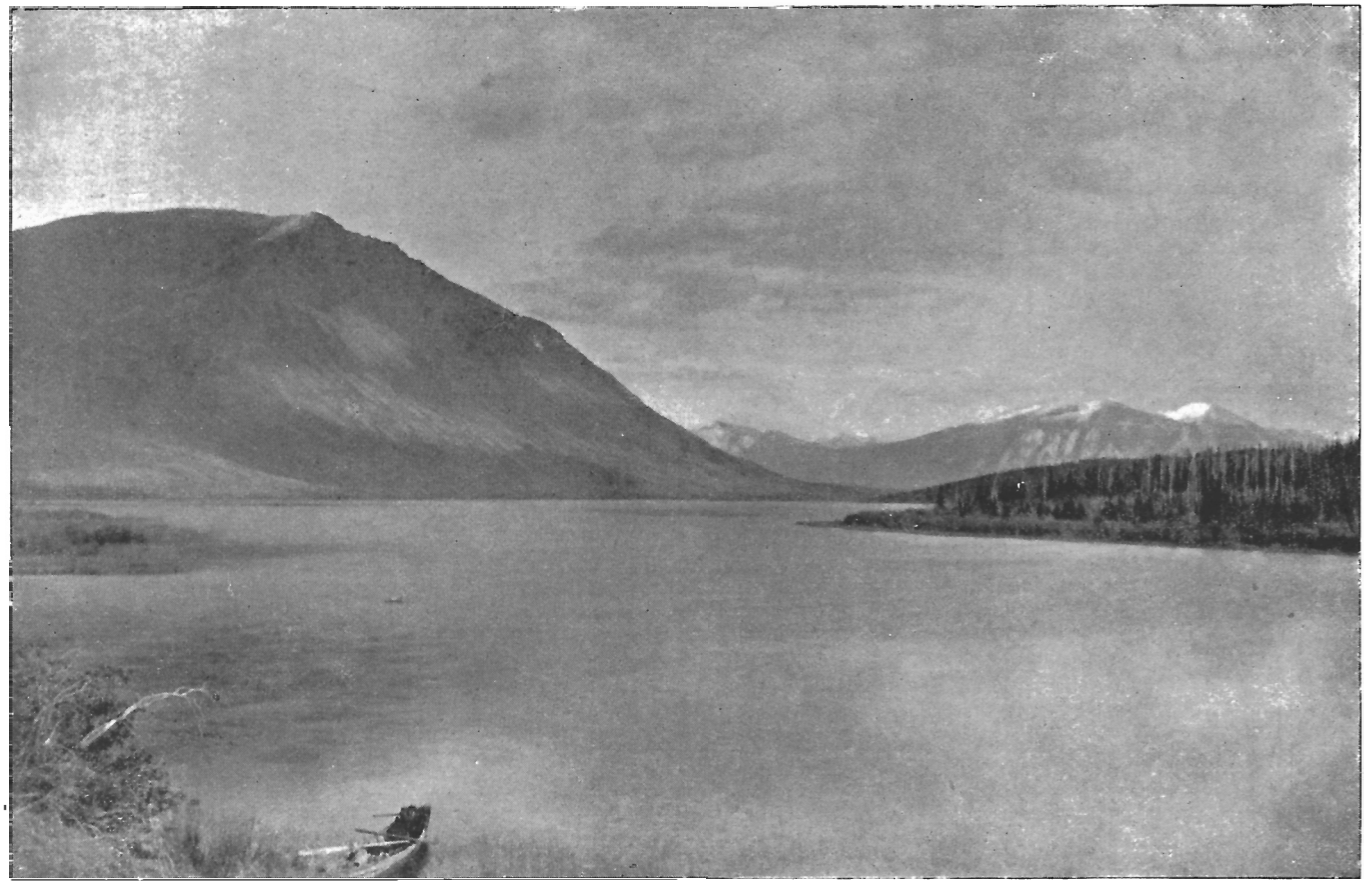
Connection of the lakes.

The lower part of Tagish Lake is very generally bordered by terrace-flats or by low land of the nature of terraces, and the valley runs through to the lower end of Bennett Lake, with a nearly uniform width, as measured between the bases of the mountains, though the lake is somewhat constricted between Tako and Windy arms by the extension of the low land from the north side. A similiar projection of low alluvial land separates Lake Nares from the west end of Tagish Lake, a river-like current being distinctly observable in the narrows. The same occurs at the narrows known as the Caribou Crossing which separates Nares from Bennett Lake, but here with the addition of a number of irregular sand-hills, with which the low land in question is covered, and which also extend round a considerable part of the north end of Bennett Lake.

Arms of the lakes.

The Windy Arm of Tagish Lake, together with the upper part of Bennett Lake and its West Arm are comparatively narrow mountain-walled inlets, with all the characters of true fiords. The Windy Arm terminates in low, hilly land, from which a couple of small brooks come, but no important stream; and it would appear that the drainage which might be expected to enter here is cut off by a transverse valley which holds a lake and flows out toward the Tako Arm.

The West Arm of Bennett Lake was not explored to the head, but terminates in a mass of wild, rugged and bare mountains, of which the outline sketch given on p. 167 B may give some idea. The upper part of the main lake lies, as a narrow water-way, between beetling granite ranges which rise almost perpendicularly to heights of 3000 and 4000



G. M. DAWSON, PHOTO., SEPT. 14, 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

LAKE NARES, LOOKING EASTWARD FROM CARIBOU CROSSING.

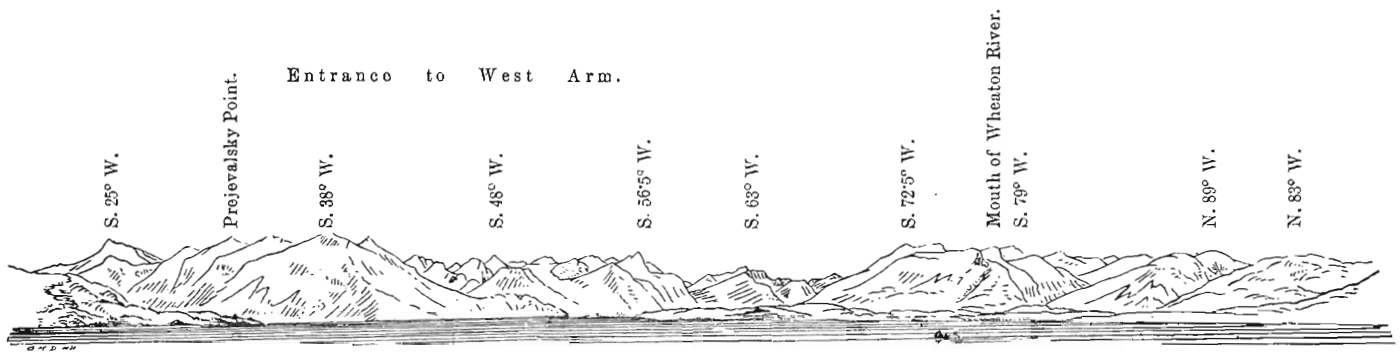


FIG. 7. LOOKING TOWARD COAST RANGES, UP WEST ARM OF BENNETT LAKE, FROM EAST SIDE OF LAKE.

(*The figures placed above the various summits are true bearings.*)

feet above it. Many of the summits beyond the heads of these fiords and in the vicinity, attain heights of 6000 to 7000 feet above the sea, and the region is in every sense an alpine one, though no dominating peaks of great altitude occur.

Climate and vegetation.

In consequence of the position of this country, in the lee of the higher crests of the Coast Ranges, and notwithstanding its considerable altitude, the climate appears to be equally dry with that met with about the site of old Fort Selkirk, and no very striking difference is met with in the character of the vegetation. The southward-facing slopes of some of the mountains, to a height of a thousand feet or more above the lake, are grassy and open, a circumstance particularly observable on the north side of the west part of Tagish Lake and on Lake Nares. The *Amelanchier* was seen on the lower part of Tagish Lake, this being the most northern station observed, and *Anemone patens* continues abundant, locally. Somewhat more alpine conditions are, however, indicated by the occurrence of *Picea subalpina*, which was noted as abundant at the water-level on Windy Arm, and on the upper part of Bennett Lake forms entire groves, growing to a considerable diameter, but tapering rapidly and very rough and knotty. Several places were, however, noticed where miners had built boats on Bennett Lake, and it was here that Mr. Ogilvie constructed a large scow for the transport of his provisions and bulky freight down the river.

Tako Arm.

The Tako Arm, which has already been alluded to, really constitutes the main continuation and upper part of Tagish Lake. It is narrowed at its entrance to a width little exceeding a mile, by a promontory from its west side, but further on, maintains pretty uniformly, for ten miles or more, a width of a mile and a-half to two miles. It is bordered on the west by a uniform, bare and wall-like range of limestone mountains, between which and the edge of the lake, however, a certain width of lower slopes intervenes. The east side is similarly bordered by mountains which also appear to be in the main composed of limestone, but the forms of these were not so well seen, as they were continuously covered by clouds and mists while we were near them. This arm was not explored and with its connected waters yet remains to be properly delineated on the map. It runs in a south-eastward direction for a distance estimated at ten miles, beyond which it turns more nearly south, and its length and other features connected with it can only be given on the authority of Indian reports and sketches. A long way up this arm, possibly twenty miles or more, a considerable river enters from the east. This is the main continuation of the Lewes and is reported to be a tranquil stream of no great length, resembling that between Marsh and Tagish lakes. It flows out of the west side of an-

other very long lake which lies nearly parallel to Tahko Arm. This lake, near its south end, receives several feeders, one of which, entering at its extremity, I suppose to be the Hotalinqu River of the Telegraph Survey, already mentioned, though the Tagish Indians informed me they named it Yil-hī-nī. It is probably the south end of this lake which was reached by Byrnes in 1867, and its connection with the Tako Arm and the remarkable system of lakes just described, would explain the statement made to Byrnes by the Indians, viz. that it was three days good paddling in a canoe to the lower end of the lake. The length of the portage from the head of this lake to the Indian houses on the Taku was variously stated by Indians at from two to four days. The trail is said to be good, and to run through low country except at one place where it follows along the mountain to avoid swampy land. The name of this lake was given by one Tagish Indian as *A-tlin*, by another as Tā-koo-shok and again Sik-ī-nī-kwan, the last being said to be the Taku Indian name. The first-mentioned name is adopted on the map.

Connection with Taku River.

It is certain that the greater part of the water constituting the Lewes River enters by the Tako Arm. This is rendered apparent in comparing the stream which flows out of Tagish Lake with that entering it by the narrows from Lake Nares, where the discharge is probably not much over one-fourth of the volume of that of Tagish Lake. The brooks entering Tagish Lake (exclusive of Tako arm) are quite insignificant.

Main source of Lewes River.

The Indian name of the lake here named Tagish Lake, is Ta-gish-ai (Tagīschā of Krause). It is commonly known by the miners as Tako Lake, and Schwatka adopts this name on his map. It appears, however, admissible to revert to the proper Indian pronounciation of the name, as is here done. I am obliged, by the facts of the case, to include Bove Lake, of Schwatka, as part of Tagish Lake, but in order to preserve the name, propose to attach it to the large island in the mouth of Windy Arm. Lake Nares is known to the miners as "Moose Lake," Lake Bennett as "Boat Lake." In these cases, though not without some doubt as to the propriety of so doing, I retain Schwatka's later names. The Tagish Indian name of Lake Bennett is Koo-soo-wā'. It is the East Kussooā Lake, of Krause. Its west arm is called Noo-koo-tahk. The name of the island on Bennett Lake is Ketle-di-kā'-te. I did not ascertain the Indian name of Lake Nares. The islands on Tagish Lake, of which Bove Island is one, are named In-te'-i.

Names of the lakes.

It will be observed, on comparing Lieut. Schwatka's map with that now published, that he names the west arm of Bennett Lake (though nearly two miles wide at the mouth) "Wheaton River." To the river which enters near this arm from a valley parallel to the Watson

Observations by Schwatka.

valley, I propose to apply this name. In the same way, Windy Arm is put down as "Bove Bay and probably river," and the great Tako Arm is shown as "Tako River," and described as a stream of inconsiderable dimensions. I can offer no reasonable explanation of these errors.

Geology of the Lakes.

General character of the rocks.

The eastern edge of the granitic rocks of the Coast Ranges, is found to cross Bennett Lake obliquely, and probably runs northward along the Wheaton valley. The rocks exposed on the lakes to the east of this line, may be described as belonging, in so far as ascertained, to a single great Palæozoic series, of which the sub-division cannot yet be attempted, but in which the only fossils found by us are of Carboniferous age. It is the same to which the older rocks on the Lewes belong, and closely resembles, both lithologically and in its fossils, the typical area of the Câche Creek series on the Thompson and Fraser. The series, as a whole, here consists of massive limestones, with a great thickness of green and green-grey diabase and felsite rocks, representing altered volcanic materials, and dark- or light-colored cherty quartzites and argillaceous or calcareous schists. The order of superposition is uncertain, but the limestones appeared probably to constitute an upper member of the series, and to be closely associated with the more important masses of contemporaneous volcanic material, while the cherty quartzites and schistose or slaty beds may follow respectively in descending order beneath the limestone. Volcanic materials are, however, fonnd in greater or less quantity in all parts of the series.

Schists.

Black argillaceous schists and grey, silvery calc-schists were found on the east side of Tagish Lake, between the lower end and the entrance of Tako Arm, and again at the head of Windy Arm, in considerable force. At the latter place, the argillite is finely cleaved, forming a true slate. It contains quartzite pebbles, which have been remarkably sheared by pressure acting at right angles to the cleavage-planes and doubtless the same which has produced these. The great

Limestone.

mass of limestone occurs in the ranges bordering Tako Arm on both sides and in the mountains between this arm and Windy Arm. It is generally in the state of marble, and usually rather fine grained, many specimens being very handsomely and curiously marked with grey and black lines or spots. Some beds contain a good deal of silica, and weather rough, occasional layers are more than half composed of cherty matter. Numerous crinoidal remains are often visible, and a microscopical examination of thin sections, prepared by Mr. T. C.

Weston, proves some parts of the stone to be largely composed of the remains of *Fusulina*.* Fusulina.

To the west of this great limestone belt and between it and the edge of the granites, most of the rocks consist of altered volcanic materials, as previously described. Some distinct amygdaloids were observed among these, but no minute lithological examination of them has been made.† Altered volcanic rocks.

The eastern edge of the granites is reached at about ten miles up Bennett Lake, on the east side. Granites continue thence, on the same side, for about five miles and a-half; when they are replaced for five miles by an included belt of stratified rocks, chiefly quartzites, but including also some hornblendic schists. This belt crosses the lake very obliquely in a nearly north-and-south bearing, and appears to represent a detached portion, more highly altered, of the Palæozoic rocks before described. Edge of granites.

The quartzites are here much shattered and pyritized, weathering to rusty surfaces and causing the red appearance of some of the mountains. The same rocks were seen from a distance in the mountains to the west of the lake, but the greater part of the mountains on the west side is evidently granite.

The granites seen along the shores of Bennett Lake are generally rather coarse-grained and hornblendic, though an abundance of black mica is also developed in some places. The felspar is not uncommonly of two kinds, a pink (probably orthoclase) which is often in large porphyritic crystals, and a white triclinic variety. The general tint of the rock is grey, and it closely resembles those described from the vicinity of Vancouver Island in the Annual Report for 1886. No gneissic structure was observed, and the micaceous and hornblendic schists locally developed at the junction with the stratified series, are no doubt the result of the extreme alteration of volcanic portions of that series. Character of granites.

Glaciation was observed in many places in this system of lakes. It is unnecessary to specify these, but it may be stated that conclusive evidence is afforded that glacier-ice moved northward, down Tako Arm, Windy Arm and Bennett Lake, as well as eastward, nearly at right angles, in the east-and-west part of the lake between Windy and Tako arms. This eastward motion was, however, probably subordinate and local, for no great number of granite boulders is found about the lakes till the lower end of Bennett Lake is reached, a circumstance which Glaciation.

* The *Fusulinæ* found here are often remarkably large. The largest actually observed in the few slices prepared for microscopical examination has a transverse diameter of 0·25 inch. Fragments occurring in the same slides, however, indicate the existence of much larger individuals. No critical examination of these fossils has yet been made, but they appear referable to *Fusulina robusta* (Meek), found in California. Palæontology of California. vol. i., p. 3.

† In Appendix V. (Tagish Lake, No. 93), some notes on a felsite from Windy Arm are given.

show that the main mass of ice passing down the Bennett Lake valley continued on to the north by the Watson valley. Well marked and extensive terrace deposits occur on the mountains on the north side of Tagish Lake, at an elevation estimated at 1000 feet above it, or about 3100 feet above the sea-level.

Valleys of the lakes.

A glance at the map will show that the lakes of this system occupy a portion only of a still more extensive system of wide valleys, which are probably of great antiquity, and the pre-glacial direction of drainage in some of which can only be conjectured. All these valleys are now, to a great extent, filled with detrital deposits, probably due for the most part to the glacial period. No appreciable deepening of drainage levels is going on, and the action at present in progress is constantly tending toward the filling up of the lake-basins. It may be presumed, here as elsewhere, that the lakes of this region now occupy the place of the last tongues of the great glacier, which in the end disappeared so rapidly that their beds had not time to become filled with detritus.

Lake Lindeman.

Lake Lindeman, occupies the continuation of the same valley in which Lake Bennett lies, but is separated from that lake by a small rapid stream, three-quarters of a mile in length. This stream falls about twenty feet between the two lakes and is rough and rocky. The portage is on the east side, and after carrying the greater part of our stuff overland, no difficulty was experienced in bringing the boat up the rapids. Lake Lindeman (Tī-tshoo-tah-min′ of the Tagish Indians Schütlüchroā Lake of Krause) is five miles in total length, with an average width of about half a mile. It is the extreme head of navigation in this direction. The lower end is shallow, and the occurrence there of many large boulders, may show that it is moraine-dammed. Its shores are rough and rocky along both sides, high rough mountains rising on its north bank, while lower country, consisting of rocky hills, extends to the south-eastward, as far as the White Pass. A stream joins the head of the lake from the west, in which direction the main valley runs, but bifurcates at a distance of about three miles, the branches running off among high granite mountains. A second stream of some size, which shows evidence of being a formidable torrent at certain seasons, flows into the lake about a mile from its head, on the south side. It is the valley of this stream which is followed by the trail by which the Coast Mountains are crossed. The scenery about this lake is wild and fine, though solitary and alpine in the extreme. The rocks everywhere about the lake are granites of the kind just described.

As a number of miners had preceded us, on their way to the coast, we found several boats drawn up on the shore at the mouth of the stream above mentioned. We were also so fortunate as to find a small party of Tagish Indians camped there, but as most of the men had

G. M. DAWSON, PHOTO., SEPT. 19, 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

LAKE LINDEMAN, LOOKING UP FROM OUTLET.

already gone over the portage with some of the miners, we were obliged to wait two days for their return, before we could obtain the requisite assistance to carry over our stuff. Meanwhile we put our boat in a place of security, and occupied ourselves in eliminating everything which was no longer of value from our "outfit."

General Notes on Lewes River.

Length of route

The total length of the route by the Lewes River from "the Landing" on Lake Lindeman to the site of Fort Selkirk is 357 miles. From the outlet of Lake Labarge, to the same point, is a distance of 200 miles, in which the total descent is 595 feet, or at the rate of 2·97 feet to the mile.

Opening and closing of rivers

The information obtained respecting the dates of opening and closing of the river in spring and autumn is very fragmentary. It would appear, however, that the rivers generally throughout the region open early in May, while they may be expected to freeze over, in slack-water reaches, any time after the middle of October, on the occurrence of a few consecutive days of hard frost. Loose ice sometimes begins to run in the rivers as early as September 20th, but this generally precedes the actual closing of the rivers by a couple of weeks. In some seasons the rivers do not freeze over till well on in November. The ice, however, remains much longer unbroken upon the lakes, the lakes on the course of the Lewes thus generally preventing the descent of that river by boats till June. In 1887, some of the lakes were not open for navigation till June 10th, but as already mentioned the season was an unusually late one. The Tes-lin-too could be crossed in places on ice-jams as late as May 22nd in the same year, but was open throughout within a day or two after that date.

Travel on the river.

Miners entering the Yukon district by the Chilkoot Pass and Lewes River, frequently leave the head of Lynn Canal in April, and after crossing the pass,—for which fine weather is essential,—continue on down the lakes on the ice, and then, if necessary, wait at some convenient point for the opening of navigation, and build their boats.

In ascending the river, much depends on the build of the boat employed and skill of the men in poling, as well as on the occurrence, or otherwise, of head-winds on the lakes. The whole distance from Forty-mile Creek to Lake Lindeman has been made once or twice in so short a time as thirty days, and I believe that even this record has been surpassed by a couple of days on one occasion, but under very exceptional circumstances.

Travelling time

Our actual travelling time, from the mouth of the Lewes to the lower end of Lake Labarge, deducting all stoppages, was 121 hours, 15

minutes. From the head of Lake Labarge to the lower end of Lake Marsh, deducting stoppages as before, and not including the time occupied on the portages (at White Horse Rapid and Miles Cañon) 25 hours 55 minutes. Much, however, depends on the stage of water in the river, as when it is unusually high, the current is not only stronger but many of the bars and beaches are covered, and the poling and tracking is much worse. The time occupied in traversing the lakes is not included in the above statement.

Timber. Timber suitable for building boats can scarcely be found in the vicinity of Lake Lindeman, but no difficulty is met with in obtaining trees of fair size on Bennett and Tagish lakes. Below these lakes, the country is generally wooded, and there is an abundance of spruce of fair quality, growing tall and straight in sheltered localities, but seldom attaining a diameter of two feet.

Chilkoot or Taiya Pass.*

Cross Chilkoot Pass. On the 19th of September we set out with four Indian packers, crossed the summit, and reached a point in the valley of the west slope near what is known as Sheep Camp, the same evening. On the evening of the 20th we arrived at the head of tide-water on Taiya Inlet, and were hospitably received by Mr. J. Healey, who has established himself at that point for purposes of trade with the Indians and miners. We had at this time just completed our fourth month of arduous and incessent travel from Wrangell, at the mouth of the Stikine River, by the rivers, lakes and portages of the interior described in the foregoing pages, the total distance traversed being about 1322 miles. No serious accidents had befallen us by the way, and though, like the miners, we came back to the coast with a deplorably ragged and uncouth aspect, we had with us, intact, our collections, instruments, survey-records and notes. It was not the least pleasing moment of the entire journey when, from a distance of some miles, we first caught sight of the sea shining like a plate of beaten bronze under the rays of the evening sun.

The Pass. The length of the mountain portage from Lake Lindeman to Healey's house, is twenty-three miles and a-half, the summit of the pass being at a distance of eight miles and a-half from Lake Lindeman, with an elevation of 3502 feet.

The valley on the north or inland side of the summit contains several little lakes which are evidently true rock-basins, with lumpy bottoms and irregular contours. The trail is rough and crooked, and entirely

* Known as Chilkoot Pass by the miners, named Perrier Pass by Schwatka. (1883). Dejäh Pass of Krause (1882) of which Taiya is merely an alternative rendering adopted for the sake of conformity with published charts.

without attempt at improvement of any kind. It follows the stream in one place, for about a mile, through a narrow rocky defile, which has evidently been cut out since the glacial period. Where it crosses wide areas of shattered rocks, it requires the closest attention to follow it, and this can only be done, in the absence of guides, by noting the slightly soiled appearance of the grey stones from one to another of which the Indians step. Some of the valleys to the north of the summit, and near it, are deeply filled with perennial snow, over which the trail runs by preference, to avoid the rocky slopes. The small lakes highest in the pass were, at the time we crossed, about two-thirds covered with new ice, which showed little sign of melting, even under the bright sun which prevailed. Hard frosts were evidently occurring here in the mountains every night at this season. Character of the route.

From seven to eight miles of the highest part of the pass may be said to be entirely destitute of timber, even of a stunted growth such as might be used for firewood. The nature of the ground is, however, so rocky that it does not afford a proper criterion of the normal height of the timber-line. Timber-line

At the actual summit, the trail leads through a narrow, rocky gap, and the whole scene is one of the most complete desolation, the naked granite rocks rising steeply to partly snow-clad mountains on either side. The slope of the pass on the north side is rather gradual, and the total ascent from the lake not very great, being but 1334 feet. To the south, on the contrary, it is at first abrupt and even precipitous, being accomplished over huge masses of fallen rock, which alternate here and there with steep, slippery surfaces of rock in place; but the travelling here is after all not so bad as that met with lower down the valley, where the trail goes through the woods along the steep, rocky and often boggy hillside, leading up and down the sides of several deep, narrow gullies. Two small detached glaciers occupy hollows in the slope of the mountains on the west side of this valley, and from these a considerable part of the water of the stream is derived. The "Stone house," or stone houses, and "Sheep camp" are points noted in this part of the pass, the first consisting of several natural though inconvenient shelters, beneath great masses of rock which have rolled down from the mountain, where the Indians often stop over night; the second being the point where arboreal vegetation of fair growth first begins. Summit. South slope.

At six miles from the head of the inlet, the stream followed down from the summit is joined by another which has been dignified by the name of the Nourse River. A short distance up the valley of the latter, are somewhat extensive glaciers and high snow-covered mountains. Both the valley of this stream and that coming from the pass, are narrow and V-shaped, but from their point of junction, a wide flat- The Forks.

bottomed valley runs due south between high mountain walls and is continued further on in that occupied by the inlet itself. This valley is largely floored by gravel-flats and is evidently subjected at times to heavy floods. The little river formed by the confluence of these streams may be ascended with difficulty by canoes, for some miles, when the water is not low, but at the time we passed this was scarcely practicable. It is, however, easy to walk along the gravel-flats, the only discomfort being the necessity of fording the ice-cold and very swift water several times *en route*.

Taiya River.

In the early summer, when the valleys on both sides of the summit are deeply filled with hard snow for a number of miles, the Indians secure a less abrupt grade (particularly on the south slope) by travelling on the snow and altogether avoiding the rough sides of the valley. This was the state of the pass when Mr. Ogilvie made his way inland over it in June. His greatest difficulty was found in connection with the Indians, who are untrustworthy and extortionate to a degree. He and his men were in consequence obliged to pack over a great part of their stuff themselves, and in so doing most of the party became snow-blind. He had with him two Peterborough boats, intended for use in his survey, and in safely transporting them across the Coast Ranges, accomplished a feat hitherto not attempted.

Spring travel.

The rocks met with on the Chilkoot Pass are practically all granites, generally hornblendic and grey, though varying in coarseness of grain, and often porphyritic with pink orthoclase. The granite is cut in places by dark grey-green dykes, probably diabase. Near the actual summit it assumes a brecciated or shattered appearance, and here a considerable mass of coarse, black, and probably intrusive diorite occurs. In the valley south of the summit similar granites prevail, but in some places include rocks with pretty evident gneissic lamination, which were observed locally to pass into mica-schists. The gravel in the valley is also almost entirely composed of grey granite, though some specimens weather red on account of the quantity of pyrites they contain. Below the Forks, on the east side of the valley, the summits of several mountains show rocks evidently stratified, dipping at high angles. These are probably gneiss or schist, like those seen in the valley of the pass.

Rocks.

Many rock-surfaces on both sides of the summit and up to the highest level of the pass were observed to be glaciated, and though no very certain evidence on this point could be obtained, it seemed probable that the ice had moved southward through the gap at the summit. The probable great accumulation of snow and ice on the north slope of the range might account for the parting-axis of the glacier lying to the north of the present actual water-parting.

Glaciation.

Scrubby hemlock (*Tsuga Pattoniana*) in a prostrate form occurs not far below the actual summit on both slopes. Below the "Stone house" this tree begins to become arboreal, and a few miles further down the valley, grows tall and straight, forming entire groves. Menzies spruce (*Abies Sitchensis*) also appears, a short distance below "Sheep camp," together with cottonwood (probably *Populus balsamifera*). Here also elder and birch were first seen on the south slope. The devil's club (*Fatsia horrida*) comes in about a mile above "Sheep camp." *Pinus contorta* was not seen till the Forks was reached. Vegetation.

The "Stone house" is named Te-hīt by the Indians. The Indian name of the Taiya River of the maps, is Daī-ē'. Nourse River is named Kītlī-koo-goo-ā', the stream followed southward from the summit of the pass Sī-tīk'. These rivers are named Katlakúchra and Ssidrajīk on the map of Dr. A. Krause. Indian names.

THE WHITE PASS.

Having heard reports of the existence of a second pass from Taiya Inlet to the lakes on the head-waters of the Lewes, Mr. Ogilvie sent Capt. W. Moore to make an examination of it, with instructions to rejoin the party to the east of the mountains. This pass Mr. Ogilvie has named White Pass in honour of the late Minister of the Interior. It leaves the coast at the mouth of the Shkagway River* five miles south of the head of Taiya Inlet, and runs parallel to Chilkoot Pass at no great distance from it. Though the land carriage is somewhat longer by this pass, it appears to present less difficulty to the construction of a practicable trail or road. Some account of this pass, based on Capt. Moore's notes, is given in Mr. Ogilvie's preliminary report,† and additional particulars have since been obtained by correspondence with Capt. Moore. The distance from the coast to the summit is stated as seventeen miles, of which the first five miles is level bottom-land, thickly timbered. The next nine miles is in a cañon-like valley where heavy work would be encountered in constructing a trail. The remaining distance of three miles, to the summit, is comparatively easy. The altitude of the summit is roughly estimated at 2600 feet. Beyond the summit a wide valley is entered and the descent to the first little lake is said to be not more than one hundred feet. The mountains rapidly decrease in height and abruptness after the summit is passed, and the valley bifurcates, one branch leading to the head of Windy Arm of Tagish Lake, the other (down which the water drains) going to Tako Arm of the same lake. Character of the pass.

* So named on chart in U. S. Coast Pilot, Schkague River of Krause.

† Annual Report of the Department of the Interior, 1887. Part ii, p. 64. See also Report by Moore to Chief Commissioner of Lands and Works of British Columbia, dated April 25th, 1888.

Other routes. The Chilkat Pass has already been noticed (p. 161 B). There is still another route into the interior, which the Indians occasionally employ in winter when the travelling is good over the snow. This leaves the Nourse or west branch of the Taiya and runs west of the Chilkoot Pass to the head of Lake Lindeman.

Exploration and Prospecting on the Lewes, and Gold Mining in the Upper Yukon Basin.

Various maps. The discovery and naming of the Lewes River by Campbell has already been referred to, (p. 138 B) but the information respecting the river obtained by the officers of the Hudson Bay Company during their short occupancy of Fort Selkirk, as embodied on Arrowsmith's map of 1854, was very incomplete, consisting merely of the fact that it divided into two main streams when followed up, and that large lakes existed on these. A considerable improvement is found in the delineation of the river on the map accompanying Dall's work on Alaska, (1870) in which information collected by the explorers of the Telegraph Survey is embodied, but the Lewes is there still merely outlined from report, and no approach to a reasonably correct map of its course existed up to the date of Schwatka's expedition in 1883. The first map of the Chilkoot and Chilkat passes and their vicinity is due, as mentioned further on, to Dr. A. Krause.

Indian jealousy The passes connecting the coast with the interior country, from the heads of Lynn Canal to the upper waters of the Lewes, were always jealously guarded by the Chilkat and Chilkoot Indians of the coast, who carried on a lucrative trade with the interior or "Stick" Indians, and held these people in a species of subjection. Though the existence of these routes to the interior were known to the traders and prospectors, the hostility of the Chilkats and Chilkoots to the passage of whites long prevented their exploration.

Fables. In the Alaska Coast Pilot (1883, p. 278) it is stated on the authority of Captain J. C. Carroll, that the first transit of the Lewes River and Chilkoot Pass, by a white man, was accomplished in 1864 or 1865 by an employee of the Hudson Bay Company, who started from Fort Selkirk and was delivered by the Chilkoot Indians to Captain Swanson, then in command of one of the Company's steamers. This story is repeated and amplified in a work by Mrs. E. R. Scidmore, where the adventurer is designated as "a red-headed Scotchman" who "forced his way alone through the unknown territory to Chilkoot Inlet."*

I have endeavoured to verify this tale, but quite unsuccessfully, and while it is possible that some deserter from the Company's posts in

* Alaska, its Southern Coast and the Sitkan Archipelago. Boston, 1885, p. 119.

the interior may thus have reached the coast, it is more probable that the story is entirely apochryphal. Enquiry made on the ground among the miners and others fails to substantiate it. Fort Selkirk had been in ruins for twelve years at the date referred to, and officers of the Hudson Bay Company who were on the coast at the time do not believe in its authenticity. It may, however, not improbably have grown out of the circumstance that a gun and some other articles which had belonged to Campbell's people at Fort Selkirk were, shortly after the raid upon that post, obtained from the Coast Indians by servants of the Company.

Discovery of gold.

I have been able to find no reference to the discovery of gold in any part of the Yukon waters earlier than that given by Mr. F. Whymper, who writes in 1869: "It is worthy of mention that minute specks of gold have been found by some of the Hudson Bay Company's men in the Yukon, but not in quantities to warrant a 'rush' to the locality." *

Holt.

The first white man who crossed from the coast to the head-waters of the Lewes appears probably to have been one George Holt†, who did so with the object of prospecting the country.‡

The date of Holt's journey was, I believe, 1878. He was accompanied by one or more Indians, and crossed by the Chilkoot or by the White Pass to the head of the Lewes. He followed the river down to the lower end of Lake Marsh and walked over the Indian trail thence to the Tes-lin-too, returning to the coast again by the same route. On his return, he reported the discovery of "coarse gold," but none of the miners who afterwards prospected the region mentioned, have been able to confirm his statement in this particular. In the Alaska Coast Pilot the date of Holt's journey is given as 1875, and in the addendum to the same work as 1872§ in Mrs. Scidmore's book, already quoted, as "1872 or 1884." The date and route above assigned to Holt are, however, probably correct, being the result of enquiry among miners who knew him, followed his route through the country, and came in contact with the Indians whom he had met.

Some years later, in 1880, a prospecting party of nineteen men was organized at Sitka under the leadership of one Edward Bean. Amicable

* Travels in Alaska and on the Yukon. London, 1869, p. 227.

† Afterwards murdered by Indians at Cook's Inlet in 1885. Shores and Alps of Alaska, H. W. Seton Karr, London, 1887.

‡ U. S. Coast Pilot. Alaska, 1883, pp. 200, 278.

§ Other extraordinary journeys assigned to Holt in Mrs. Scidmore's book are, according to the miners, altogether incorrect. Holt appears to have been a romancer with considerable inventive powers, but it is possible that he made more than one journey. In May 1878, Messrs. Rath Bros, of Victoria, and Mr. Bean, of California, set out to cross by the Chilkoot Pass for the purpose of prospecting, but were not allowed to go inland by the Indians. Morris, Report upon the Customs District, etc., of Alaska, 1879, p. 97.

First prospecting party, 1880.

relations were established with the Chilkats and Chilkoots through the kind offices of Capt. Beardslee, U.S.N., and the Chilkoot Pass was crossed to Lake Lindeman. The party had, by this time, increased to twenty-five in number.* Boats were built on Lake Lindeman, and on the 4th of July the prospectors set out down stream. The Tes-lin-too was reached and was then, for the first time (and as it proves, erroneously,) recognized as the Hotalinqu. Before returning, the Tes-lin-too, was ascended and prospected for some distance. From George Langtry who was a member of the original party, and R. Steel, who joined it later, the facts, as above given, are derived.† No encouraging "prospects" were met with at this time, though Steel states that he found bars yielding at the rate of $2·50 a day in a small stream which joins the Lewes fifteen miles above the cañon.

This large party was closely followed by two miners known as Johnny Mackenzie and "Slim Jim," who reached Lake Lindeman on July 3rd. It is possible that other parties as well may have entered the country in this year, but if so I have been unable to trace them.

1881.

In 1881, a party of four miners, including G. Langtry and P. McGlinchey again crossed the Chilkoot Pass. These men got as far as the Big Salmon River, which they called the Iyon, by which name it is marked on the U. S. Coast Survey map of 1884. They ascended the Big Salmon, according to their estimate, about 200 miles, finding a little gold all along its course and meeting with some remunerative river-bars. This may be characterized as the first discovery of paying placers in the district. According to the U.S. Coast Pilot, already quoted, some account of this expedition is given in the New York Herald, of Sept. 21st, 1881, to which I have been unable to refer.

1882.

In 1882, a number of miners entered the Yukon country by the Chilkoot Pass, and probably during this season, but certainly not before,‡ two prospecting parties ascended the Pelly to Hoole Cañon and some of the men appear to have even gone some distance further up.§

Exploration by Krause.

Dr. Arthur Krause, engaged in an expedition on behalf of the Bremen Geographical Society, in May and June, 1882, made an explora-

* It had increased to twenty shortly after leaving Sitka. See Report by Capt. Beardslee, 47th Congress, 1st Session, Senate, Ex. Doc. No. 71, p. 65. In the same report, the names of the nineteen original members of the party are given and some account of its organization, etc.

† The account of the further wanderings of the party given in the U.S. Coast Pilot, Alaska (1883) p. 278 is incorrect.

‡ According to miners who were in the country at the time, the statements which have been published of earlier prospecting along the Upper Pelly are erroneous.

§ Through the kindness of Mr. François Mercier, I have obtained from Mr. D. Bertrand, who was a member of one of the parties above referred to, the names of the men composing both, as follows :—Thomas Boswell, John Dougan, Robert Robertson, D. Bertrand, Frank Densmore, John Riley, P. Cloudman, Robert Fox, Thomas Curney. The date, as above given is from Mr. Bertrand. Mr Boswell, whom we met on the Lewes in 1887, was understood to say that he had been prospecting up the Pelly in 1884 or 1885, but this statement probably referred to a subsequent expedition.

tion of the Chilkoot and Chilkat passes, reaching Lake Lindeman and the sources of the Tahk-heena River respectively. His work is embodied in maps published by the Bremen and Berlin Geographical Societies, and it is worthy of special note on account of its conscientious accuracy.*

In 1883, some mining was again in progress, but details respecting it have not been obtained. It was in this year that Lieut. Schwatka crossed the Chilkoot Pass and descended the Lewes and Yukon to the sea.† In 1884 a little mining was done on the Pelly and on the Tes-lin-too, and possibly also on the Lewes. In 1885, mining was begun along the Stewart River, and in the following year, the greater part of the mining population was engaged on that river. Cassiar bar, on the Lewes, twenty-seven miles below the Tes-lin-too, was discovered in the spring of 1886, and actively worked during the same summer.

Schwatka's journey.

Late in the autumn of 1886, "coarse gold" was found on Forty-mile Creek (Cone-hill River of Schwatka) still further down the main river than the Stewart, and the announcement of the fact drew off nearly the entire mining population to this place in 1887. In the attempt to bring out the news of this discovery, a miner named Williams was frozen to death on the Chilkoot Pass in January, 1887.

Gold found on Forty-mile Creek.

Taking a general view of the gold discoveries so far as made in the Upper Yukon country, we find that, though some small bars have been worked on the upper part of the Lewes, and "prospects" have been obtained even in the stream flowing into Bennett Lake, paying bars have been found on this river only below the mouth of the Tes-lin-too. The best of these are within a distance of about seventy miles below this confluence, and the richest so far has been Cassiar Bar. This is reported to have yielded, in some cases, at the rate of $30 a day to the hand, and gold to the value of many thousand dollars has been obtained from it, chiefly in 1886. In 1887 only three or four men worked here. All along the Lewes below the Tes-lin-too, many bars occur which, according to the reports of prospector's, yield as much as $10 a day, and the same is true of the Tes-lin-too itself, both below and above Tes-lin Lake. Bars of this kind are, however, considered scarcely remunerative at present.

Lewes and Tes-lin-too.

Cassiar Bar.

Gold has also been found for a long distance up the Big Salmon River, and on the Upper Pelly as far as it has been prospected. The Tes-lin-too, Big Salmon and Pelly have each already afforded some good paying ground, but in consequence of the rush to Forty-mile Creek only about thirteen miners remained in 1887 on the first-named river, four

Salmon and Pelly.

* Deutsche Geographischp Blätter Bd. v. Heft. 4, 1882. Zeitschr. des Ges. für Erdk. zu Berlin Bd. xviii, 1883.

† See Science vol. iii, 1884, also Report of a Military Reconnaissance in Alaska, Washington Government, 1885. Along Alaska's Great River, New York, 1885.

on the second, and two on the Pelly. On the Stewart River, as much as $100 a day to the hand was obtained in 1885 and 1886, and probably over $100,000 worth of gold has already been obtained along this stream. It has been prospected for a distance of 100 to 200 miles from its mouth, (according to varying statements) and the gold found furthest up is said to be somewhat "coarser" than that of the lower part.

Character of Forty-mile Creek.

Forty-mile Creek is reported to be a river of some size, but more rapid than most of those in the district. It has, according to miners, been prospected for about a hundred miles from its mouth, gold being found almost everywhere along it as well as in tributary gulches. The gold varies much in character, but is quite often coarse and nuggety, and very large amounts have been taken out in favourable places by individual miners. Few of the men mining here in 1887 were content with ground yielding less than $14 a day, and several had taken out nearly $100 a day for a short time. The amount obtained from this stream in 1887 is reckoned by some as high as $120,000, but I believe it would be safe to put the entire output of the Upper Yukon region for the year, at a minimum of $75,000, of which the greatest part was derived from this stream.

Miners.

The number of miners in the whole Upper Yukon country in 1887 may be stated at about 250; of these, 200 were on Forty-mile Creek, and it was estimated that at least 100 would winter on the creek to be ready for work in the spring.

Forty-mile Creek is what the miners term a "bed-rock creek" i.e., one in which there is no great depth of drift or detrital deposits below the level of the actual stream. It is so far the only locality which has been found to yield "coarse gold," but from the extremely wide distribution of "fine gold," it may safely be predicted that many more like it remain to be discovered.

General features of mining.

Mining can scarcely be said to have begun in the region more than five years ago, and the extent of country over which gold has been found in greater or less quantity is already very great. Most of the prospecting has been confined to the banks and bars of the larger rivers, and it is only when their innumerable tributary streams begin to be closely searched, that "gulch diggings" like those of Dease, McDame and other streams in the Cassiar district, and possibly even on a par with Williams and Lightning creeks in Cariboo, will be found and worked. The general result so far has been to prove that six large and long rivers, the Lewes, Tes-lin-too, Big Salmon, Pelly, Stewart and White, yield "fine gold" along hundreds of miles of their lower courses. With the exception of the Lewes, no part of the head-waters

of any of these have yet been prospected or even reached by the miners, and scarcely any of their innumerable tributaries have been examined. The developments made up to this time are sufficient to show that when means of access are improved, important bar-mining will take place along all these main rivers, and there is every reason to anticipate that the result of the examination in detail of the smaller streams will be the discovery of much richer auriferous alluviums. When these have been found and worked, quartz mining will doubtless follow, and the prospects for the utilization of this great mining field in the near future appear to me to be very promising.

Difficulties to be encountered

I must not, however, omit to state that great difficulties and hardships have to be overcome by the miners now entering this country. The traverse of the Chilkoot Portage is itself a formidable obstacle, and over this pass most of the provisions and requisites for the miner must be carried. There is at the present time a trading post belonging to Messrs. Harper, McQuesten & Co., (established in the spring of 1887) at the mouth of Forty-mile Creek, but the supplies are brought to this point by small stern-wheel steamers which ascend the whole length of the Yukon. Goods do not arrive by this route till late in the summer, and any accident or detention may prevent their arrival altogether. The winter in the country is long and severe, and the season of low-water suitable for working on river-bars is short. It is also found that beneath its mossy covering, the ground is often frozen, presenting difficulties of another character to the miner, which have prevented the working of many promising flats and benches. This, however, is likely to be remedied before long by the general burning off of the woods and moss in the mining camps. Frozen ground was found in the same way in the early days of the Cassiar mines, (see p. 82 B) but the destruction of the timber has now almost everywhere allowed the summer heat to penetrate to the lower layers of the soil. It is not likely that this great inland country will long want some easy means of connection between the coast and its great length of navigable lake- and river-waters, and when this is afforded, there is every reason to believe that it will support a considerable mining population.

APPENDIX I.

NOTES ON THE DISTRIBUTION OF TREES AND OF CERTAIN SHRUBS IN THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA.*

Some observations on the trees and plants noticed during the progress of the exploration here reported on, have been given in the preceding pages in connection with the localities described. In this note the general results obtained are presented in a connected form. A list by Prof. Macoun, including the names of all the species recognized, forms Appendix III.

Area included.

The various lines traversed in the course of the exploration are included between 56° 30′ and 63° north latitude, the 128th and 138th meridians of west longitude. This area embraces the extreme northern part of British Columbia and adjacent regions of the North-west Territory, together with part of the "coast strip" of Alaska. Observations by the writer on the distribution of trees in the more southern portion of British Columbia, are contained in previous reports of this survey, particularly in that of 1879–80, which is accompanied by a map showing the limits of some of the more important species.

Character of the region.

As already more fully stated, the region above defined is drained by the Stikine and other rivers, which flow through the Coast Ranges to the Pacific, by the Liard, a great tributary of the Mackenzie, and by several branches of the Yukon, but the several drainage basins do not mark out regions of diverse floras. The main division, from this point of view, is found as between the humid and comparatively uniform climate of the coast and the relatively dry and extreme climate of the interior, the first constituting the northern extension of the botanical region of the British Columbian coast, the second that of the interior of the same province. The dividing line is found along the higher ranges of the Coast Mountains.

The considerable altitude of the interior region also has its influence on the flora, but within the limiting parallels above stated, difference of latitude produces a comparatively small effect, in consequence of the

* The facts included in this note were published substantially in their present form in Garden and Forest, vol. i, No. 5, March 28. 1888.

fact that the country as a whole becomes lower to the northward or north-westward.

The chief facts to be recorded with respect to the distribution of trees are those connected with the northern limits of the well-known West Coast species, the total number of arboreal forms represented so far north being quite restricted.

Trees of the interior.

In the interior, which may be treated as a whole, the Douglas fir (*Pseudotsuga Douglasii*), Engelmann's spruce (*Picea Engelmanni*), the hemlock (*Tsuga Mertensiana*) and the red cedar (*Thuya gigantea*), all common and characteristic trees a few degrees of latitude to the south, are nowhere found. The white and black spruce (*Picea alba* and *P. nigra*), balsam-fir (*Abies subalpina*), aspen (*Populus tremuloides*) and cottonwood (*Populus trichocarpa*, probably with *P. balsamifera*), are found in suitable localities over the whole region east of the Coast Mountains, the two first-mentioned trees constituting probably half the entire forest covering of the country.

Ubiquitous species.

The white spruce, along the rivers and in sheltered valleys and low ground, everywhere forms fine groves to the furthest northern point reached, many trees attaining a diameter of two feet, tall and well grown. It affords lumber of very fair quality,—the best to be obtained in the country. It is found, with *Abies subalpina*, at the highest limit of timber,—about 4200 feet,—on the inland mountains. The black spruce has scarcely received mention in previous notes on the distribution of trees in British Columbia, but is now known to be abundant locally on high plateaux about the region of the Upper Fraser, and in the country here specially described, grows, mingled with the white spruce, in swampy situations and along cool, shady and damp river-banks. It attains a considerable height, but is never large enough to afford good lumber. *Abies subalpina* was found wherever the upper limit of trees on the mountains was approached, but was not observed near the rivers, except on Bennett Lake (2150 feet), near the head-waters of the Lewes River, in latitude 60°, where it becomes very abundant. The aspen is specially characteristic of second-growth woods and of dry, open, grassy hill-sides facing to the southward, of which there is a great extent on the Upper Pelly and Lewes. The cottonwood here represented is, so far as the specimens brought back can be determined, *Populus trichocarpa*, but there is little doubt that the balsam-poplar also occurs. Specimens six feet in diameter were seen on the Stikine River near the Coast Mountains, but further in the interior the tree is rarely large enough for the manufacture of dug-out canoes, or, say, three feet in diameter.

Greater interest, from a botanical point of view, attaches to the trees of which the ranges are more restricted. The black pine (*Pinus Mur-*

rayana), perhaps the most common and characteristic tree of the whole interior of British Columbia, is also pretty widely distributed in this northern region. It is found in abundance on the Stikine, near the Little Cañon, on the eastern side of the Coast Mountains, and thence inland, in suitable localities. It was observed on the Dease and Upper Liard, and from the mouth of the Dease (according to specimens sent back by Mr. R. G. McConnell) extends down the Liard to Devil's Portage, some miles east of the range which appears to represent the northern continuation of the Rocky Mountains proper. Beyond this point the Banksian pine becomes characteristic of the great valley of the Mackenzie, which is here entered, but this tree does not extend to the west of the Rocky Mountains. On the head-waters of the Liard *Pinus Murrayana* reaches nearly to Finlayson Lake, its most northern source, but does not occur on the Upper Pelly, on descending which it was first met with in long. 133° 30′. From this point down the Pelly and up the whole length of the Lewes to its sources at the base of the Coast Mountains, it was constantly noted, becoming quite abundant near the Lewes head-waters. Mr. W. H. Dall gives the mouth of the Lewes (lat. 62° 47′) as the northern limit of this tree. * Cones were brought back from this place by Ketchum, of the Telegraph Survey party, which were sent by Mr. F. Whymper to Sir J. Hooker, who determined them. (Under the name of *P. contorta*, from which *P. Murrayana* was not at that date separated.) Black pine.

My own observations did not extend to the north of this point, down the river, but Mr. McConnell, who has since examined the lower river, states that this tree does not occur at Forty-mile Creek, and that he did not observe it till he reached the vicinity of old Fort Selkirk, in ascending the stream, thus confirming Mr. Dall's remark.

The known range of the common larch (*Larix Americana*) has, by the observations here reported on, been carried to the west of the Rocky Mountains. This tree extends westward on the Dease River to a point twenty-two miles above its mouth, and along the Liard and Frances rivers spreads northward nearly to Finlayson Lake, reaching latitude 61° 35′. Between the limits thus defined it is quite abundant, and characteristic of cold, swampy tracts and northern slopes, where it grows with the black spruce. It was looked for all along the Pelly, but nowhere found either on this river or on the Lewes. It appears quite probable, however, that this tree will eventually be proved to characterize the sub-arctic country, further to the north, from the Mackenzie valley nearly to the shores of Behring Sea, as Dall refers to the presence of a larch in several places on the Lower Yukon (under Larch.

* Alaska and its Resources, pp. 441-592.

the names *L. microcarpa*? and *L. Davurica*?),* which can scarcely be any other than this species. *Larix Lyallii*, which, about the 49th and 51st parallels in the Rocky Mountains, is the most characteristic tree at the timber-line, was not anywhere seen in the region now in question, and would therefore appear to be a relatively southern mountain species.

Birch. The birch (*Betula papyrifera*) was first seen on leaving the coast by the line of the Stikine, near Kloochman Cañon, thirty miles below Telegraph Creek, some trees here being two feet in diameter. It was also seen on the Dease River, and on the Liard head-waters northward to Frances Lake, where it is abundant, but does not occur on the Upper Pelly till a point a few miles beyond the 131st meridian is reached. Below this, along the Pelly, it is found with increasing frequency, and also occurs here and there on the Lewes, though its limit toward the head-waters of this stream was not noted. The birch never in this region forms extensive groves, but grows singly or in small groups among other trees. It is also found on the Yukon far below the confluence of the Porcupine.

Dwarf birch. *Betula glandulosa*, though only a shrub, may be mentioned here, and probably occurs throughout the entire region. It was first noted on the trail between Telegraph Creek, on the Stikine, and Dease Lake.

Juniper. The juniper (*Juniperus Virginiana*) was observed as a small tree, with trunk six inches in diameter, in the dry country in the lee of the Coast Mountains at Telegraph Creek on the Stikine, (540 feet), but is not elsewhere arboreal.

Alder. The alder, (probably *Alnus rubra*) and one or more species of willows, become small trees along some of the rivers of the interior. The alder was noted as specially abundant and large on the Upper Pelly.

Service-berry. The service-berry (*Amelanchier alnifolia*), as a low shrub, was also noted in the vicinity of Telegraph Creek, and was there in full flower on May 24th. It was again seen, to the east of the Cassiar Mountains, in the valley of the Dease (about 2400 feet), on June 22nd, somewhat more advanced than at the first-mentioned locality, but still, in the stage of growth to which it had attained at this date, indicating a comparatively retarded summer in this locality. It does not occur on the Upper Liard or the Pelly, and was only once again observed, on Tagish Lake (2150 feet), at the head of the Lewes; here also in the dry lee of the Coast Ranges. It is here in latitude 60° 15′, which is believed to be the furthest northern point from which this species has been recorded to the west of the Rocky Mountains. From observations made in the Peace River region, and elsewhere in British Columbia, it appears that the northern range of this species nearly coincides with that of

* Alaska and its Resources, pp. 29-441.

the growth of wheat, and it is interesting to note, in connection with its appearance at Telegraph Creek, that wheat can actually be grown and ripened there, under the 58th parallel. *Elæagnus argentea* was also noted at Telegraph Creek, but was not again seen till near the mouth of the Lewes, on the Pelly River. In ascending the Lewes it was observed in several places, and always indicates a rather dry climate.

Timber-line.

As already stated, the timber-line, or upper limit of the growth of forest, on the mountains of the interior, in the vicinity of the watershed between the Liard head-waters and those of the Pelly in lat. 61° 30′, was found to be at about 4200 feet. At a similar distance from the Pacific Coast, in the corresponding range of the mountains, in lat. 51° 30′, the same line is found at about 7000 feet, showing a descent to the north of 2800 feet in ten degrees of latitude, or about 280 feet in each degree.

Change due to latitude on the coast.

It is generally stated that the influence of the warm waters of the Pacific Gulf Stream, striking the northern part of the West Coast and flowing southward along it, is such as to produce a nearly similar climate and flora from the Straits of Fuca far to the north. While this is true in a general way, it is a mistake to suppose that no effect is produced by the increasing latitude. The most marked change of climate, as indicated by the arboreal vegetation, nearly coincides with Dixon Entrance, on the 54th parallel. The forest north of this point is generally inferior in growth, and the quantity of marketable timber is much smaller. The red cedar (*Thuya gigantea*) is not found in any abundance north of the latitude of the mouth of the Stikine River, and though closely looked for along the coast in the vicinity of Lynn Canal, no single specimen of it was detected there. It is confined to the mouth of the Stikine River, and does not follow up this low valley for any distance inland. The yellow cedar (*Thuya excelsa*) scarcely reaches Sitka, and is not anywhere found among the inner islands near the entrance to Lynn Canal. The alder (*Alnus rubra*) forms groves along the shore at least as far north as latitude 59°. The western crab-apple (*Pyrus rivularis*) occurs here and there as far north as Lynn Canal. The broad-leaved maple (*Acer macrophyllum*) may reach latitude 55° on the Alaskan coast, as stated by Prof. Sargent,* but was not observed by me, and must be quite rare. North of the Prince-of-Wales Archipelago, eight-tenths of the entire forest of the coast region consists of the single species, Menzie's spruce (*Picea Sitchensis*). *Pinus contorta* was noted at the head of Lynn Canal and elsewhere along the coast. Here also, in the valley of the stream on the south side of the Chilkoot Pass, by which the Coast Mountains are crossed, *Tsuga Pattoniana* grows to a fair size. It is found also within a few hundred

Northern limits of certain trees.

* Report on the Forests of North America, U. S. 10th Census, p. 47.

feet of the summit of the pass, at an altitude exceeding 3000 feet, in a prostrate form, but still frequently bearing cones. *Abies amabilis* (?) was noted in the valley of the west slope of the pass, and occurs along Lynn Canal and elsewhere on the coast.

The devil's-club (*Fatsia horrida*), a plant most characteristic of an atmosphere saturated with moisture, is not anywhere seen in this part of the interior country, but was met with in the valley to the west of the Chilkoot Pass, and ascends the Stikine valley to a point a few miles above the Kloochman Cañon.

NOTE.—The approximate limits of several species of trees, etc., are indicated on the Index Map attached to this report.

APPENDIX II.

NOTES ON THE INDIAN TRIBES OF THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA.

Region included.

Such information as I have been able to obtain during our journey respecting the Indian tribes of the extreme northern portion of British Columbia and the adjacent Yukon District, are given in the following pages. Between the northern edge of the ethnological map of British Columbia prepared by Dr. Tolmie and myself in 1884,* and the known portion of the area of Mr. W. H. Dall's similar map of Alaska and adjacent regions,† a great gap has existed, which I had proposed to endeavor to fill in connection with the work of the Yukon Expedition. While this intention has been very imperfectly executed, owing to various causes not necessary here to particularize, but especially to to the fact that during a great part of our journey we met with neither Indians nor whites from whom information might have been obtained, it is felt that any facts on the Indians of the district possess some value, not alone from a scientific point of view, but also in their bearing on the Indian question from an executive standpoint.

Inland and Coast Indians.

Throughout the more southern portion of British Columbia, a difference of the most marked kind is everywhere found as between the maritime Indians of the coast and the inland tribes. While this difference is largely one of habit and mode of life, it is also almost everywhere coincident with radical differences in language; the natural tendency to diversity as between coast-inhabiting fishermen and roaming hunters being intensified and perpetuated by the great barrier of the Coast Ranges. Only upon certain routes of trade which have existed between the coast and the interior is this striking diversity to some extent broken down. The Fraser, the Skeena, the Nass and—in the region here specially referred to—the Stikine and the passes at the head of Lynn Canal, constitute the most important of these routes.

Thlinkit.

From Dixon Entrance northward, with the exception of certain small outlying colonies of the Haida on Prince-of-Wales Island, the

* Comparative Vocabularies of the Indian Tribes of British Columbia, 1884.

† Contributions to North American Ethnology, Vol. i.

Coast Indians are undoubted Thlinkit, forming a series of contiguous and more or less closely allied bands or tribes, between which the diversity in language is small. The inland Indians, on the contrary, belong to the great Tinné family. On the Stikine, as explained below, a certain overlapping of these two races has occurred; and to the north, the Tagish, a branch of the Thlinkit, extend a considerable distance inland into the basin of the Lewes, as now first ascertained. The interior Indians are collectively known on the coast as "Stick Indians," and the fact that this name is also applied to the Tagish, in consequence of their situation and habits being like those of the Tinné, explains the circumstance that they have heretofore been confounded with that people.

Tinné.

Respecting the Thlinkit of the coast I am unable to add anything of value to what has already been published. In what follows regarding the inland Indians, the several tribes are taken up in the order in which they were met with on our line of travel.

The region included between the Coast Ranges and the Rocky Mountains, to the south of that here reported on, and in which are the head-waters of the Skeena, Fraser and Peace rivers, is inhabited by two great divisions of the Tinné people, designated on the map before referred to, as Takulli and Sikani. These main divisions comprise a large number of small tribes or septs. Since the publication of the map, I have ascertained that these divisions are known to the people themselves as Tah-khl and Al-ta'-tin respectively. The division of the Tinné met with on ascending the Stikine is named Tahl-tan, and consists of the Tahl-tan people proper and the Taku. These Indians speak a language very similar to that of the Al-ta'-tin, if not nearly identical with it, and, so far as I have been able to learn, might almost be regarded as forming an extension of the same division. They appear to be less closely allied by language to the Kaska, with which people they are contiguous to the eastward.

Tahl-tan Indians.

Their territory.

The Indian village near the Tahl-tan or First North Fork of the Stikine, is the chief place of the Tahl-tan Indians, and here they all meet at certain seasons for feasting, speech-making and similar purposes. The Tahl-tan claim the hunting-grounds as far down the Stikine, coastward, as the mouth of the Iskoot River, together with all the tributaries of the Iskoot and some of the northern sources of the Nass, which interlock with these. Their territory also includes, to the south, all the head-waters of the main Stikine, with parts of adjacent northern branches of the Nass. Eastward it embraces Dease Lake, and goes as far down the Dease River as Eagle Creek, extending also to the west branch of the Black or Turnagain River. It includes also all the northern tributaries of the Stikine, and the Tahl-tan River to its sources.

Taku Indians.

The Taku form a somewhat distinct branch of the Tahl-tan, though they speak the same dialect. They are evidently the people referred to by Dall as the Tāh'-ko-tin'-neh.* They claim the whole drainage-basin of the Taku River, together with the upper portions of the streams which flow northward to the Lewes; while on the east their hunting-grounds extend to the Upper Liard River, and include the valleys of the tributary streams which join that river from the westward. They are thus bounded to the south by the Tahl-tan, to the west by the coast Taku (Thlinkit), to the north-west by the Tagish, and to the east by the Kaska.

Rights of coast and inland tribes.

The territorial claims of the Tahl-tan and Stikine Coast Indians (Thlinkit) overlapped in a very remarkable manner, for while, as above stated, the former hunt down the Stikine valley as far as the Iskoot, and even beyond that point, the latter claimed the salmon-fishery and berry-gathering grounds on all the streams which enter the Stikine between Shēk's Creek (four miles below Glenora) and Telegraph Creek, excepting the First South Fork, where there is no fishery. Their claim did not include Telegraph Creek nor any part of the main river; nor did it extend to the Clearwater River or to any of the tributaries lower down. In whatever manner the claim to these streams may have been acquired, the actual importance of them to the Coast Indians lay in the fact that the arid climate found immediately to the east of the Coast Ranges enabled them to dry salmon and berries for winter provision, which is scarcely possible in the humid atmosphere of the coast region.

The strict ideas entertained by the Indians here with respect to territorial rights is evidenced by the fact that the Indians from the mouth of the Nass, who have been in the habit of late years of coming in summer to work in the gold mines near Dease Lake, though they may kill beaver for food, are obliged to make over the skins of these animals to the local Indians. Thus, while no objection is made to either whites or foreign Indians killing game while travelling, trapping or hunting for skins is resented. In 1880 or 1881 two white men went down the Liard River some distance to spend the winter in trapping, but were never again seen, and there is strong circumstantial evidence to show that they were murdered by the local Indians there.

Trade between coast and interior.

On the Stikine, as in the case of other rivers and passes forming routes between the coast and the interior, the Coast tribes assumed the part of middle-men in trade, before the incursion of the miners broke up the old arrangements. The Stikine Indians allowed the Tahl-tan to trade only with them, receiving furs in exchange for goods obtained on the coast from the whites. The Tahl-tan, in turn, carried on a

* Contributions to North American Ethnology, vol. i.

similar trade with the Kaska, their next neighbors inland. The right to trade with the Tahl-tan was, in fact, restricted by hereditary custom to two or three families of the Stikine Coast Indians.

Houses. With the exception of the houses already referred to as constituting the Tahl-tan village, and some others reported to exist on the Taku, the residences and camps of these people are of a very temporary character, consisting of brush shelters or wigwams, when an ordinary cotton tent is not employed. We noticed on the Tahl-tan River a couple of square brush houses formed of poles interlaced with leafy branches. These were used during the salmon-fishing season. At the same place there were several graves, consisting of wooden boxes or small dog-kennel-like erections of wood, and near them two or three wooden monumental posts, rudely shaped into ornamental (?) forms by means of an axe, and daubed with red ochre.

Chief's name. On attaining the chieftaincy of the Tahl-tan tribe, each chief assumes the traditional name Na-nook, in the same manner in which the chief of the Coast Indians at the mouth of the Stikine is always named Shēk or Shake.

Superstitions. The Tahl-tan Indians know of the culture- or creation-hero Us-tas, and relate tales concerning this mythical individual resembling those found among the Tinné tribes further south, but I was unable to commit any of these to writing. Amongst many other superstitions, they have one referring to a wild man of gigantic stature and supernatural powers, who is now and then to be found roaming about in the summer season. He is supposed to haunt specially the vicinity of the Iskoot River, and the Indians are much afraid of meeting him.

Character of wars. Between the Tahl-tan and the Indians inhabiting the Upper Nass* there has been a feud of long duration, which is even yet outstanding. There is much difficulty in settling such feuds when life has once been sacrificed, as they assume the character of a vendetta, a strict account being kept, which must be balanced by the killing of an equal number on each side before lasting peace is possible. The account of the feud here referred to is derived from Mr. J. C. Callbreath, who has been at some pains to ascertain the circumstances. It may serve to illustrate the nature of the intertribal "wars" carried on in the sparsely inhabited region of the interior.

* We are unfortunately without precise information as to the tribal divisions of the Indians of the Nass. According to the late Dr. Tolmie, who had long resided at Fort Simpson, in the vicinity of the Nass, the people about the mouth of the river are named Niska (sometimes written Naskar), while further up the river are the Nitawālik (Tinné?). (Comparative Vocabularies, p. 113 B.) It is probably the people so designated who come in contact with the Tahl-tan, but in the meantime I prefer to call them merely Nass Indians. The statement above quoted, however, does not tally with that made to G. Gibbs by Celestine Ozier, a Tshimsian half-breed, *i.e.*, that to the northward of the tribe inhabiting the Nass was a tribe named Nis-kah. (Contributions to North American Ethnology, vol. i, p. 143.)

Feud between Tahl-tan and Nass.

For a long period preceding 1856 there had been peace between the Tahl-tan and Nass Indians, but in or about that year the latter, following up one of the branches of the Nass River into Tahl-tan territory, killed two individuals of that tribe, who happened to be men of importance. Two or three years later, the Tahl-tan found an opportunity of killing in retaliation four of the Nass. In 1861, the year preceding the first gold excitement on the Stikine, a peace having been meanwhile concluded, the Nass Indians induced some of the Tahl-tan to visit them in their own country, a short distance from the recognized boundary, at a place named Yak-whik, which is the furthest up fishery of the Nass Indians, and at which they have a large house. The Nass people then persuaded two of the Tahl-tan men to return some distance into the Tahl-tan country, ostensibly that they might bring their friends to engage in a peace talk and dance, two of the Nass Indians accompanying them. The Nass, however, killed both Tahl-tan Indians the first night out, and then turned back. When they arrived at the house, the remaining Tahl-tan men were killed and their women (seven in number) and children (three boys) were made prisoners. Two of the women, with one of the boys, however, escaped and eventually found their way back to their friends. Another of the women was afterwards brought up the Stikine and redeemed by her people. Two more have since died in the Nass country, and one still remains there as a slave. The last event in connection with this feud occurred in 1863 or 1864, when the Tahl-tans raided into the Nass country and waylaid a man and woman with three children. The adults, with two of the children, were left for dead, but the man afterwards recovered consciousness and managed to get home. One of the children was not harmed and has since grown to manhood, and is known to be meditating revenge on the Tahl-tan people.

Notes on the Tahl-tan Indians by Mr. J. C. Callbreath.

The following account of the principal characteristics of the Tahl-tan Indians has been kindly drawn up at my request by Mr. J. C. Callbreath, who has spent many years among these people. The general order followed is that of the Circular of Enquiry issued by the Committee of the British Association on the North-western tribes of the Dominion of Canada. In transcribing Mr. Callbreath's notes some unimportant verbal alterations only have been made.

Measurements.

Maximum stature about 5 feet 7½ inches. Maximum girth about the chest 37 inches. Legs and thighs well muscled. Arms rather light. As a rule full chested. Heads, unlike the coast tribes, small. Feet and hands generally small, as are also the wrist and ankle, especially

in the women. We sell more No. 2 women's and No. 6 men's shoes than any other size [representing a length from toe to heel of 8⅝ inches and 10 inches respectively]. In hats for the Indian trade we take nothing above No. 7 [equal to circumference of 22 inches].

The trunk is generally long and the legs short,—the former nearly always straight, with small waist and broad hips, the latter usually curved or crooked, a circumstance which appears to be due to too early walking and carrying packs by the children. Brain-capacity small, head round, forehead low and bulging immediately above the eyes, but generally broad.

Half-breeds. The half-breeds are more like the father, and three generations where the father is in every case white, seem to obliterate all trace of Indian blood. If the case were reversed and the male parent in all cases an Indian, the result might be different. Have never seen or heard of an

Diseases. albino among them. Their most common ailments are pulmonary consumption and indigestion. The former caused by careless and unnecessary exposure, the latter by gorging and drinking at their periodical feasts. They have other diseases peculiar to themselves, induced, as I believe, by imagination or through fear of the medicine-men or witches.

Acuteness of senses. Their acuteness of sight, hearing and smell are great, but I do not believe racial. Practise and training as hunters, render them proficient in these respects. Their eyes fail early, and are even more liable to disease than those of whites. It is rare to meet a man of fifty among them with sound eyes. Snow and sun together, with smoky dwellings, probably explain this. The children are cunning and clever when young, more so than those of the white race, but grow dull as they age.

Language. I have never seen anything like gesture-language among them, and will not attempt a description of their common tongue, except to say that I can see no similarity in it to that of the Chinese, with whom I have had intercourse to a considerable extent for the past forty years.

Stone implements. They reckon time by moons, and now seem to rely more on what the whites may tell them as to the coming of winter or spring, than on their own knowledge. The stone age is now scarcely more than a tradition, though they know of the time when they had no iron, axes, knives, guns or the like. Stone knives, adzes, and sledges or hammers, have been found by the miners from time to time, and it is said that the sledges were used for killing slaves on certain occasions, as well as for braining bears in their hibernating dens.

Weaving. I cannot learn that these Indians ever used copper before its introduction by the whites. Yarn is spun from the wool of the mountain goat (not the mountain sheep or big-horn) and is woven into excellent

blankets which are highly coloured and ornamented. The process of boiling water with hot stones in baskets or wooden bowls was formerly common.

The dances of the Tahl-tan are tame affairs compared with those of the Coast tribes. Masks representing birds or bears are sometimes worn on these occasions. Their musical propensities and capabilities are, however, considerable. In their dances they use the common Indian drum, known all over the continent. No athletic games are practised. Kinship, so far as marriage or inheritance of property goes, is with the mother exclusively, and the father is not considered a relative by blood. At his death his children inherit none of his property, which all goes to the relatives on his mother's side. Even though a man's father or his children might be starving, they would get none of his property at his death. I have known an instance where a rich Indian would not go out or even contribute to send others out to search for his aged and blind father who was lost and starving in the mountains. Not counting his father as a relative, he said,—"Let his people go and search for him." Yet this man was an over-average good Indian. They seem to have no inherent good qualities which will overcome the vicious and unnatural rules and customs of their tribe. Although the son thus, in many cases, seems to have no regard for his father, the latter generally has a parent's love for the son, and desires to see him do well.

Dances. Kinship.

The whole tribe is divided into two casts, *Birds* and *Bears*. A man who is a Bird must marry a Bear and his children belong to the Birds, but the Bears, his mother's people, inherit all his effects. The right to hunting-grounds is inherited. A Bear marrying a Bird may go to the Birds hunting-ground, that is to the hunting-ground belonging to the particular family of Birds into which he has married, or he may stay on his own hunting-ground belonging to his particular Bear family, which he inherited from his mother. His children, however, by his Bird wife or wives, after becoming adult, cannot resort to his hunting-ground. His children, both male and female, being Birds, must marry Bears. They might, if males, marry his full sister, who being a Bear is not counted a relative, and thus, through her, inherit a right to her father's old hunting-ground. In some cases, when such proprietary rights are valuable, and the father is anxious that his son should be able to claim the old homestead or hunting-ground, such an arrangement is made. The son may be eighteen and his father's sister (his aunt) may be fifty, but such disparity in age is of no consequence at all. The son's wish is to secure his title. He may forthwith take another young wife to please his fancy.

Totems.

Marriage.

A man's female children are as much his property as his gun and he sells them to whom he pleases without consulting their feelings at all. The vendor sometimes gets his pay at once, sometimes by installments, and if the installments are not paid, he may take back his daughter with her children as well. If, however, the husband pays for his wife in full, the vendor is held strictly to his bargain in respect to supplying a wife, and should the first die and he have any more eligible daughters, one of these must take her place, and that without any additional compulsory payment. Thus, for instance, a man of fifty may buy a young wife of fifteen (a not uncommon occurrence) and pay for her in full. Ten years afterward the young wife may die, and if there be another unsold sister, that sister, according to their laws, must take her place without any compensation, unless it be voluntary. The husband always evinces a high regard for his wife's parents and never tires, if able to do so, of making them presents.

Chieftaincy.

A chief's son has no right to his father's title or any claim to rule by virtue of his being the son of the chief, although the tribe may choose him as their chief. A chief's brother (full or half) or his sister's child, is the legal heir, but his right must be sanctioned by a majority of the tribe, and the office frequently passes to whoever has most property to give away.

Customs and laws.

All the Indians are very miserly, and they often go hungry and naked for the purpose of saving up blankets, guns, etc., with which to make a grand "potlatch" (donation feast) to their friends. This secures them consideration and a position in the tribe. Practically very few of the men have more than a single wife. When a man has two wives, the younger, if she be sound and lively, is the head. Separation and divorce is easy and requires no formal act, but if a man should send away his wife, on whose hunting-grounds he may have been staying, he must leave her inherited hunting-ground, unless he has another wife who has a right to the same ground. These hunting grounds are extensive and are often possessed in common by several families.

The laws are based on the principle that any crime may be condoned by a money payment. If a man should kill another, he or his friends must pay for the dead man—otherwise he himself or one of his friends must be killed to balance the account.

The vicious and unnatural practices of these people appear to be traceable in all cases to the teaching of their medicine-men or witches, in whom they believe implicitly. Their religious belief was simply what their medicine-men might lay down for them from time to time, the idea of a Supreme Being, being very obscure, if not altogether wanting.

They have no war chiefs, and I cannot find that they ever had a general war with any other tribe. Some families have had and are yet having trouble with families of other tribes whom they claim encroach on their hunting-grounds. These families fight it out among themselves by waylaying and murdering each other, but there it ends without producing any inter-tribal war. Wars.

Gratitude and charity seem to be foreign to the natures of these people. A man often gives away all he has to his friends, but it is for purposes of personal aggrandizement, and his father, mother or sister may be sick, freezing or starving within sound of his voice. His presents bestowed upon those who are strong and above want bring him distinction, which is his only object. The young Indians are, however, more humane and charitable than the aged. Manners and traits.

The Tahl-tan Indians have no totem-poles, although they preserve the family lines, and observe them as strictly as do the salt-water tribes. They have no fear of death except from dread of the pain of dying, and this is very much lessened if they have plenty of goods to leave to their friends. They are very stoical, and not emotional, in any sense. I have never seen one of them tremble or quake with fear or anger. There is a belief propagated by their medicine-men or witches that the otter gets inside of their women and remains there until death, sometimes causing death by a lingering illness unlike anything I have ever seen, in other cases allowing the woman to live on till she dies from some other cause.

The name Kaska (from which that of the district Cassiar is derived*) is applied collectively to two tribes or bands occupying the country to the eastward of the Tahl-tan. I was unable to learn that this name is recognized by these Indians themselves, and it may be, as is often the case with names adopted by the whites, merely that by which they are known to some adjacent tribe. It is, however, a convenient designation for the group having a common dialect. This dialect is different from that of the Tahl-tan, but the two peoples are mutually intelligible and to some extent intermarried. The Kaska are still more closely allied by language and marriage to the Indians of the Lower Liard, who are commonly referred to as the "Hudson Bay Indians," from the circumstance that they trade with that company. Practically the whole of the Kaska trade either at McDame Creek or at the little outpost at the mouth of the Dease. The entire number of Indians re- Kaska Indians.

* Mr. J. W. McKay states, in answer to a question addressed to him on that subject, that Cassiar is a corrupt spelling of the word Kaska. Mr. McKay further adds that he has a suspicion that the word Kaska is connected with that *kaska-met* used by the Stuart Lake Indians to designate dried beaver meat, though he has been unable to confirm this.

sorting to the first named place is 70. That at the mouth of the Dease 94, made up of 23 men, 18 women, and 53 children. The aggregate number of the Kaska, who inhabit a vast territory, is thus very small.

Boundaries. To the westward, the Kaska are bounded by the Tahl-tan. They hunt over the country which drains to the Dease east of McDame Creek; but north of the sources of streams reaching the Dease, they wander seldom, if at all, to the west of the Upper Liard. They also hunt over the basin of the Black or Turnagain River, southward, but not to the head-waters of that stream, as the country there is claimed by the Al-ta'-tin ("Siccanie") of Bear Lake region, who have lately returned to it after having abandoned it for a number of years. Eastward they claim the country down the Liard to the site of Old Fort Halkett, and northward roam to the head of a long river (probably Smith River) which falls into the Liard near this place, also up the Upper Liard as far as Frances Lake, though it would appear that not till recent years have they ventured so far in that direction.

Composed of two tribes. The two cognate tribes here referred to collectively as the Kaska are named respectively, by themselves, Sa-zē-oo-ti-na and Ti-tsho-tī-na. The first occupy the corner between the Liard and Dease, above referred to, as well as the country southward on Black River, where they meet the Bear Lake Indians, named by them Sat-e-loo'-ne. The Ti-tsho-tī-na claim the remaining eastern half of the Kaska country, and call the Indians further down the Liard, below Fort Halkett, A-tsho-to-tī-na.* These are no doubt the tribes referred to by Dall (following a manuscript map by Mr. Ross, of the Hudson Bay Company) as the Achē'-to-tin'-neh and Dābo'-tenā' respectively.† The latter are, however, I believe, distinct from the "Siccanie" or Al-ta'-tin proper. The number stated for the Indians trading at the mouth of the Dease, probably includes some individuals properly referable to the tribe just mentioned. The Indians from Pelly River also sometimes come to the same place to trade, but are not included in the enumeration, and occasionally a few Taku or Tagish wander so far, following the trail eastward from Lake Marsh on the Lewes.‡

Names of the tribes. The Ti-tsho-tī-na call the Pelly River people Ta-koos-oo-ti-na and designate those beyond there again by the term Ai-ya'-na.

Characteristics. The Kaska have the reputation of being a very timid people, and they are rather undersized and have a poor physique. They are lazy and untrustworthy. We met practically the entire tribe of the Ti-

* Erèttchi-ottinè or Ndu-tchô-ottinè (?) of Petitot in Bul. Soc. Geog., 1875.

† Contributions to North American Ethnology, vol. i.

‡ Mr. Campbell, in answer to my enquiries, states that there were no leading tribes, under chiefs, in his time on the Upper Liard, but scattered family bands only. These included the "Bastard" tribe or family, the "Thlo-co-chassies" and the "Nahanies of the Mountains," the last-named trading indifferently on either side of the mountains, but being quite a different race from the Nahanies of the Stikine (Tahl-tan).

tsho-tī-na at the little post at the mouth of the Dease, and their curiosity proved to be very embarrasing. Mr. Egnell, who was in charge of the post, excused it by explaining that they had never seen so many Whites together before, the number being nine in all, including our party, Mr. Egnell himself and Mr. McDonald, of the Hudson Bay Company. Of these Indians, only two had been as far west as Dease Lake, and none had ever seen the sea. They are, however, fairly well off, as their country yields abundance of good furs. They visit the trading post only once in the course of the year, spending the remainder of their time moving from camp to camp in isolated little family parties, hunting and trapping; each one traversing a very great extent of country in the course of the twelve months. Some of their traps or household goods are packed on dogs, but the greater part of their impedimenta is carried by themselves on their backs, canoes being seldom employed. Rivers and lakes are crossed in summer by rafts made for the occasion. They generally bring in only the fine furs, as bear-skins and common furs are too heavy to transport. They evidenced great curiosity with regard to our equipment, being particularly struck by a canvas boat and an air pillow. These and other objects, I have no doubt, furnished subjects of conversation round many camp fires for the ensuing year. Migrations.

The Kaska form a portion of the group of tribes often referred to by the Hudson Bay Company's people as the Nahanie or Nahaunie, and so classed collectively by Dall in the absence of more definite information.*

For the northern district, drained by the Pelly, Stewart and other rivers, I am unfortunately unable to give much detailed information respecting the Indians, a circumstance due to the fact that we scarcely met any of these Indians, nor did we proceed far enough down the main river to meet the traders, from whom something might doubtless have been obtained. Indians of northern district.

The name of the Indian tribe inhabiting the Upper Pelly valley was given to me by the Indians at the mouth of the Dease as Ta-koos-oo-ti-na, by Indians met by us near the site of Fort Selkirk as Na-ai'. The territory of this tribe includes also the basin of the Macmillan and that of the Stewart as far down as the mouth of the Beaver, or "First North Fork," a very extensive region. I believe, however, that the names above noted either refer to local sub-divisions of the tribe, or are terms applied to them by neighbouring tribes and not recognized by themselves. Dall in his article already cited (following Ross) gives Abbăto-tenā' as the name of a tribe inhabiting the Upper Pelly and Macmillan, while Petitot places the name Esbá-ta-otinnè in the same Indians of Upper Pelly.

* *Op. Cit.*

region. Campbell again states that the Indians met by him on the Pelly were "Knife Indians," and I think there can be very little doubt that the true name of this tribe is Es-pā-to-ti-na, formed by the combination of the word Es-pā-zah (meaning knife in the neighbouring Kaska language) and ti-na. This is again evidently the same with the name rendered to me as Spo-to-ti-na by a trader in Cassiar and said by him, to be a Kaska name for the tribe to the north of their country.

From the Indians above mentioned as having been met with at the site of Fort Selkirk, who were travelling with miners, the following information was obtained:—

Tribes below Fort Selkirk.

A tribe or band named Klo-a-tsul-tshik' (-otin ?) range from Rink Rapid and its vicinity on the Lewes to the head of the east branch of White River, where they go at the salmon-fishing season. These people probably also range down the river as far as the mouth of the Lewes, or further. They are the Gens des Bois or Wood Indians of the fur-traders. It will be observed that their name does not terminate in the usual way, but of this no explanation could be obtained.*

The To-tshik-o-tin are said to live about the mouth of Stewart River, and to extend up the Stewart as far as the Beaver River, meeting there the Es-pā-to-ti-na to whom they are or were hostile. They are no doubt the Tutchone-kutchin of Dall's map.

Near the mouth of Forty-mile Creek are the Tsit-o-klin-otin and a short distance below this point on the river, so I was informed, is a tribe named Ka-tshik-o-tin. These were said to be followed by the Ai-yan', below which come the O-til'-tin, the last tribe occupying the vicinity of the mouth of the Porcupine and extending some way up that river.

It was further stated that the people of the above mentioned tribes, with others, making seven in all, were collectively classed as Ai-yan'. This agrees sufficiently closely with the name Ai-ya'-na, given to me as a general name of Indians beyond those of the Pelly River by those found at the mouth of the Dease.

Number.

According to Schwatka the entire number of Indians along the main river from the mouth of the Lewes to the Porcupine is about 250. I can make nothing, however, of the local names given by him, with respect to which indeed he appears to have been himself in doubt.

The Indians inhabiting the whole basin of Peel River, were said, by my informants at Fort Selkirk, to be named Sa-to-tin. A tribe named

* Mr. Campbell informs me that in his time while a very few families of the "Knife Indians" inhabited the region of the Upper Pelly, the Indians were very numerous and divided into bands, under chiefs, along the river from Fort Selkirk to Fort Yukon. The "Wood Indians" numbered several hundreds. Below them on the river were the "Ayonais" as well as other tribes, of which Mr. Campbell was unable to learn the names.

San-to-tin′ was further said to occupy the territory about a lake on White River and westward to extend down the Tanana River to a point nearly opposite the head of Forty-mile Creek. Below this people, on the Tanana come the Sa-tshi-o-tin′ or "Bear Indians," Lieut. Allan* gives the names of tribes or bands along the Tanana, from its head down (though on doubtful authority) as Nutzotin, Mantototin, Tolwatin, Clatchotin, Hautlatin, the second and fourth of which seem to represent the names given to me. Tanana River Indians.

From the above information, such as it is, I think it probable that the Ai-ya′-na or Ai-yan people may be said to consist of the following tribes: Klo-a-tsul-tshik, To-tshik-o-tin, Tsit-o-klin-o-tin, Ka-tshik-o-tin, O-til′-tin, San-to-tin, and Sa-tshi-o-tin′. The name Ai-yan may be that of a premier tribe or of a meeting place common to the various tribes. The Ai-ya′-na would thus extend from the lower part of the Lewes to the mouth of the Porcupine, and include the basin of White River, together with the greater part or all of that of the Tanana. Conclusions.

The term Kutchin as a general suffix to the names of tribes, replacing *tinné*, *tina* or *otin* has, I believe, been carried much too far westward in this region on ethnological maps, being properly referable only to certain tribes situated to the north of the Ai-ya′-na and Es-pā-to-ti-na and lying between these and the Eskimo. Docking off this gratuitous termination from the names Han-kutchin and Tenăn′-kutchin applied as tribal names by Dall on the main river above the mouth of the Porcupine and along the Tanana River respectively; we may, with some probability, consider Han and Tenan as versions of Ai-yan. Differences such as this and others previously referred to in the rendering of Indian words—which are never clearly pronounced by the people themselves—are, as I think any one who has had some experience in endeavouring to reduce them to writing will admit, very easily explained. "Kutchin."

A grave was seen on the Upper Pelly, near the mouth of the Macmillan and others near the site of Fort Selkirk. There were the usual coffin-boxes, surrounded by pickets, and near them tall poles were set up, bearing streamers of cloth. Graves.

The Tagish Indians, occupy the greater part of the valley of the Lewes above the mouth of the Tes-lin-too, as well as the last-named river as far as to its efflux from Tes-lin Lake, the lake itself being in the Taku country. To the Tagish belong the group of lakes of which Tagish-ai or Tagish Lake is the principal. They may be said to be separated from the coast tribes by the water-shed ridge of the Coast Mountains on Chilkoot Pass, though the line of division is not apparently well drawn, and they likewise probably reach the head- Tagish Indians.

* Report of an Expedition to the Copper, Tanana and Koyukuk Rivers, etc., 1887.

Territory.

waters of the Tahk-heena branch of the Lewes. The name of this stream evidently means Tagish River, and though I follow the usual orthography, this is incorrect. The precise line of demarcation between this tribe and the Taku, in the valley which connects A-tlin Lake with the Taku River, is not known. One of the Tagish people informed me that they claim also the head-waters of the Big Salmon River, and Lieut. Schwatka (who calls these people Tahk-heesh) in his report mentions having found some of them temporarily in occupation of a spot not far above the mouth of the Lewes. I believe, however, that this party may have been merely on a trading expedition and feel doubtful also of their extension to the Salmon, unless temporarily on some such errand. Their principal place is upon the short reach of river connecting Tagish Lake with Lake Marsh, where two rough wooden houses, somewhat resembling those of the Coast Indians, are situated. Here the greater part of the tribe congregates during the winter.

Position and relations.

So far as I was able to judge, the Tagish in their mode of life and habits are identical with the Tinné Indians. They are classed with those as "Stick Indians," by the coast tribes, and have been assumed to be Tinné, but their language very clearly shows that they are in reality a Thlinkit people. Most of their words are either identical or very nearly so with those of the Thlinkit, while a few appear to resemble those of the Tinné. Till of late, they have been effectually dominated by the Chilkats and Chilkoots of Lynn Canal and have thus been kept poor both in goods and in spirit. From time immemorial they have been in the position of intermediaries in trade between the Coast and the Tinné Indians, without being sufficiently strong to levy a toll. On the question as to whether the blending of characteristics which they appear to show physically, as well as in other respects, has resulted only from intermingling of the two peoples, or may be regarded as preserving evidence of the actual derivation of the Thlinket from the Tinné, or its converse, I can offer no definite opinion. The question is, however, a very interesting one for further investigation, and may eventually throw light on the connection between these peoples, first, I believe, pointed out by my friend, the late Dr. W. F. Tolmie.*

Number.

The Tagish tribe is a very small one, and includes about fifteen families only, all told,—representing possibly seventy or eighty individuals. Their snow-shoes, together with their travelling and hunting equipment generally and their mode of camping, are identical with those of the Tinné, so far as I was able to observe.

* Comparative Vocabularies of the Indian Tribes of British Columbia.

At the lower end of Lake Marsh we found several graves which, no doubt, belonged to the Tagish. One was a small tent-shaped erection covered with calico, another a box wrapped in spruce bark and piled round with neatly cut pieces of wood and logs, held in place by pickets. A third, a similar box, on which billets of wood and finally rough branches and rubbish had been piled. The boxes were too small to contain the corpses of adults, even if placed in the constrained posture usual to Indians, and as the ground beneath and around each of the deposits was thoroughly burnt, it appeared quite possible that the bodies had been cremated and the ashes only coffined. Graves.

Respecting the Chilkat and the Chilkoot tribes of Lynn Canal, I can add little or nothing to what is already known. Lieut. Schwatka, in his report already referred to, speaks of these people as constituting divisions of a single tribe under the general name of Chilkat. They are certainly very closely allied, though in times past they have not always been at amity. Schwatka further states that "the Chilkats, proper, have three permanent villages, which are situated in the immediate neighbourhood of Pyramid Harbour, and at no great distance from each other. The Chilkoots, the other division of the tribe, have one village, situated permanently in the Chilkoot Inlet." These people are of course, in all respects, typical Thlinkit. They number, in all, according to Lieut. Symons, U.S.N., 981. Schwatka says they call the Tagish, in some connection, Si-him-e-na. Chilkat and Chilkoot Indians.

Mr. J. C. P. De Krafft* says that he was informed of the Chilkat, Chilkoot and neighbouring interior tribes, that they are all of the general classification Thlinkit, and name the whole region inhabited by them Kunana, the inhabitants Kunaäni. That one group of tribes named Alitch (being their name for people) consists of six small tribes viz.: Tagesh (living nearest the coast), Kluhtane, Netlatsin, Tahtlin, Klukha, and Tahho. Of the above names, most are recognisable as those of places in the Tagish country, and they may refer to the hunting-grounds of various families, but there is evidently some confusion respecting the names, which are quoted here chiefly with the object of suggesting further enquiry.

The subjoined table, giving a census of the Indian population of the Mackenzie River District, and including the Yukon region so far as known to the Hudson Bay Company in 1858, is of interest, as showing the tribal sub-divisions as recognized by the Company, and as throwing some light on the questions discussed above. The table is due to the late Chief Factor, James Anderson, and has been communicated to me through the kindness of his son. Hudson Bay Company's census.

* U. S. Senate Doc. 1 Session, 47th Congress, vol. iv, p. 100.

	Married.		Adults.		Children.		Total.		Total Males and Females.	
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.		
Fort Simpson and Big Island.										
Slaves, Dog Ribs and Hares.	124	129	96	20	159	130	379	279	658	
Nahanies	13	14	35	....	12	13	60	27	87	—745
Fort Rae.										
Dog Ribs and a few Slaves and Yellow Knives	123	131	91	25	145	142	359	298	657	—657
Peel R. and La Pierre's House.										
Loucheux (Koochin). A few Esquimaux occasional visitors.	81	92	21	7	83	53	185	152	337	—337
Yukon.										
Loucheux of six tribes. These are all that resort to the fort.	135	156	121	75	218	137	474	368	842	—842
Fort Liard.										
Slaves	45	47	38	14	84	53	167	114	281	
Sicannies or Thicannies	12	16	7	....	16	27	35	43	78	
Nahanies	9	9	2	....	11	7	22	16	38	—397
Fort Resolution.										
Chipewyans and Yellow Knives, with a few Dog Ribs and Slaves	98	149	....	....	119	103	217	252	469	—469
Fort Good Hope.										
Hare Indians	76	78	68	23	80	39	224	140	364	
Loucheux and Batard Loucheux	23	22	18	3	17	12	58	37	95	
Nahanies	1	1	3	3	....	....	4	4	8	—467
Fort Norman.										
Slaves	19	19	10	2	20	14	49	35	84	
Hares	23	25	17	....	27	11	67	36	103	
Dog Ribs	22	24	21	9	28	29	71	62	133	
Nahanies	8	9	....	....	18	8	26	17	43	—363

	Married.		Adults.		Children.		Total.			
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Total Males and Females.	
Fort Halkett.										
Sicannies or Thicannies.....	17	19	7	5	14	11	38	35	73	
Mauvais Monde, Batard Nahannies and Mountain Indians. All tribes of Nahannies	63	63	19	9	57	48	139	120	259	—332
										4609
RECAPITULATION.										
Slaves, Dog Ribs, Chipewyans and Yellow Knives, who are all of the same race, and speak — with slight variations — the same dialect of the Chipewyan language.....	530	602	341	93	662	521	1533	1216	2749	
Nahanies or Mountain Indians, who speak a very corrupt dialect of the Chipewyan	94	96	59	12	98	76	251	184	435	
Sicannies or Thicannies, who also speak a dialect of the Chipewyan language	29	35	14	5	30	38	73	78	151	
Loucheux or Koochin and Batard Loucheux (half Hare, half Loucheux). Only some words of this language are understood by the Slaves	239	270	160	85	318	202	717	557	1274	
	892	1003	574	195	1108	837	2574	2035	4609	

SHORT VOCABULARIES OF THE TAHL-TAN, TI-TSHO-TI-NA, AND TA-GISH OBTAINED IN 1887.

The alphabet employed is identical with that of the "Comparative Vocabularies of the Indian Tribes of British Columbia," and is as follows:—

Vowels.

a	as in	English	*fat.*
ā	"	"	*father.*
e	"	"	*met.*
ē	"	"	*they.*
i	"	"	*pin.*
ī	"	"	*marine.*
o	"	"	*pot.*
ō	"	"	*go, show.*
u	"	"	*nut, but.*
y	"	"	*year.*
ai	"	"	*aisle.*
ei	"	"	*vein.*
oo	"	"	*pool, fool.*
eu	"	French	*peu* (seldom used).
ow	"	English	*now.*

The distinction of long and short vowels (following Gibbs) is noted as far as possible, by the division into syllables,—the consonant that follows a vowel being joined immediately to one intended to be pronounced short, while a long vowel is left open, being followed by a hyphen. When this is insufficient, or a nicer distinction is desirable, the usual long and short marks are supplied.

Explosive or klicking sounds are represented by the letters *k*, *t*, etc., in combination with an apostrophe, thus—*'k 't*.

An acute accent (') at the end of a syllable indicates its accentuated character, when this is very distinct. In some cases certain syllables are run very hurriedly over and almost whispered, and though really forming a part of the word, might easily be omitted by a careless listener. Where this has been noted it is indicated by the use of smaller type. Strongly guttural syllables are printed in small capitals, thus,—*law*-KH. A nasal sound is denoted by a small letter above the line, thus—^{n}.

ENGLISH.	TAHL-TAN.	TI-TSHO-TĪ-NA.	TA-GISH.
Man	den′-e	skel-ē′-nă	tah-kā′-ne
Woman	e-ga-tēn′	is-tshī-yong	ug uh-tē′-na
Boy	etō-nē′	is-tshī′-ma	too-nī′-na
Girl	'tē′-da	is-too′-ā	ti-tshoo-tlug′-a-tē-na (*little woman*)
Infant	——	——	is-too′-ā
My father	e-te′-uh	a-ta′-a	e-tāh′
My mother	e-tlī	en-ā′	ah-mā′
My husband	es-kuh-lē′-na	sine-ske-lē- nă	uh-hoh′
My wife	es-tsi-yā′-na	sine-is-tshī-yong	us-sa-wut-tē
My son	es-tshī-me	sine-is-tshī′-ma	uh-hī-yit′-e
My daughter	es-too′-eh	sine-is-too′-ā	——
My elder brother	es-tī-uh	kut-ē′-uh	——
My younger brother	es-tshīt′-le	ē-tshī′ala	——
My elder sister	e-tā′-ta	a-tad-ē	——
My younger sister	es-tē′-juh	a-tad′-zuh	——
An Indian	dī-den′-e	den′-uh	tshut-lēk′
Head	es-'tsī	es-sē′	ka-suh
Hair	es-tsī-gā′	es-tsē-ga′	ka-sha-hā-oo
Face	es-snē	es-enē′	ka-guh′
Forehead	es-tsē′-ga	es-tsī′-ge	ka-kok′
Ear	es-thēs′-botl	sus-pā′-luh	ka-kook′
Eye	es-tā′	es-tā′	ka-wok
Nose	es-tshi′	es-tsī	ka-tlooh
Mouth	es-sāt′-a	es-zā-de	'kōh
Tongue	es-sā′	es-zā-de	ka-tloot′
Teeth	es-gooh′	es-čyuh′	ka-ōh′
Beard	es-stane′-GUH	es-ton-o-kh′	ka-kuh-tad-zai′
Neck	es-kōs′	es-'kōs	ka-hloo-tih′
Arm	es-sī-tluh	es-kā′-nuh	ka-tshīn
Hand	es-sluh′	es-sitā′	ka-tshīn
Fingers	es-sluh′ *or* slus-sē-guh	es-sitā′	ka-tlē-uk
Thumb	slus-tshō′	slas-tshō′	ka-koosh′
Little finger	slus-tshed′-le	——	——
Nails	is-lā-gun′-a	sla-kun-ā′	ka-hakwh
Body	es-hīa′	es-zī′	ka-kē-sin′
Chest	es-tshān	es-tzong	ka-hāt-ka′
Belly	es-bēt	es-pēt	ka-yoo-kuh′
Female breasts	ma-tō′-ja	es-tō′-ja	too-tlā
Leg	es-tsēn-a	es-tsut′-za	kā-kud′-ze
Foot	es-kuh′	es-'kiā′	ka-kōs
Toes	es-kus-tshō′ (*probably great toe*)	es-kuh-gau′-da′	ka-tlē-uk
Bone	es-tsen′	es-tsun′-uh	tsāk

ENGLISH.	TAHL-TAN.	TI-TSHO-TĪ-NA.	TA-GISH.
Heart	es-tshēa′	es-tzi-ā	ka-teh′
Blood	e-ted-luh	e-til-uh′	sheh
Village	kē-yē′	kon′-a	ai-ē-i-tī (?)
Chief	tin-ti′-na	tin-a-tē′-yuh	an-kow′
Warrior	e-ted′-etsha	——	——
Friend	es-tsīn-ē	sā-za	yu-keh′
House	kī-mah′	es-kon′-a	hīt
Brush wigwam	tso-la-hīt′	es-kon′-a	hīt
Kettle	'kōtl	sīoo-sā′-a	kī-sha′
Bow	des-ān	sī-te-uh′	tshoo-net′
Arrow	'k-ah	es-kā-ah	kā-kutl
Axe	tsī-tl	tsēntl	shin-a-whā
Knife	pēsh	es-pā-zuh	klī-ta
Canoe	ma-lā′-te	sa-la-ah′	yakw
Moccasins	e-tshil-e-kēh′ (*skin shoes*)	es-kuh′	tītl
Pipe	t′	es-tzil-e-kē′-duh	tsik-ta-kēt′
Tobacco	tsē-a-KH	tzid-a-too′-de	tsē-uk
Sky	ya-za	kōs	tik-kī′
Sun	tshā	sā	ka-kun′
Moon	——	sā	itl-tīs′
Star	SUHM	sun	kwat-a-hin-a-ha
Day	zeu-ēs	do-te-dzuh	ha
Daylight	yē-kā′	——	——
Night	ih-klē-guh	kla-klē-ge	tāt
Morning	tshut-tshaw-tlunē′	e-klā-dzi	tsoo-tāt′
Evening	hīh-guh′	tlah-kā-ha'	hā′-nā
Spring	tā-nē′	ta-tuna-kā-ga	ya-kunē-tshatl′
Summer	klī-we-guh′	ī-pah	kus-sī-at′
Autumn	tā-tla′	——	yes'k
Winter	ih-ha-yēh	hat′-ya	——
Wind	it-tsī′	it-sī	nook
Thunder	it-ti-i-tshī′	it-tī-ji	in-dī-jeh′
Lightning	kun-ta-tsēl	kun-tā-tzil′	soon-tsha′-na
Rain	tshā′	tsha^{n}	tsoo
Snow	zus	zus	kliēt
Fire	kŏn	kun	'kān
Water	tsoo	too	hīn
Ice	ten^{n}	tun	't-īk
Earth, land	nēn	nin	hoo-tī-tluk
Sea	ē-ētlă	ē-ētla	ē-'tl
River	too-dēsă	ta-kā′-koo-tsho (*when large*) / too-za-za (*when small*)	hīn

ENGLISH.	TAHL-TAN.	TI-TSHO-TĪ-NA.	TA-GISH.
Lake	mēn	mēn	āh
Valley	tā-gōs′-ke	tsin-ī-tla	yīn-a-tlet′-ki
Prairie	'klo′-ga	a-tega	tshoo′-kun
Hill	tah	hi-za-za	shāh
Mountain	his-tsho	tsutl	——
Island	ta-ĕ-too-e	ta-dō-a	kā′-tuh
Stone, rock	tsē	tsa	tēh
Salt	ē-ētlă	——	ē-'tl
Iron	pes-te-zīn′	pē-zin	ki-ye′-tsuh
Forest	got-ĕ	——	shī-tī-hin-as (*many trees*)
Tree	tli-gē-gut′	tsoo	she-tlek′-as
Wood	tset-tsh-tsēlsh	tsutz	et-ka-whut′-ti
Leaf	e-tāne′	a-tōna	ke-ga-nĭ
Bark	ed-lā	se-tēd-za	a-hloo-nĭ
Grass	klōăh	klō-ye	tshoo′-kun
Pine	gā-za	——	kletl *or* kaon-sē
Cottonwood	——	——	tīe
Flesh, meat	e-tsēt′	a-tzun	tlī
Dog	klī	kli	kētl
Bear	shush	sus	hootz
Wolf	tshī-yō-ne	tshi-yō′-nuh	noos
Fox	nus-tsē′he	nis-tsā′	na-kat-sē
Deer	kīw-igana	——	——
Mountain-goat	——	——	tshen-oo
Mountain-sheep	——	——	tā-wēh′
Caribou	ō-tsī′	goo-dzi′	but-sīh′
Beaver	tshā	tsa	tsi-ge-di′
Rabbit, hare	guh	guh	kah
Fly	tsī-mēh	tso-tsa′	ka-kon-a-wit′-se
Mosquito	tsī	tsī-a	tā′-ka
Snake	——	——	ti-koo-too′-dă
Bird	tsī-mēh	tīh	koktl
Egg	ē-ga-zuh′	ē-ga′-zuh	et-kot′-ē
Feathers	tshōsh	met-tshōsa	a-kwat′-le
Wings	mī-ī-tsēne	me-tzon-a	e-ki′-je
Goose	gān-jeh	gun-tsha	ta-wuk
Duck (mallard)	too′-deh	too′-dah	ka-whw
Fish	klew′-eh	hloo′-ga	hat
Salmon	klew′-eh	gēs	tāh
Name	on-yēh	toon′-ya	——
White	ta-'kād′-le	ta-kud′-za	klē-tuh′-uh-tē
Black	ten-es-klā′-je	ten-as-kluz′-e	too′-teh
Red	te-tsī-je	a-tul-a′	ka-nuh′-e-te
Blue	te-tlesh′-te	det-līs-da	ta-tlin-suh
Yellow	tsīm′-tlet	ten-a-tsē-a	tsoo-yuh-uh-ta

ENGLISH.	TAHL-TAN.	TI-TSHO-TĪ-NA.	TA-GISH.
Green	(*same as yellow*)	tsud-a-da-tsō′	(*same as yellow*)
Great, large	e-tsho	ta-etshō	a-tlin′
Small, little	ta-a-tsed′-le	ta-tzille′	ti-tshoo-tluh′
Strong	na-tī-yi	nun-tī	hlī-tsin′
Old	es-tshān	sa-ā	yoo-got
Young	es-kī-uh	tī-too	yīs
Good	e-tī′-uh	e-tē′-uh	ya-kā′
Bad	tshā′-ta	koos-tsa′-tsa	kon-ai-a-oo
Dead	a-juh′	a-jah	yoo′-na
Alive	te-tshī′	goo-te′	kwa-gi-tī′
Cold	hos-tlī′	goos-tli *or* el-oo-goo	ye-tīk
Warm, hot	hos-sītl	a-te-zulle′	yoo-tli-tik
I	shī-ni	nin′-e	hat
Thou	nīn-e	sin′-e	me-eh
He	a-yī-ge	ī-ye	——
We	ta-hun′-e	——	——
Ye	kla′-tse	——	——
This	tī-te	di-di	——
That	a-yī-ge	ī-ye′	——
All	sē-tse	ta-tē-da	ut-la-kut
Many, much	oo-tla^{n}	nus-tlo^{n}	shi-a-te-hen′
Who	ma-dai-e	——	——
Far	nī-sā-te	goo-din-e-sat′	na-hlī
Near	hah′-ne	ha-nā	kwun-a-sī
Here	tīs-tsik	——	——
To-day	too′-ga	di-doo-den-e	ye-ki′-yi
Yesterday	kit-sō′-kuh	ta-tsho^{n}	tet-kuh
To-morrow	tsha-tshā′	ta-tshon	tsoo-tāt′
Yes	ēh	ho^{n}	a-huh
No	tī-wuh	in-too-uh	klēk
One	tlī-geh′	e-tle′-ga	tshut-lēk
Two	tla-kēh	hlek-et-e-ta′	tēh
Three	tā-tē′	ta-di-da	natz
Four	klen-teh′	hlen′-ta	ta-koon′
Five	klo-dlāe′	klo-la′	kī-tshin′
Six	na-slikē′	nod-sli′-ga	kle-doo-shuh′
Seven	na-sla-kēh′	nod-i-slik-a	tuh-a-doo-shuh′
Eight	na-stāe′	nos-ta-di-da′	natz-ka-doo-shuh′
Nine	na-sten-tēh′	nos-ī-slen-e-ta	koo-shok′
Ten	tso-snā′-ne	tis-ĕnō-go-anzi-tli-ga′	tshin-kat
Eleven	tso-snā′-ne-tes-liheh	tis-ĕnō-go-anzi-la-kut-e-tla	tshin-kat-ka-tlah′
Twelve	o-dis-lā-kēh′	tleh-gad-ih-no′	tshin-kat-ka-tēh

ENGLISH.	TAHL-TAN.	TI-TSHO-TĪ-NA.	TA-GISH.
Twenty	ten-tlā-dih-teh′	ta-tis-no	teh-tshin-kat
Thirty	ta-tsos-nan	tlen-tad-es-no	nats-tshin-kat
Forty	klon-ta-tsos-nan	klan-tad-es-no	ta-koon-tshin-kat
Fifty	tlo-tlāts-oos-nā-ne	hloo-lad-es-no	——
Sixty	na-stlik′-is-oos-nā-ne	no-sli-gi-tis-no	——
Seventy	na-slak-ets′-oos-nā-ne	no-sa-sla-kad-is-no	——
Eighty	na-stā-e-tsoos-nā-ne	no-de-tad-es-no	——
Ninety	na-stlin-tēs-oos-nā-ne	no-slan-tad-es-no	——
One hundred	klo-la-ten-ān-e-ta	tis-no-kin-e-ta′	tshin-kat-ka
One thousand	——	——	——
To eat	etz-et-etz′	en-tsutz (?)	at-huh′
To drink	etz-oo-tān-en-e	too-in-to[11]′	too-nuh′
To run	kīs-too-tshē′-ane	in-gulh′	klakw
To dance	en-dlē′	in-le′	kit-li-gatz′
To sing	en-tshīn	in-jīn	a-tshi′
To sleep	nes-tētl′	sin-te′	tah
To speak	hun-tēh	goo-din-tah′	yoo-kwa-tin′
To see	nat-sī	guan-es-ta′	hle-tin′
To love	na-is-tlook′	——	tloon-kut-la-tin (?
To kill	tsin-hia′	ze-hī	whā-tshuk
To sit	sīn-tuh′	sin-ta′	sī-tah′
To stand	nun-zit′	nun′-zut	git-a-han′
To go	un-tlēh′	had-in-tlelh	yuh-kōt
To come	a-nēh′	a-nī	ha-koo
To walk	yes-shā′-dle	had-in-tle′	yoo-tin-a-kooh′
To work	ho-ya-estluh′	kin′-hla	kloon-kut-tlai-yuh
To steal	en-a-ī	in-ī′	ha-ti-tih′
To lie	tse-es-tsīt′	toon-tsit′	skai-tli′-ilh
To give	me-ga-nī-āh′	ta	ī-ka′-wha-te
To laugh	na-es-tlook′	ted-in-tlooh′	a-tshook′
To cry	eh-tshih	en-tsai′	kāh

APPENDIX III.

LIST OF PLANTS COLLECTED BY DR. G. M. DAWSON IN THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA IN 1887.

By Prof. J. Macoun, F.L.S.

Note.—References are also included to plants contained in a small collection made by Mr. W. Ogilvie, D.L.S., during the progress of his work on the Lewes River.

Ranunculaceæ.

1. *Anemone parviflora*, Mx.
   Cañon of Upper Liard River.
2. *Anemone deltoidea*, Hook.
   Dease Lake. Fl. June 8th. A rare and interesting species.
3. *Anemone Richardsoni*, Hook.
   Cassiar Trail twenty miles west of Dease Lake. A very remarkable species with yellow flowers.
4. *Anemone multifida*, DC.
   Frances River.
   Lake Bennett. (W. Ogilvie.)
5. *Anemone patens* L. var. *Nuttalliana*, Gray.
   Dease River, east of Cassiar Mountains; Upper Liard near Frances River; Upper Pelly River near its confluence with the Lewes.
6. *Ranunculus Flammula*, var. *reptans*, Meyer.
   "Pelly Banks;" Upper Pelly River.
7. *Ranunculus affinis*, var. *validus*, Gray.
   Cassiar Trail nine miles west of Dease Lake. Fl. June 5th.
8. *Ranunculus abortivus*, L.
   Cassiar Trail twenty miles west of Dease Lake. Fl. June 3rd.
9. *Aquilegia brevistyla*, Hook.
   Frances River.
10. *Delphinium scopulorum*, Gray.
    Hills west of Finlayson Lake.

11. *Caltha palustris*, L.
Chilkoot Inlet. (W. Ogilvie.)
12. *Aconitum Napellus*, var. *delphinifolium*, Sevinge.
Finlayson River. Very fine specimens.
13. *Actæa spicatà*, var. *arguta*, Torrey.
Telegraph Creek. Fl. May 28th.

NYMPHÆACEÆ.

14. *Nuphar polysepalum*, Engelm.
Finlayson Lake.

FUMARIACEÆ.

15. *Corydalis glauca*, Pursh.
"Pelly Banks," Upper Pelly River.
16. *Corydalis aurea*, var. *occidentalis*, Gray.
Telegraph Creek. Fl. May 27th.

CRUCIFERÆ.

17. *Cardamine pratensis*, L.
Frances River; Finlayson River.
18. *Cardamine hirsuta*, L.
Hills west of Finlayson Lake.
19. *Arabis lyrata*, var. *occidentalis*, Watson.
Cassiar Trail nine miles west of Dease Lake. Fl. June 5th.
20. *Arabis Holbœllii*, Hornem.
Stikine River above the cañon. Fl. May 22nd.
Telegraph Creek. Fl. May 27th.
21. *Barbarea vulgaris*, var. *arcuata*, Hook.
Finlayson River.
22. *Sisymbrium incisum*, Engelm.
Telegraph Creek; Stikine River. May 27th.
23. *Sisymbrium humile*, C. A. Meyer.
Mouth of Lewes River. Aug. 15th.
24. *Draba nemorosa*, var. *hebecarpa*, Lindb.
Tahl-tan River. Fl. May 31st.

VIOLACEÆ.

25. *Viola blanda*, Willd.
Cassiar Trail 36 miles west of Dease Lake. Fl. June 2nd.

CARYOPHYLLACEÆ.

26. *Silene Douglasii*, Hook.
Dease River.
27. *Silene acaulis*, L.
Lake Lindeman. (W. Ogilvie.)
28. *Arenaria verna*, var. *hirta*, Wat.
Mouth of Lewes River.
29. *Arenaria congesta*, var. *subcongesta*, Wat.
Lewes River.
30. *Arenaria lateriflora*, L.
Telegraph Creek. Fl. May 27th.
31. *Arenaria physodes*, DC.
Pelly Banks; Mouth of Lewes River; Lake Lindeman.
32. *Stellaria longipes*, var. *minor*, Hook.
Telegraph Creek, Fl. May 27th; Tahl-tan River, Fl. June 1st; Lewes River.
33. *Cerastium alpinum*, var. *Behringianum*, Regel.
Hills west of Finlayson Lake.
34. *Cerastium trigynum*, Vill.
"Pelly Banks." Very rare.

LINACEÆ.

35. *Linum perenne*, L.
Upper Pelly River.

SAPINDACEÆ.

36. *Acer glabrum*, Torr.
Stikine River above the cañon. Fl. May 22nd. (The form with laciniate-lobed leaves.)

LEGUMINOSÆ.

37. *Lupinus Nootkatensis*, Donn.
Upper Liard River; Second North Fork of Stikine River. Fl. June 1st.
38. *Lupinus arcticus*, Watson.
Upper Liard River. A very interesting species.
39. *Astragalus alpinus*, L.
Forks of Liard and Dease rivers.
40. *Oxytropis campestris*, DC.
Upper Liard River.
Lewes River. (W. Ogilvie.)
41. *Oxytropis viscida*, Nutt.
Dease River.

42. *Oxytropis Lamberti*, Pursh (?)
Dease River.
43. *Hedysarum boreale*, Nutt.
Frances Lake.
Tagish Lake. (W. Ogilvie.)
44. *Hedysarum Mackenzii* Richards.
Telegraph Creek, Fl. May 27th; Upper Liard River.

ROSACEÆ.

45. *Prunus Virginiana*, L. (?)
Telegraph Creek. Fl. May 27th. A very remarkable form, and seems to be the one referred to on p. 167 of the Botany of California, as distinct from *P. demissa*, and yet not true *P. Virginiana*.
46. *Rubus arcticus*, L.
Francis River.
47. *Rubus arcticus*, var. *grandiflorus*, Ledeb.
Dease Lake. Fl. June 8th.
48. *Dryas octopetala*, var. *integrifolia*, Cham. & Schlecht.
Francis River, cool, shady bank, not seen in any other locality.
49. *Dryas Drummondii*, Hook.
Glenora, Stikine River. Fl. May 25th. (Common along river bars.)
Lewes River. (W. Ogilvie.)
50. *Geum macrophyllum*, Willd.
Hills north of Finlayson Lake.
51. *Fragaria Virginiana*, Duchesne.
Telegraph Creek. Fl. May 25th. Abundant locally over the whole region.
52. *Potentilla Norvegica*, L.
Mouth of Lewes River.
53. *Potentilla Hippiana*, var. *pulcherrima*, Wat.
Telegraph Creek. Fl. May 27th.
54. *Potentilla palustris*, L.
Lewes River.
55. *Potentilla fruticosa*, L.
Frances River. Very common throughout district.
Lake Bennett. (W. Ogilvie.)
56. *Poterium Sitchensis*, Wat.
Lake Lindeman; near the mouth of Lewes River.
57. *Rosa Sayi*, Schw.
Upper Liard River; "Pelly Banks"; Lewes River. August 26th (second flowering).

58. *Pirus sambucifolia*, Cham. & Schlecht.
Lake Bennett.
59. *Amelanchier alnifolia*, Nutt.
Telegraph Creek. Fl. May 24.
Dease River, east of Cassiar mountains.
Tagish Lake.

SAXIFRAGACEÆ.

60. *Saxifraga nivalis*, L.
Frances River.
61. *Saxifraga tricuspidata*, Retz.
Telegraph Creek, Fl. May 25th; Dease River, east of Cassiar Mountains.
Lake Bennett. (W. Ogilvie.)
62. *Tellima tenella*, Walp.
Telegraph Creek. Fl. May 27th.
63. *Chrysosplenium alternifolium*, L.
Dease River. Fl. June 7th.
64. *Parnassia palustris*, L.
Lewes River, near the cañon. Common generally along the rivers.
65. *Ribes setosum*, Lindl.
Glenora, Stikine River. Fl. May 25th.
66. *Ribes rubrum*, L.
Head of Dease Lake. Fl. June 7th.
Chilkoot Inlet. Fl. May 27th. (W. Ogilvie.)
67. *Ribes laxiflorum*, Pursh.
Dease Lake. Fl. June 7th.
68. *Ribes Hudsonianum*, Richards.
Glenora, Stikine River. Fl. May 25th.
Telegraph Creek. Fl. May 27th.

CRASSULACEÆ.

69. *Sedum stenopetalum*, Pursh.
Cañon of Lewes River.
Tagish Lake. (W. Ogilvie.)

HALORAGEÆ.

70. *Hippuris vulgaris*, L.
Lewes River.

ONAGRACEÆ.

71. *Epilobium coloratum*, Muhl.
Lewes River.
72. *Epilobium augustifolium*, L.
Common and generally distributed.
Lake Bennett. (W. Ogilvie.)
73. *Epilobium latifolium*, L.
Common along rivers generally.
Lake Bennett. (W. Ogilvie.)

UMBELLIFERÆ.

74. *Selinum Dawsoni*, C. & R.
Pelly River.
Lake Labarge. (W. Ogilvie.)
A new and very interesting species described in Coulter's Botanical Gazette, Vol. XIII. p. 144, June 1888.
75. *Archangelica Gmelini*, DC.
Chilkoot Inlet. (W. Ogilvie.)

ARALIACEÆ.

76. *Fatsia horrida*, Benth. & Hook.
Two miles from Kloochman Cañon, Stikine River, and in the valley on south side of Chilkoot Pass. Not seen in interior.

CORNACEÆ.

77. *Cornus Canadensis*, L.
Common generally.
78. *Cornus stolonifera*, Mx.
Telegraph Creek, and common generally.

CAPRIFOLIACEÆ.

79. *Viburnum pauciflorum*, Pylaie.
Telegraph Creek, and generally abundant throughout the entire district.
80. *Linnæa borealis*, Gronov.
Common generally.

RUBIACEÆ.

81. *Galium boreale*, L.
Upper Pelly River; Tagish Lake; Lake Bennett.
Lake Labarge. (W. Ogilvie.)

COMPOSITÆ.

82. *Solidago multiradiata*, Ait.
Tagish Lake. (W. Ogilvie.)
83. *Solidago Virgaurea*, var. *alpina*, Bigel.
Lewes River. (W. Ogilvie.)
84. *Aster occidentalis*, Gray.
Lewes River.
85. *Aster Sibiricus*, L.
"Pelly Banks;" Frances River; between Frances Lake and Pelly River.
Lewes River. (W. Ogilvie.)
86. *Erigeron acris*, L.
Lewes River.
87. *Erigeron acris*, var. *Dræbachensis*, Blytt.
"Pelly Banks"; Lake Lindeman; hills south of Pelly Banks.
88. *Erigeron compositus*, var. *discoideus*, Gray.
Telegraph Creek. Fl. May 25th.
89. *Erigeron cæspitosus*, Nutt.
Pelly River in two localities (above and below Macmillan River).
90. *Erigeron glabellus*, var. *pubescens*, Wat.
Near mouth of Lewes River.
91. *Antennaria plantaginifolia*, Hook.
Lewes River.
92. *Achillæa Millefolium*, L.
"Pelly Banks."
Tagish Lake. (W. Ogilvie.)
93. *Artemisia borealis*, var. *Wormskioldii*, Bess.
"Pelly Banks."
94. *Artemisia Canadensis*, Mx.
Pelly River.
95. *Artemisia vulgaris*, var. *Tilesii*, Ledeb.
Francis Lake; "Pelly Banks."
96. *Artemisia dracunculoides*, Pursh.
Pelly River.
97. *Artemisia frigida*, Willd.
Telegraph Creek, Fl. May 27th; Upper Pelly River; Dease River to east of Cassiar Mountains.
98. *Petasites sagittata*, Gray.
Second North Fork of Stikine River. Fl. June 1st.
99. *Arnica cordifolia*, Hook.
Telegraph Creek. Fl. May 28th.

100. *Arnica latifolia*, Bong.
Lake Bennett. (W. Ogilvie.)
101. *Senecio palustris*, Hook.
Hills south of "Pelly Banks."
102. *Senecio lugens*, Richards.
Upper Liard River; Frances River; hills west of Finlayson Lake.
103. *Senecio aureus*, var. *borealis*, T. & G.
Dease River; Finlayson River; Telegraph Creek. Fl. May 27th.
104. *Crepis elegans*, Hook.
Upper Pelly River above the cañon.
105. *Taraxicum officinale*, var. *glaucescens*, Koch.
Cañon of Upper Liard.

ERICACEÆ.

106. *Vaccinium uliginosum*, L.
Frances River; Lewes River; head of Bennett Lake.
107. *Vaccinium ovalifolium*, Smith.
Head of Bennett Lake.
108. *Vaccinium cæspitosum*, var. *cuneifolium*, Nutt.
Dease River; Cañon of Upper Liard.
109. *Arctostaphylos alpina*, Spreng.
Cassiar Trail twenty miles west of Dease Lake, Fl. June 3rd; also about height of land between Liard and Pelly, and on the Upper Pelly River.
110. *Arctostaphylos Uva-ursi*, Spreng.
Telegraph Creek. Fl. May 27th. Generally abundant.
111. *Loiseleuria procumbens*, Desv.
Chilcoot Pass. (W. Ogilvie.) Fl. June 10th.
112. *Ledum latifolium*, Ait.
First seen on Cassiar Trail about thirty miles from Dease Lake. Abundant on Upper Liard and Pelly rivers.
Tagish Lake. (W. Ogilvie.)
113. *Menziesia ferruginea*, Smith (?).
Lake Lindeman, and west slope of Chilkoot Pass.

PRIMULACEÆ.

114. *Primula Mistassinica*, Mx.
Francis River, in flower and quite common on river banks from which water had lately receded.
115. *Androsace septentrionalis*, L.
Telegraph Creek, Fl. May 27th; Glenora, Stikine River, Fl. May 24th.

GENTIANACEÆ.

116. *Gentiana Amarella*, var. *acuta*, Hook.
Finlayson River.
Lewes River. (W. Ogilvie.)
117. *Gentiana glauca*, Pall. (?)
On mountain near Finlayson River.

POLEMONIACEÆ.

118. *Polemonium cæruleum*, L.
Finlayson River; quite abundant about the height of land between Liard and Pelly rivers.
119. *Polemonium humile*, var. *pulchellum*, Gray.
Telegraph Creek, Fl. May 27th; Glenora, Stikine River, Fl. May 25th; very abundant and characteristic on south-east part of Cassiar Trail.

HYDROPHYLLACEÆ.

120. *Phacelia Franklinii*, Gray.
Cañon of Lewes River.

BORRAGINACEÆ.

121. *Echinospermum Redowskii*, var. *occidentale*, Wat.
Telegraph Creek, Fl. May 27th.
122. *Mertensia paniculata*, Don.
Cassiar Trail thirty miles south-west of Dease Lake. Fl. June 2nd. Common.
Lake Bennett. (W. Ogilvie.)

SCROPHULARIACEÆ.

123. *Castilleia pallida*, var. *septentrionalis*, Gray.
Lewes River.
124. *Collinsia parviflora*, Dougl.
Glenora, Fl. May 25th; Telegraph Creek.
125. *Euphrasia officinalis*, L.
Lewes River.
126. *Pedicularis hirsuta*, L.
Finlayson River.
127. *Veronica alpina*, L.
Hills west of Finlayson Lake; Finlayson River.

128. *Pentstemon confertus*, var. *cæruleo-purpureus*, Gray.
Cañon of Lewes River.
Tagish Lake. (W. Ogilvie.)

LENTIBULARIACEÆ.

129. *Pinguicula villosa*, L.
Frances River.

CHENOPODIACEÆ.

130. *Chenopodium capitatum*, Wat.
Telegraph Creek, Stikine River, Fl. May 27th; "Pelly Banks."
Lake Labarge. (W. Ogilvie.)

POLYGONACEÆ.

131. *Polygonum viviparum*, L.
Francis River.

ELÆAGNACEÆ.

132. *Elœagnus argentea*, Pursh.
Telegraph Creek, near confluence of Pelly and Lewes Rivers, and in several places on latter river.
133. *Shepherdia Canadensis*, Nutt.
In flower, abundant at Glenora and Telegraph Creek, May 23rd.

SANTALACEÆ.

134. *Comandra livida*, Richards.
Frances River.

BETULACEÆ.

135. *Betula papyrifera*, Ait.
Stikine River, May 22nd; Lewes River, near its mouth; Dease River. Occurs generally throughout the district, except along upper part of Pelly River.
136. *Betula glandulosa*, Mx.
Abundant everywhere in suitable localities.
137. *Alnus rubra*, Bong.
Frances Lake.
Chilkoot Inlet. May 27th. (W. Ogilvie.)

SALICACEÆ.

138. *Salix speciosa*, Hook. & Arn.
Upper Liard River.
139. *Salix cordata*, Muhl.
Upper Liard River. A singular form.
140. *Salix longifolia*, Muhl.
Upper Liard River.
141. *Salix conjuncta*, Bebb, n. sp.
Cassiar Trail twenty miles north-west of Dease Lake. June 3rd.
142. *Salix rostrata*, Rich.
Telegraph Creek. May 27th.
143. *Salix flavescens*, var. *Scouleriana*, Bebb.
Stikine River above Little Cañon. May 22nd.
144. *Salix reticulata*, L.
Finlayson River. Abundant in cold, mossy swamps about height of land between Liard and Pelly Rivers.
145. *Salix glauca*, L.
Near mouth of Lewes River.
146. *Populus trichocarpa*, T. & G.
Mouth of Lewes River, August 15th; "Pelly Banks"; Stikine River, above the cañon, May 22nd; Lake Francis; Dease River; Forks of Taiya River.
147. *Populus tremuloides*, Mx.
Generally abundant.

CONIFERÆ.

148. *Juniperus Virginiana*, L.
Telegraph Creek (arboreal); general elsewhere in a shrubby form.
149. *Pinus contorta*, Dougl.
Common along the coast.
150. *Pinus Murrayana*, Balf.
From the Little Cañon, on the Stikine, north-eastward to Devil's Portage, on the Lower Liard (McConnell); northward to Finlayson Lake; along Lewes River, from Lake Lindeman to mouth of, and up Pelly River to long. 133° 45′.
51. *Pinus Banksiana*, Lambert.
East of Devil's Portage, on Lower Liard (McConnell.)
152. *Picea Sitchensis*, Carr.
The most abundant forest-tree along the coast and on the seaward slopes of the Coast Ranges. Not found to the eastward of these mountains.
153. *Picea alba*, Link.

The most abundant forest tree over the entire region east of the Coast Ranges.

154. *Picea nigra*, Link.
More or less abundant over the entire region east of the Coast Ranges.

155. *Tsuga Pattoniana*, Engelm.
Forming groves in Taiya valley and on the mountains, Chilkoot Pass. Probably characteristic of the higher parts of the Coast Ranges throughout.

156. *Abies subalpina*, Engelm.
Bennett Lake, and generally on the mountains in the vicinity of the timber-line.

157. *Larix Americana*, Mx.
Extends westward twenty-two miles up Dease River, and northward along Upper Liard to lat. 61° 35′. Nowhere seen along the Pelly or Lewes.

Orchidaceæ.

158. *Corallorhiza innata*, R. Br.
Upper Liard River.

159. *Calypso borealis*, Salisb.
Cassiar trail, thirty-six miles south-west of Dease Lake.

160. *Cypripedium montanum*, Dougl.
Lewes River. (W. Ogilvie.)

Liliaceæ.

161. *Disporum Oregana*, Watson.
Glenora, May 27th.

162. *Allium Schœnoprasum*, L.
Frances River; mouth of Lewes River.
Lake Labarge. (W. Ogilvie.)

163. *Veratrum viride*, Ait.
Lake Lindeman; south slope of Chilkoot Pass.

164. *Zygadenus elegans*, Pursh.
Cañon of Lewes River. (W. Ogilvie.)

Juncaceæ.

165. *Juncus Lescurii*, Bolander.
Lewes River.

166. *Juncus castaneus*, Smith.
Lewes River.

CYPERACEÆ.

167. *Eriophorum capitatum*, Host.
Upper Pelly River, above the cañon.
168. *Carex siccata*, Dew.
Upper Pelly River.
169. *Carex festiva*, Dew.
Lake Lindeman.
170. *Carex leporina*, L., var. *Americana*, Olney.
Stikine River, above the cañon, May 22nd; Telegraph Creek, May 27th.
171. *Carex atrata*, L.
Frances River.
172. *Carex aurea*, Nutt.
Upper Pelly River.
173. *Carex alpina*, Swartz.
Lewes River.
174. *Carex acuta*, L.
Lewes River.
175. *Carex ambusta*, Bailey.
Frances River; Lewes River; "Pelly Banks."
176. *Carex podocarpa*, R. Br.
Lewes River.

GRAMINEÆ.

177. *Hierochloa alpina*, Roem. & Schultz.
Mountain near Finlayson River, alt. 4300 feet, lat. 61° 30′.
178. *Hierochloa borealis*, Roem. & Schultz.
Telegraph Creek; Upper Liard River; Lewes River.
179. *Phleum alpinum*, L.
Lake Lindeman.
180. *Agrostis scabra*, Willd.
Lake Lindeman
181. *Cinna pendula*, Trin., var. *mutica*, Vasey.
"Pelly Banks."
182. *Deyeuxia neglecta*, Kunth.
"Pelly Banks," and confluence of Lewes and Pelly rivers.
183. *Deyeuxia neglecta*, var. *brevifolia*, Vasey.
"Pelly Banks."
184. *Deyeuxia sylvatica*, Kunth.
Lewes River; "Pelly Banks."
Dease River.

185. *Deyeuxia Columbiana*, Macoun. n. sp.
Tagish Lake.
186. *Deschampsia cæspitosa*, Beauv.
Lewes River, and "Pelly Banks."
187. *Trisetum subspicatum*, Beauv.
Upper Liard River; "Pelly Banks;" Frances Lake; Finlayson Lake.
188. *Poa alpina*, Linn.
Lake Lindeman; "Pelly Banks."
189. *Poa cæsia*, Smith.
Lake Lindeman; Dease River; Frances River; "Pelly Banks."
190. *Poa cenisia*, All.
Hills west of Finlayson Lake.
191. *Festuca ovina*, L.
Lake Lindeman; "Pelly Banks."
192. *Festuca scabrella*, Torr.
Frances Lake, and Finlayson Lake.
193. *Agropyrum violaceum*, Lange.
Lake Lindeman; "Pelly Banks"; Lewes River.
194. *Hordeum jubatum*, L.
Lewes River.
195. *Elymus dasystachys*, Trin.
Dease River.

EQUISETACEÆ.

196. *Equisetum variegatum*, Schleicher.
Upper Liard River. June 2, 1887.

FILICES.

197. *Aspidium fragrans*, Swartz.
On rocks, Frances River.
198. *Cystopteris fragilis*, Bernh.
Telegraph Creek.

MUSCI.

199. *Splachnum luteum*, L.
200. *Webera nutans*, Hedw.
Upper Liard River. June 27, 1887.
201. *Marchantia polymorpha*, L.
Upper Liard River. June 27, 1887.

APPENDIX IV.

ZOOLOGY.

List of Diurnal Lepidoptera by James Fletcher, F.R.S.C., F.L.S.

1. *List of Diurnal Lepidoptera collected in the Yukon District and adjacent Northern Portion of British Columbia.*

Specimens in this list, not otherwise noted, were collected by Dr. G. M. Dawson and assistant, J. McEvoy, in 1887.

Papilio Machaon, L., var. *Aliaska*, Scud. Frances River, July 1; three miles below summit of Chilkoot Pass (from Mr. McDougall). July 15, 1886.

Papilio Turnus, L., June 28, 1887; three miles below Little Cañon, Lower Liard (long. 128° 13′), McConnell; Devil's Portage, Lower Liard (long. 126° 10′), July 15, 1887, McConnell; Frances River (lat. 60° 29′), July 1.

Pieris Nelsoni, Edw, Telegraph Creek, Stikine River, May 27.

Pieris Napi, Esper. Arctic form, *Bryoniæ*, Ochs. Dease Lake, June 6.

Pieris Napi, Esper. Arctic form, *Bryoniæ*, Ochs., var. *Hulda*, Ed., West of Finlayson Lake (lat. 61° 45′, long, 130° 55′), July 28.

Pieris Napi (1); winter form *Venosa*, Scud. Dease Lake, June 17.

Pieris Napi (2); winter form *Oleracea-hyemalis*, Har. Frances River (lat. 60° 29′), July 1; Lewes River (lat. 61° 55′), August 27.

Anthocaris Ausonides, Bd. Cassiar Trail, ten miles west of Dease Lake, June 4; Telegraph Creek, Stikine River, May 29; Dease Lake, June 7.

Anthocaris Stella, Edw. Telegraph Creek, May 29.

Colias Christina, Edw. Upper Pelly River (lat. 62° 47′, long. 137° 20′) August 7; site of Fort Selkirk, August 17, Ogilvie.

Argynnis Chariclea, Schneid. Finlayson River (lat. 61° 40′, long. 130° 16′), July 22; Finlayson Lake, July 27; Upper Pelly River (lat. 61° 50′, long. 132°), August 3. Pelly or Yukon River, August 7, 1888. McConnell.

Argynnis Freya, Thunb. Cassiar Trail, ten miles west of Dease Lake, June 4; Dease Lake, June 5.

Phyciodes Tharos, Dru. Devil's Portage, Lower Liard (long. 126° 10′), July 15, McConnell.

Phyciodes Pratensis, Behr. Upper Liard River (lat. 60°), June 26.

Grapta Faunus, Edw. Fifty miles below Forty-mile Creek, Pelly or Yukon River, August 7, 1888, McConnell.

Grapta Progne, Cram. Lewes River (lat. 61° 55′), August 27.

Thecla Irus, Godt. Telegraph Creek, Stikine River, May 29; Cassiar Trail, twenty-two miles east of Telegraph Creek, June 1.

Chrysophanus Helloides, Bd. Upper Pelly River (lat. 62° 40′, long. 134° 30′) August 7.

Lycæna Sæpiolus, Bd. Devil's Portage, Lower Liard (long. 126° 10′), July 17, McConnell; Finlayson Lake, July 25.

Lycæna Couperii, Grote. Telegraph Creek, Stikine River, May 31; Cassiar Trail, thirty miles west of Dease Lake, June 2; Cassiar Trail, ten miles west of Dease Lake, June 4; Dease Lake, June 5; Devil's Portage, Liard River (long. 126° 10′), July 13, McConnell; Upper Liard River (lat. 60°), June 26; Frances River (lat. 60° 29′), July 1.

Lycæna Shasta, Edw. Upper Pelly River (lat. 61° 50′, long. 132°), August 3; Lewes River (lat. 62° 20′), August 21.

Lycæna Pseudargiolus, Bd. Lec.; winter form (1) *Lucia*, Kirby. Dease Lake, June 4; Dease Lake, June 8.

Lycæna Pseudargiolus, Bd. Lec.; winter form (2) *Marginata*, Edw. Cassiar Trail, twenty miles west of Dease Lake, June 3.

Lycæna Pseudargiolus, B.-L., winter form (3) *Violacea*, Edw. Cassiar Trail, ten miles west of Dease Lake, June 4.

Lycæna Amyntula Bd. Devil's Portage, Liard River (long. 126° 10′), July 17, McConnell.

Nisoniades Icelus, Lint. Telegraph Creek, Stikine River, May 27.

Nisoniades Persius, Scud. Dease Lake. June 4.

Nisoniades Juvenalis, Fab. Cassiar Trail, ten miles west of Dease Lake, June 4.

2. *List of Diurnal Lepidoptera collected by Mr. W. Ogilvie on Mackenzie River in* 1888.*

Papilio Machaon, L., var. *Aliaska*, Scud. Fort Macpherson (lat. 67° 20′), June 21.

Pieris Napi, Esper.; Arctic form *Bryoniæ*, Ochs., var. *Hulda*. Fort Macpherson (lat. 67° 20′), June 21.

* This and the following list do not come strictly within the limits of this report, but are included here to ensure publication.

Anthocaris Ausonides, Bd. Mackenzie River, July 8.
Colias Christina, Edw. Fort Good Hope (lat. 66° 15′), August 11.
Vanessa Antiopa, L. Ninety miles above Fort Good Hope (lat. 65° 20′), July 19; Fort Smith (lat. 60°), August 24.

3. *List of Diurnal Lepidoptera collected by Mr. Fredk. Bell, at the instance of Mr. R. G. McConnell, at Fort Simpson, Mackenzie River (lat. 61° 52′), 1888.*

Papilio Turnus, L. (Five specimens.) June 24 to July 8.
Pieris Napi, Esper. (2); winter form *Oleracea-hyemalis*, Har. (Thirteen specimens.) June 24 to July 8.
Colias Occidentalis, Scud. July 17.
Colias Christina, Edw. Male, July 17; female, July 25.
Grapta Progne, Cram. (Two specimens.) July 12.
Vanessa Milbertii. Godt. (Eleven specimens.) June 26 to July 20.
Limenitis Arthemis, Dru. (1); dimorphic form *Lamina*, Fab. (Three specimens.) July 23.
Erebia Discoidalis, Kirby. June 25.
Lycæna Pseudargiolus, Bd. Lec.; winter form (1) *Lucia*, Kirby. June 25.
Nisoniades Icelus, Lint. June 26.

FISHES, DETERMINED FROM PHOTOGRAPHS, BY DR. T. H. BEAN, UNITED STATES COMMISSIONER OF FISH AND FISHERIES.

Photographs were taken of some of the fishes met with, but no specimens were brought back. The photographs have been kindly examined by Dr. Bean, who enumerates the species represented as follows:—

Salvelinus namaycush, Walbaum.
Lake Trout. Frances River, July 2. Spent male, judging from great length of maxilla. "Much darker than the other lake trout, and with white instead of yellow flesh."

Salvelinus namaycush, Walbaum.
Lake trout. Frances Lake, July 14. "Ordinary lake trout of the region."

Esox lucius, Linné.
Pike. Frances Lake, July 12. Length, 3 feet 3 inches.

Coregonus Nelsoni, Bean.
Nelson's whitefish. Frances Lake, July 16; also Lake Lindeman, September 18.

Catostomus catostomus, Forster.
Northern sucker; small-scaled sucker. Frances Lake, July 16.

Thymallus signifer, Richardson.
Back's grayling. Finlayson River, July 19.

Description of a New Red-backed Mouse (Evotomys Dawsoni) from the Head-water of Liard River, North-West Territories.

BY DR. C. HART MERRIAM.

Of a few skins of birds and small mammals brought back, the only one of particular interest is that described below by Dr. J. Hart Merriam, *American Naturalist*, July, 1888. (The figure given with the original description, illustrating the dentition, is not here reproduced.)

"Dr. George M. Dawson, Assistant Director of the Geological and Natural History Survey of Canada, has kindly sent me for determination a red-backed mouse collected by him June 23, 1887, at Finlayson River, one of the northern sources of Liard River, in lat. 61° 30′ N., long. 129° 30′ W., altitude 3000 feet.

"So little is known of the small mammals of this remote and inaccessible region that it is not particularly surprising to find that the mouse collected by Dr. Dawson proves to be undescribed. In some respects it is intermediate between the circumpolar *Evotomys rutilus* and its more southern congener, *Evotomys gapperi*. But since it differs from both and no intermediate forms are known, it must be regarded as specifically distinct. Hereafter, should intergrades be discovered, it may be necessary to consider it a sub-species. It may be characterized as follows:—

Evotomys Dawsoni, sp. nov.

Dawson's Red-backed Mouse.

"Type in Museum of Geological and Natural History Survey of Canada, at Ottawa. From Finlayson River, a northern source of Liard River, N. W. T. (lat. 60° 30′ N., long. 129° 30′ W., altitude 3000 feet). Size, about equal to that of *Evotomys gapperi*. Measurements from mounted specimen (apparently well mounted and not at all stretched): Head and body, 75 mm.; tail vertebræ, 28 mm.—pencil, 8 mm. (total, 36 mm.); ears, from crown, 7 mm. Tail shorter and thicker than in *gapperi*, but longer and slimmer than in *rutilus*, in this respect (but no other) agreeing with a specimen collected at Fort Liard by Kennicott (No. 4562, U. S. National Museum). The hind foot is intermediate between that of *rutilus* and that of *gapperi*, being thicker than in *gapperi*, but not so thick as in *rutilus*. The ears conspicuously overtop the fur, fully equalling those of *gapperi*. The tail is bicolor, the yellowish of the under part occupying a little more than half of the circumference. It is well haired, and the terminal pencil is nearly black above (and 8 mm. long). The red dorsal stripe begins just behind the

eye and extends to the root of the tail. In color it is bright chestnut—not far from ferruginous; the sides are tawny gray, and the belly is strongly washed with ochraceous buff. The admixture of black-tipped hairs is as great as in *gapperi*, and it is very much more conspicuous, owing to the lighter ground-color of the back and sides. The result is a sort of 'peppery' appearance not seen in any other representative of the genus. There is a tolerably well-defined whitish post-auricular spot—an exaggeration of the pale blotch sometimes seen behind the ear in *rutilus*. The whiskers are black and white; they reach back to the shoulders, instead of stopping at the occiput, as usual in the genus. A blackish stripe, bordered below with fulvous, runs from the base of the whiskers to the tip of the nose. The projecting margin of the ear is well covered with reddish hairs, brightest on the interior of the auricle.

"*Cranial and Dental Characters.*—Unfortunately the skull was badly smashed and part of it altogether wanting; hence no cranial characters can be made out. The teeth, however, remain, and are represented in the accompanying cut [not reproduced]. Their most marked peculiarity, compared with those of *gapperi*, consists in the openly-communicating loops. The upper molar series measures 4·5 mm. on the crowns, 4·8 mm. on the alveolæ. The lower molar series measures 4·4 mm. on the crowns, 4·6 mm. on the alveolæ.

"I take great pleasure in bestowing upon this handsome mouse the specific name *Dawsoni*, as a slight recognition of the indefatigable zeal of its discoverer, the distinguished explorer and geologist, Dr. Geo. M. Dawson, who has added so much to the fund of knowledge relating to North-western Canada."—*C. Hart Merriam.*

APPENDIX V.

NOTES ON THE

LITHOLOGICAL CHARACTER OF SOME OF THE ROCKS COLLECTED IN THE YUKON DISTRICT AND ADJACENT NORTHERN PORTION OF BRITISH COLUMBIA.

By Mr. F. D. Adams, M.A.Sc.

(Of the rocks described below, Nos. 16, 25, 2, 4, 7 and 10 were collected by Mr. R. G. McConnell, "No. C." by Mr. W. Ogilvie, and the remaining specimens by Dr. G. M. Dawson.)

Stikine River, No. 16. (Near mouth of Clearwater River. See p. 55 B.)

Diabase Porphyrite.—A rock consisting of a fine-grained groundmass, through which crystals of plagioclase, augite and iron-ore are porphyritically distributed. The plagioclase individuals are well twinned and have good crystalline forms. The augite occurs in eight-sided crystals, both prinacoids being well developed, and the iron ore, which is ilmenite, partly decomposed to leucoxene. The groundmass is cryptocrystalline and microcrystalline. A good deal of chlorite and other decomposition products occurs disseminated through the rock.

Marsh Lake, No. 86. (North end of lake, near outlet. See p. 164 B.)

Diabase Porphyrite.—Resembles No. 16, but the porphyritic crystals are, as a general rule, smaller. The groundmass also, although for the most part microcrystalline, is in some places isotropic, consisting of glass.

Stikine River, No. 25. (Telegraph Creek. See p. 57 B.)

Diabase Tuff.—A somewhat fine-grained clastic rock a good deal decomposed, made up of irregular-shaped grains of plagioclase, pyroxene

and titanic iron ore, with a very little pyrite and some fragments of a fine-grained porphyritic rock. The majority of the grains are plagioclase, showing polysynthetic twinning, a few untwinned felspar grains are also present, some of which may be orthoclase. The plagioclase is a good deal decomposed, many grains consisting almost entirely of a cryptocrystalline or microcrystalline aggregate of calcite, kaolin and other decomposition products. The pyroxene is clear and colorless, being as a general rule less decomposed than the feldspar. It is biaxial, and shows the usual pyroxene cleavages, with a high angle of extinction on the clinopinacoid, which in one case reached 41°. It is sometimes decomposed to chlorite, a considerable quantity of this mineral also occurring scattered through the rock. The fragments of titanic iron-ore are for the most part decomposed to leucoxene, showing the characteristic cross-hatched structure. The fragments of fine-grained porphyritic rock above mentioned have a fine-grained groundmass, in which are imbedded lath-shaped crystals of plagioclase and crystals of augite, and are apparently pieces of a decomposed diabase-porphyrite. Traversing the section are several bands or streaks, much finer in grain and showing cataclastic structure, and which were evidently lines of motion caused by crushing.

Dease Lake, No. 8. (About eight miles from head of lake, west shore. See p. 78 B.)

A very fine-grained yellowish-green rock, with schistose structure and somewhat talcose appearance. Under the microscope it is seen to consist of an exceedingly fine-grained groundmass, almost opaque, in which are a few strings and irregular-shaped segregations of calcite and a number of porphyritic crystals of pyroxene. Under a very high power, the groundmass is seen to be composed largely of little shreds of a micaceous mineral, probably sericite, which are approximately parallel in position and give to the rock an appearance resembling flow structure. With this is associated a smaller quantity of a colorless mineral polarizing in dull bluish tints and with somewhat undulatory extinction, which resembles felspar, but does not show any lines of twinning. The pyroxene crystals are colorless. Cross sections are eight-sided, showing the development of both prism and pinacoids, with cleavages parallel to both and extinction parallel to the latter. It is biaxial, and longitudinal sections show a single set of cleavages, sometimes intersected by tranverse cracks. The extinction direction makes an angle with this cleavage, which in one case was as high as 34°. The crystals are short and stout, and are occasionally twinned, they generally have good crystalline forms, but are sometimes broken.

A few grains of pyrite and a little chlorite are also present in the rock. As would be expected from the appearance of the hand specimen, the section shows that the rock has been subjected to a good deal of motion, two varieties of the rock differing somewhat in appearance, being irregularly mixed with one another. It is probably *some highly altered basic igneous rock;* the presence of the pyroxene crystals, retaining, as a general rule, their crystalline form, is however, somewhat remarkable.

Tagish Lake, No. 93. (Windy Arm. See p. 171 B.)

Felsite.—An exceedingly fine-grained rock, much crushed and altered. Small irregular-shaped segregations of calcite are scattered through the rock, and here and there little fragments of plagioclase can be seen. It is impossible by means of a section alone to determine its original character. Before the blowpipe it fuses easily to a black magnetic globule, and may provisionally be termed a *felsite.*

Cassiar Trail, No. 4. (Tooya River, at trail-crossing. See p. 70 B.)

Tuff?—An exceedingly fine-grained, red, somewhat schistose rock, holding numerous irregular-shaped cavities, filled with a light green chloritic mineral, mixed with calcite. The section is rendered nearly opaque by a dense impregnation with iron-oxide. It is also traversed by thin veins of calcite. Before the blowpipe the rock fuses to a black magnetic bead. It is probably an altered tuff.

Granitic Rocks from the Coast Ranges.

Wrangell, No. 2. (Wrangell Island. See p. 54 B.)

Biotite Granite.—A rather fine-grained gray granite, with very indistinct foliation. It is composed of quartz, orthoclase, plagioclase, biotite and epidote, with a very small amount of apatite and of an isotropic mineral, light brown in color, with high index of refraction, but without good crystalline form, and which is probably garnet. Almost every grain of quartz exhibits, between crossed nichols, an uneven extinction, showing that the rock has been submitted to pressure. Both the orthoclase and plagioclase are generally fresh. The epidote, which is present in considerable amount, is colorless, strongly doubly refracting, and is almost always associated with the biotite. It occurs in curiously corroded, somewhat elongated, prismatic crystals, with perfect cleavage parallel to the longest axis, the plane of the optic

axes being at right angles to this cleavage. The mode of occurrence of this epidote is very similar to that found in the mica-diorite from Stony Point, on the Hudson River, and described by Dr. George Williams (*American Journal of Science*, June, 1888).

Stikine River, No. 4. (Near mouth of river. See p. 54 B.)

A Porphyritic Biotite Hornblende Granite, approaching a Quartz Diorite in composition.—A medium-grained grey rock, with numerous small white porphyritic crystals. It is composed of quartz, plagioclase, orthoclase, biotite and hornblende. The porphyritic crystals are felspar, which is almost invariably plagioclase. They possess a zonal structure, and contain numerous colorless inclusions heaped up toward the centres of the crystals. Some of them also contain inclusions of muscovite, which is probably a decomposition product. The quartz generally shows an uneven extinction, owing to pressure. The plagioclase preponderates largely over the orthoclase, but some untwinned grains have been referred to the latter species. The biotite and hornblende are intergrown with each other. Two or three grains showing granophyr structure are also seen in this section.

Stikine River, No. 7. (Moraine of Great Glacier. See p. 54 B.)

Biotite Hornblende Granite.—A rather coarse-grained grey granite, with very indistinct foliation. It is composed of quartz, orthoclase, plagioclase, biotite, hornblende, sphene and magnetite. The quartz shows a somewhat uneven extinction. Both feldspars often show zonal structure. The hornblende is about equal to the mica in amount, and only small quantities of sphene and magnetite are present. The latter is probably titaniferous.

Stikine River, No. 10. (Little Cañon. See p. 54 B.)

Biotite Granite.—A coarse-grained grey granite, poor in mica. The orthoclase, of which there is a very large amount, often shows an indistinct zonal structure. A small quantity of magnetite, or more probably ilmenite, with which a little sphene is associated, is also present. A crystal of zircon was observed in one of the mica grains. Although the rock has no foliation, it shows very distinct cataclastic structure, induced by great pressure. The constituent minerals are seen to have been much squeezed and twisted, the larger grains being often, around their edges, broken up into a very fine-grained mass. The mica also, which is in part decomposed to chlorite, has been in many places pulled apart into shreds.

Granitic Rocks from the Interior Ranges.

Upper Pelly River, No. 61. (Near mouth of river. See p. 132 B.)

Muscovite Biotite Granite.—A medium-grained grey granite, with very indistinct foliation. It is composed of quartz, orthoclase, microcline, plagioclase, muscovite, biotite and epidote, with small amounts of garnet, sphene, pyrite and calcite. The plagioclase is present in relatively smaller amount than in the granites from the Coast Ranges. The muscovite is more plentiful than the biotite. The epidote occurs in colorless corroded crystals, and has the appearance of an original constituent of the rock. The garnet is reddish, and occurs in a few irregular-shaped isotropic grains, usually much cracked. The sphene occurs in the usual wedge-shaped crystals. The calcite is seen in the section in a few large grains. The grains of quartz and orthoclase are somewhat cracked and broken, but beyond this, no distinct evidence of pressure is exhibited by the section.

Upper Pelly River, No. 57. (Granite Cañon. See p. 130 B.)

Biotite Granite.—A rather coarse grained, much decomposed, massive grey granite. The feldspars are so decomposed that it is difficult to determine their character, but a considerable amount of plagioclase is present, and probably a still larger amount of orthoclase. The biotite is entirely decomposed to chlorite and epidote. A few small grains of hæmatite are present in the section. The quartz grains are much cracked, and show very uneven extinction, owing to the pressure to which the rock has been subjected.

Pelly or Yukon, "No. C." (Opposite Stewart River. See p. 34 B.)

Quartoze Biotite Gneiss.—A rather fine-grained red gneiss, showing very distinct foliation. It is composed of quartz, orthoclase, plagioclase, calcite, chlorite, ilmenite and a little pyrite. The plagioclase is present in rather small amount. The chlorite is a decomposition product, probably of biotite, and the calcite, of which there is a considerable quantity, is also a decomposition product. The ilmenite is partly altered to leucoxene. The cataclasic structure is distinctly seen in the section.

Upper Pelly River, No. 53. (Nine miles above Macmillan. See p. 129 B.)

Biotite Granite.—A rather coarse-grained, reddish-grey, massive rock, composed of quartz, orthoclase, plagioclase and chlorite, with a

little ilmenite and pyrite. Both feldspars are much decomposed, being in some places nearly opaque. The plagioclase, which is not so plentiful as the orthoclase, is generally better crystallized, and frequently occurs in crystals penetrating this mineral. The ilmenite is partly decomposed to leucoxene, and the chlorite is evidently a decomposition product of biotite. The section is traversed by a little very fine grained granitic vein, showing a banded structure parallel to its walls. The quartz has been much cracked, nearly every grain showing an uneven extinction.

APPENDIX VI.

METEOROLOGICAL OBSERVATIONS.

The Meteorological Observations here recorded are as follows:—

1. Observations made along the line of route, June 1 to September 19, 1887.

2. Observations at Telegraph Creek, Stikine River, by Mr. J. C. Callbreath, 1881–1886.

3. Observations at Laketon, Dease Lake, by Mr. J. Clearihue, 1878-1882.

4. Record of temperature at Laketon, Dease Lake, by Mr. Robert Reed, 1886–1887.

The observations included under Nos. 2, 3 and 4 are unfortunately very incomplete. They refer to the winter months only, and in general the minimum reading of the thermometer alone is recorded. The thermometers employed were, however, instruments of good class by well-known makers, and in view of the paucity of information bearing on the region, it has been considered useful to print them. I am indebted to Mr. Callbreath for the opportunity of extracting the observations made by him from his diaries, and to Mr. Reed for communicating the third and fourth series of observations. The observations forming the first part of this appendix were recorded by Mr. J. McEvoy during the progress of our journey.

G. M. D

(1) METEOROLOGICAL OBSERVATIONS IN THE YUKON DISTRICT AND ADJACENT NORTHERN PART OF BRITISH COLUMBIA, JUNE 1 TO SEPTEMBER 19, 1887.

The barometer readings are those of a single pocket aneroid (Cary No. 859) checked at intervals by reference to the mercurial barometer and corrected according to a table of differences based on these comparison. Readings made on two additional aneroids and employed in the determination of elevations are not here included.

Temperature is stated in degrees Fahrenheit. Thermometers employed, Nos. 60,361 and 60,363, Kew Observatory.

The force of the wind is estimated according to Beaufort's scale. The proportion of the sky covered by clouds is estimated by a scale of 0 to 10, 0 being a cloudless sky, 10 a completely clouded sky. The character of the clouds is denoted by the usual letters or combination of letters refering to Howard's classification.

PLACE.	Date.	Hour.	Barometer corrected.	Ther. corrected. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud	Temperature of water.	Weather at time.	Weather during last interval.
				°	°	°					°		
Tahl-tan Bridge, Cassiar Trail, 10 ft. above river	June 1	5 00 a.m.	29.86	36.5	...	30.5	W.	1	8	C & K.	.....	.....	Detached Clouds.
Wilson's	" 1	7.00 p.m	.....	59.	....	...	W.	1	2	K.	.....	Fair.	" " and blue sky.
"	" 2	5.00 a.m.	28 34	39.	...	30.5	Calm.	....	1	C.	.....	"	Passing clouds.
Cariboo Camp	" 2	7.00 p.m.	27.89	51.	....		N. W.	3	7	K.	.....	Showery.	Fair. Clear and passing showers.
" "	" 3	5.20 a.m.	27.96	42.	....	37.	Lt. var	..	9	C K.	.....	Dull.	Showers. Detached clouds and overcast.
24-m. post	" 3	7.00 p.m.	27.97	54.5	.....	....	N. E.	3	1	C.	.....	Fair.	Passing showers.
" "	" 4	6.45 a.m.	28.18	49.	....	31.	N. E.	4	0	.....	.....	.....	Clear.
Nine-mile Creek	" 4	7.00 p.m.	27.59	60.5	..		N. E.	3	0	.....	.....	Clear.	Clear. Very warm all day.
" "	" 5	6.40 a.m.	27.52	41.	...	28.	N. E.	2	0	.....	.....	"	Very light C. clouds.
Head of Dease Lake	" 5	7.00 p.m.	27.35	63.	....	.....	S. E.	2	1	C.	.....	Hazy.	Clear. Very warm.
" " "	" 6	7.00 a.m.	27.41	48.5	...	45 5	Calm.	....	0	.....	.....	.....	Fair.
" "	" 6	7.00 p.m.	27.25	83.	76.	....	W.	3	...	.....	.....	Hazy.	" " Hot sun all day. Open water 3 m. on lake.
" " "	" 7	7.15 a.m.	27.33	45.	..	35.	N. W.	1	....	.....	.....	.....	Clear. Strong N.W. wind.
" " "	" 7	7.10 p.m.	27 26	83.	74.	....	S.	1	...	.....	.....	Hazy.	" Light breeze.
" " "	" 8	7.00 a.m.	27.27	...	....	32.	N.	1	1	C.	.....	"	" Calm.
Dease Lake, 5 m. down	" 8	7.00 p.m.	27.14	61.	....	...	N.	1	1	C & K.	.....	.....	" Light N. airs.
" " "	" 9	7.00 a.m.	27.26	...	....	29.5	N.	2	1	C.	.....	.....	Cloudy. " "
" " "	" 9	7.00 p.m.	27.19	57.	68.	...	N. N. W	1	8	K.	.....	.....	Clouds. S. wind 3. Hot sun.
" " "	" 10	7.00 a.m.	27.26	49.	....	35.5	N.	3	10	S.	.....	Threatening.	Gloomy. Overcast.
" " "	" 10	7.00 p.m.	27.30	50.	63.	....	N. E.	2	9	C & S.	.....	Raining.	Rain. Wind S. & E. 5. Showery p.m.
" " "	" 11	7.00 a.m.	27.31	41 5	....	37.5	Lt. var.	...	10	S & C.	.....	Gloomy, ugly.	Overcast. Gloomy. Calm.

Dease Lake, 5 m. down	"	11	7.00 p m.	27.29	55.5	67.5	....	W.	1	1	K.	.....	.....	Light showers. Light N.E. airs.
" " "	"	12	7.00 a.m.	27.33	44.	....	28.	Calm.	....	8	K & C.	.....	Hazy.	Light W. wind.
" " 10 m. down	"	12	7 00 p.m.	27.21	53.	....	..	W.	1	1	C & K.	.....	.....	C. clouds. Light W. wind.
" " "	"	13	7.00 a.m.	27.25	43.	..	32.	S.	2	1	C K.	.....	.....	Light S. Wind. Ice formed on pools.
" " "	"	13	7.00 p.m.	27.18	52 5	63.	....	S. W.	2	10	S.	.....	Gloomy.	Clouded over. p.m., strong S. wind for a while.
" " "	"	14	7.20 a.m.	27 18	41.5	....	38.5	Lt. var.	....	4	S.	....	"	
" " "	"	14	7.00 p.m.	27.12	46 5	52.	....	Calm.	....	10	S.	.....	Clearing.	Raining all p.m.
" " "	"	15	7.10 a.m.	27.19	49.	....	39.	S.	1	5	C K.	.....	Breaking.	Overcast. Raining.
" " "	"	15	7.00 p.m.	27.17	56.	59.5	....	S.	1	10	K S.	.....	Threatening.	Detached clouds. Lt. sprinkle from S.
" " "	"	16	7.00 a.m.	27.26	44.	....	40.7	S.	2	10	K S.	.....	"	Overcast. Gloomy. S. wind 4.
" " Laketon	"	16	7.00 p.m.	27.28	....	....	....	S.	3-4	5	K.	.....	Showery.	Light showers. " 2.
" " "	"	17	8.00 a.m.	27.23	..	....	....	S.	1	5	K.	....	.....	
" " "	"	17	7.00 p.m.	27.17	..	....	..	S.	1	7	K.	.....	Showery.	Hail and rain showers. p.m., N. & S. var. wind.
" " "	"	18	7.30 a.m.	27.12	....	....	..	Calm.	....	9	S.	.....	.....	Passing showers.
" " Porter's Landing	"	18	7.00 p.m.	27.03	49.	....	....	N.	1	8	C S.	.....	Showery.	Showery all day. Wind 3 var. N. & S.
" " " "	"	19	7.00 a.m.	27.22	45.	....	39.	S.	1	10	K S.	.....	Raining, foggy.	Heavy rain.
" River, 1st camp	"	19	7.00 p.m.	27.38	53.	....	....	S. W.	2	1	K.	.....	.....	Rainy morning, cleared up 9 a.m.
" " "	"	20	6 30 a.m.	27.44	43	....	36 5	S.	2	3	C light.	....	.....	Fair. C. clouds. Wind S.W. 2.
" " McDame Creek	"	20	7.00 p.m.	27 51	64.	....	....	S.	1	10	K S.	.....	Gloomy, ugly.	Overcast Dull. p.m., wind S. 2.
" " " " "	"	21	6.30 a.m.	27 60	48.	....	41.5	Calm.	....	10	S.	.....	Dull, "	Heavy rain during night. Wind 3.
" " " " "	"	21	7.00 p.m.	27.54	61.	....	....	"	....	10	K S.	46.	Showery.	Detached clouds. W. air.
" " " " "	"	22	6.30 a.m.	27.60	54.	..	44.5	S.S.W.	1	1	K.	.....	.....	Wind 4. Cleared off.
" " " " "	"	22	7.00 p.m.	27.69	56.	....	....	S. W.	3	8	K & C K.	47.	.....	Showers of rain and hail. Wind 2.
" " " " "	"	23	6.20 a.m	27.68	41.	....	....	S. W.	2	10	S & K S.	....	Gloomy.	Cold. Windy. River rose 15 in. during night.
Mouth of Dease River	"	23	7.00 p.m.	27.66	49.	....	....	S. W.	1	10	S.	45.5	Heavy Rain.	Cold heavy rain. River rising.
" " "	"	24	8.15 a.m	27.70	43.	....	41.	W.	1	10	S.	.....	"	Heavy rain, River fell 1 ft.
" " "	"	24	7.00 p.m	27.68	46.	....	....	W.	1	10	S.	.....	Raining.	Steady rain all day.
" " "	"	25	7.00 a.m.	27.79	45.	..	40.	W.	1	10	S & K S.	....	Gloomy.	Showers last night. Clouds a little broken. River fell.
Liard River, foot of cañon	"	25	7.00 p.m	27.76	51.	..	....	W.	1	10	S & K S.	45.	"	Showery. Generally overcast.
" " " "	"	26	6.00 a.m.	27.81	43.	....	41.	N.W.	1	9	K S.	.....	.....	Light showers. River fell 3 in.
" " 6 m. above "	"	26	7.00 p.m.	27.67	58.	....	....	S.	1	5	K.	49	Fair.	K. & C. clouds. 2 to 8, sunshine.
" " " "	"	27	6.00 a.m.	27.69	50.	....	49.	W.	2	9	K S.	....	Gloomy.	Calm night. River fell 2½ in.
" "	"	27	7.00 p.m.	27.66	61.5	....	....	W.	2	1	C.	52.	Hazy.	C. & K. clouds.
" "	"	28	6.00 a.m.	27.79	54.	....	44.5	Calm.	..	1	C.	.....	.....	Calm night. River rose 2 in.
" "	"	28	7.00 p.m.	27.73	61.5	....	....	W.	2	5	K S.	52.5	.....	K. clouds. Showers. Warm day.
" "	"	29	6.00 a.m.	27.76	47.5	..	46.5	N.	1	9	S & K S.	.....	Rainy, gloomy.	Dull. Light showers this morning. River rose 1 in.
Frances River	"	29	7.15 p.m.	27.63	57.	....	..	Calm.	....	1	K.	50.5	.....	Warm day. K. clouds 3
" "	"	30	6 00 a.m	27.63	45.	....	36.	"	..	2	C K.	.....	.....	Calm night.
" "	"	30	7.00 p.m.	27.65	55.	....	....	"	....	1	C & K.	48.5	.....	p.m. S. 10. Lt. rain. Cleared off 5 p.m.
" "	July	1	6.00 a.m.	27.58	48.	....	30.	"		9	C K.	.....	Gloomy.	Clear sunshine early this morning.
" " head of 1st cañon	"	1	7.00 p.m.	27.43	59.	....	..	"	....	4	K.	48.5	.....	Detached K. clouds.
" " " "	"	2	6.00 a.m.	27.38	49.	....	43.5	"	.	1	C.	.....	.....	Calm. K. 4.
" "	"	2	7.00 p.m.	27.23	55 5	....	....	S.	1	9	K & S.	49.	Gloomy.	Light passing showers. Wind S.
" "	"	3	6.00 a.m.	27.34	46	....	44 5	S.	1	1	C.	.....	.....	Several showers during night. Wind S
" "	"	3	7.00 p.m.	27.32	54.	....	....	W.	1	1	K.	47.	.....	K. 5. Light S. wind.

PLACE.	Date.	Hour.	Barometer corrected.	Ther. corrected. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Temperature of Water.	Weather at time.	Weather during last interval.
				°	°	°							
Frances River	July 4	6.30 a.m.	27.29	38.	....	27.	Calm.	....	10	S.	.....	Gloomy.	Clouded over during night.
" "	" 4	7.00 p.m	27.16	52.	..	....	N.W.	1	5	K & S.	.....	Showery.	Drizzling rain a m.; p m., showery.
" "	" 5	6.00 a.m.	27.30	44.5	....	37.	S.	1	10	S & K S.	.....	....	Two showers during night.
" " 2nd cañon	" 5	7.00 p.m.	27 34	51.	..	....	N.W.	1	8	K.	46.5	.....	Showery. Heavy K. clouds 6.
" " "	" 6	6.00 a.m.	27.39	49.	...	33.	N.	1	2	C & K.	.....	.....	Fairnight. K. 5.
" "	" 6	7 00 p.m	27.38	50.	....	....	Calm.	....	8	K.	46.	.....	K. clouds 1-6.
" "	" 7	5.30 a.m	27.31	40.	....	36.	"	....	10	S.	.....	Gloomy.	Overcast.
" " near foot of lake.	" 7	7.00 p.m.	27.81	42.5	....	....	S. W.	1	3	K.	45.	.....	Showers. Hail in evening.
" " " "	" 8	6.00 a.m.	27.18	41.5	....	32.	S. E.	1	1	C.	....	.....	K.& S. clouds. Ice ½ in. River fell 1 in.
" Lake	" 8	7.00 p.m	27.11	51.	....	....	Calm.	....	8	C & K.	50.	.....	Showery. Wind S. K. 1-8. Rather warm.
" "	" 9	6.30 a.m	27.22	47.	..	36.	"	...	9	K & S.	.....	Gloomy.	hower this morning.
" "	" 9	7.00 p.m.	27.26	52.	....	....	"	....	9	K & K S.	49.7	....	Showery. N wind 4. K. 1-8.
" "	" 10	6 00 a.m.	27.33	47.	..	43.	S.	1	10	K & K S.	.....	Gloomy.	Calm. Overcast. K. S.
" "	" 10	7.00 p.m.	27.32	49.	....	....	S.	1	10	K & S.	.....	Raining.	Rain storms all day. 1st thunder of season.
" "	" 11	7.00 a.m.	27 42	..		34.5	W.	1	3	K	.....	Fair.	Showery.
" "	" 11	7 00 p.m.	27 42	45.	63.	....	S. W.	1	8	K & K S	46.	Showery.	Showers all day. Wind W. Warm sun
" "	" 12	6 2) a.m	27.49	48.	..	29.	W.	1	6	K.	....	Fair.	Fair night. Clear.
" "	" 12	7 00 p.m	27.34	51.	62.	....	S.	1	1	C.	47.5	"	Few showers. Wind S. 2. Lake fell 6 in. in 3 days.
" "	" 13	6.00 a.m	27.24	41.	..	32.	N.	1	9	K & K S.	.....	Raining.	Fair. K. 6 Clouded up this morn.
" "	" 13	7.00 p.m.	27.17	58.	66.	....	Calm.	....	9	K & K S.	51.	.....	Showers. Lake fell 4 in.
" "	" 14	6 00 a.m.	27.20	46	..		"		10	K & S.	.....	Gloomy.	Rain all night.
" "	" 14	7.00 p.m.	27.32	50.	58.	....	S.	1	8	C & S.	46.	Hazy.	Showers Gloomy, Water fell 3 in.
" "	" 15	7.00 a.m.	27.33	41		4.	N.	1	10	S.	.....	Raining.	Rained latter part of night.
" "	" 15	7 00 p.m.	27.32	41.	58.		S.	1	9	C & S.	49.	....	Raining a.m.; p.m. cleared.
" "	" 16	7 00 a.m.	27.39	52.5	....	40.	Calm.	....	1	K & C.	.....	Fair, clear.	Fair.
" "	" 16	7 00 p.m	27.35	6 .	65.	....	"	....	1	K.	.....	... .	Sprinkle. K. 1-4. Little thunder.
" "	" 17	6.00 a m.	27 43	45.	....	29.	"	....	1	C.	.....	Fair, clear.	Fair.
Finlayson River, 3 mi up	" 17	7.00 p.m.		5.5	....	....	E. N. E.	2	9	S & K.	50.	.....	" Clouded in p.m.
" " "	" 18	7 00 a.m	27 18	56 5	..	43.5	Calm.	....	6	S & K S.		.....	Clearing during night.
" "	" 18	7 00 p.m.	27.17	64.	....	....	S.	1	2	K & K S	53.	... .	Fair. Sunny.
" "	" 19	6.0 a.m.	27.20	52.	..	41.	W.	..	9	S & K S.	.....	Gloomy.	Dull night.
" "	" 19	7.00 p.m.	27 12	60.	..		Calm.	.	1	K.	.....	.....	Fair. K. 5.
" "	" 20	6.00 a.m.	27.15	50.	..	35.	"	..	1	C.		.....	" Calm night.
" "	" 20	7 00 p.m	27.00	6 .	....	....	"	..	1	C S.	..	Fair.	" Very warm day.
" "	" 21	6.00 a.m.	27.08	48.	....	33.	"	...	1	C.	....	"	" night. Skin of ice.
" "	" 21	7.00 p.m.	26.93	65.	....	....	W.	1	5	K.	59.5	"	" Warm day.

Finlayson River	July	22	6.30 a.m.	26.98	59.	....	41.	Calm.	....	1	K & C.	.....	Fair.	Fair. River fell 1 in.
East Branch Finlayson River	"	22	8.00 p.m.	26.84	58.5	.....	...	N.W.	....	0	.....	.....	"	" Warm.
" " " "	"	23	7.10 a.m.	26.91	57.	....	40.	Calm.	....	1	K.	....	"	" night.
Finlayson River Valley	"	23	7.00 p.m.	26 51	72.	.....	....	"	....	1	C & K.	....	"	" Very warm all day.
" " "	"	24	7.00 a.m.	26.60	67.	...	50.	S.	1	0	.....	.....	"	" night.
" Lake ...	"	24	7 00 p.m	26.80	74.	.....	....	Calm.	....	0	.....	64.	.....	K. 1 greater part of day. Fair.
" "	"	25	7.00 a.m.	26 83	59.	.....	41 5	"	....	0	.....	...	.....	Fair. S. wind 2 last night. Smoky.
" "	"	25	7.00 p.m.	26.84	74.	78.5	..	"	....	1	C.	65.	Fair.	N. wind 2. Blue sky.
" "	"	26	6.30 a.m	26.93	58.	..	52.	"	....	0	.....	.....	"	S. wind 1. Smoky. Fair.
" "	"	26	7.15 p.m.	26.79	72.	.....	....	"	....	1	C S.	66.	Fair, smoky.	Fair. S. wind 1, a.m.; calm p.m.
" "	"	27	6.30 a.m.	26.72	58.	....	51.	E.	1	3	K S.	....	" "	" E. wind 1-2 all night.
Country west of Finlayson Lake	"	27	7.30 p.m.	25 84	70.	...	....	Calm.	...	1	K.	.....	.....	" K. 2-7.
" " " "	"	28	6.00 a.m.	25.74	50.	...	37.	"	....	0	.....	.....	Fair.	" K. 1-2.
" " " "	"	28	4.00 p.m.	26.46	69.	.....	....	W.	1	1	C & K.	....	"	Smoky. K. 1-4.
" " " "	"	29	.....	26.54	40.	....	46.	Calm.	...	...	.....	.....	"	Fair.
Pelly River	"	29	7.00 p.m.	26.88	64.	.....	....	S.	1	4	C S.	61.	"	p m. S. wind 2. Like rain.
" "	"	30	6.30 a.m.	26.93	55.	...	46.	Calm.	....	6	K & K S	.....	Threatening	Fair. River fell 1 in.
" "	"	30	7.00 p.m.	26.87	55.	70.	...	"	..	10	S.	60.	"	Thunderstorm in evening. S. wind 1.
" "	"	31	7.00 a.m.	26 86	51.	.....	48.	"	....	4	K.	....	Clearing.	Rain all night. Cleared 6 a.m.
" "	"	31	7.00 p.m.	26.84	55 5	62.5	..	S. W.	2	4	K.	59.	Fair.	Wind S.W. 2. K. 1-5.
" "	Aug.	1	6.30 a.m	26.84	43.	.....	29.	Calm.	....	9	K.	.....	Threatening.	Fair. K. 2-5.
" "	"	1	7.00 p.m.	26.87	54.	....	....	"	....	10	K S.	59.	Gloomy.	Wind W. 2. Showery. K & K.S.
" "	"	2	6.00 a.m.	26.91	40.	..	40.	"	....	1	K & C.	.....	....	Light sprinkle rain during night.
" "	"	2	7 00 p.m.	27.12	57.	....	..	Lt. var.	...	2	C & K S.	56.	.....	Showers. Wind W 2. K & K.S.
" "	"	5	6.00 a.m.	27.25	33.	...	28	Calm.	....	0	.....	.....	....	Fair night. River still falling.
" " Hooles Cañon....	"	3	7.00 p.m.	27.28	49.	.....	..	Lt var.	....	9	K & S.	54.	....	" Clear. Wind N. 2.
" " " "	"	4	6.00 a.m.	27.22	50.	....	40.	N.E.	1	1	K.	.....	Fair.	Cleared off last evening. Wind 3.
" " " "	"	4	7.00 p m	27.42	51	.....	....	N.W.	2	9	S.	53.	Gloomy.	Showers p m. Wind N.W. 3, p.m.
" "	"	5	6.00 a.m	27.45	44.	...	37.	W.	1	10	S.	.....	"	Gloomy night. River fell 2 in. Wind N.W. 2.
" "	"	5	7.00 p.m.	27.62	54.	..	....	Lt. var.	....	10	K S	52.5	"	W. wind. 3showers. Dull day.
" "	"	6	6.00 a.m.	27.70	47.	....	41.	E.	....	1	K S.	....	.....	2 showers in night. K.S. 10-2.
" "	"	6	7.00 p.m.	27.81	58.	..	....	Calm.	....	3	K.	54.	Fair.	Wind W. 2. Sunshine p.m.
" "	"	7	6 00 a.m.	27.88	36.	...	....	"	....	1	K.	.....	"	Calm. Fair. K. 1.
" "	"	7	7.00 p.m	27.83	64.	...	....	"	...	0	.....	57.	Smoky.	Fair wind N. & N.E. 2 to-day.
" "	"	8	5.10 a.m	27.63	51.	...	50.	W.	2	10	K & S.	....	....	K. & K.S. 0-6 p m. River fell 1 in.
" "	"	8	7 00 p.m	27.69	59.	...	....	W.	2	3	K.	57.	Fair.	Wind W. 2. Cleared up about 12 00.
" "	"	9	6 00 a.m.	27.99	45.	....	44.	Lt. var.	....	0	.....	.....	Very clear.	Wind W. 3.
" "	"	9	7 00 p.m.	28 19	58.	....	....	"	....	0	.....	57.	Fair.	Showers. Wind 2. K. 0-6.
" "	"	10	8.0. a.m.	28 30	40.	...	34.	Calm.	....	1	C S.	.....	Fog on river.	Fair.
" "	"	10	7.00 p.m.	28.28	60.	..	....	E.	1	9	K S.	56.	Gloomy.	S.C. 5. Light winds up & down river.
" "	"	11	6.00 a.m.	28.39	35.	....	33.	Calm.	....	1	C.	.....	Fog on river.	KS. 10-0.
Camp near Fort Selkirk	"	11	7.00 p.m.	28.43	62.	.	....	"	....	6	C S.	56.3	Fair.	C.K. 2-4. Light N.W. air.
" " "	"	12	7 00 a.m.	28.46	50.	....	46.	E.	1	10	S & K S	.....	Threatening	Hazy and calm.
" " "	"	12	7.00 p.m	28.35	64.	78.	.	W.	1	4	C K.	56.	.....	C. & K.S. 0-9. Dull day.
" " "	"	13	7.00 a.m.	28 38	50.	....	45.	S.	1	1	K S.	.....	.....	K.S. 8. Calm.
" " "	"	13	7.00 p.m.	28 30	65.	75.5	....	Calm.	...	1	K.	57.	.....	" 1. " River fell 1 in.
" " "	"	14	7.00 a.m.	28.39	45.	..	38.	E.	1	1	K.	.....	.....	" 1. "
" " "	"	14	7.00 p.m.	28 33	63.	71.	....	Calm.	....	3	C.	56.5	.....	C.S. 1-4. "

PLACE.	Date.	Hour.	Barometer corrected.	Ther. corrected. Air.	Max.	Min.	Direction of wind.	Force o wind	Amt. of cloud.	Kind of cloud.	Temperature of Water.	Weather at time.	Weather during last interval.
				°	°	°							
Camp near Fort Selkirk.....	Aug. 15	7.00 a.m.	28.26	48.	.	48.	Calm.	..	6	C K.	....	Threatening.	Gloomy. Calm. C S & K 5, River fell 1 in.
" " "	" 15	7.00 p.m.	28.26	70.5	84.5	...	"	....	3	C.	58.	Smoky.	Sultry. C. 1-4.
" " "	" 16	7.30 a.m.	28.35	52	..	40.	"	....	5	C K&C S.	.....	"	Calm. C S & K 4. Very thin clouds.
" " "	" 16	7.00 p.m.	28.31	62.	70.	...	"	....	3	C & K.	57.	"	" C & K 5 all day. River fell 1 in.
" " "	" 17	8.30 a.m.	28.34	59.	.....	48.	"	....	3	K.	.....	Fair.	Cloudy. C S & C K 4-6.
" " "	" 17	7.00 p.m.	28.29	69.	80.	....	S.E. Air.	....	0	.....	59.	"	Fair. Clear.
" " "	" 18	6.30 a.m.	28 36	39.	.....	38.	Calm.	....	1	C S.	.....	"	" Very clear night.
Lewes River	" 18	7.00 p.m.	28.13	65.	.....	...	"	....	1	C.	59.	"	Wind 1 S. Clear p.m.
" "	" 19	5.30 a.m.	28 24	47.	....	45.	"	...	1	K S.	.....	"	Overcast.
" "	" 19	7.00 p.m.	28 22	56.	.....	..	"	..	10	S & K.	56.	Rainy.	Rain from S. p.m.
" "	" 20	5.45 a.m.	28.34	47.	.....	42.	"	....	10	S.	.....	Foggy	Stopped raining last evg. Calm. Ugly.
" "	" 20	7.00 p.m.	28.32	55.	.....		"	..	0	.....	56.	Fair.	Overcast till 4 p.m. Wind S.E. 1.
" "	" 21	5 45 a.m.	28.41	35.	.....	34.	"	...	0	.....	.....	Dense fog.	
" "	" 21	7.00 p.m.	28.29	65.	..	....	"	....	5	C & K.	56.	Fair.	K. 3. Wind 1 S.E. Warm day.
" "	" 22	6.00 a.m.	28.41	45.	.....	44.	"	...	0	.....	.....	Fair, clear.	Light showers during night.
" "	" 22	7.00 p.m	28 32	56.	...	....	"	..	1	K.	56.	Fair.	Sunny. Wind S S.W. 1.
" "	" 23	6 00 a.m.	28.10	33.	.....	....	"	....	0	.....	.....	Foggy.	
" "	" 23	7.00 p.m.	28.09	59.	.....	....	"	..	1	C.	56.	Fair.	Calm. C S 5.
" "	" 24	6.00 a.m.	28.08	8.	.....	31.	"	....	6	K.	.....	Clear.	Clear. Wind S. 1.
" "	" 24	7 00 p.m.	27 89	64.	.....	....	"	....	0	.....	56.	.....	Hot day.
" "	" 25	6.00 a.m.	27 95	52.	.....	51.	"	..	10	K S.	.....	Drizzling.	Rainy, light.
" "	" 25	7.00 p.m.	27.92	49	..	....	S.	1	10	K & S.	55.	Gloomy.	Clouded all day. Raining half time.
" "	" 26	6.00 a.m.	27.91	46.	.	44.	S. E.	1	10	K & S.	.....	"	Showery. Wind S. 1.
" "	" 26	7.00 p.m.	27.82	52.	.....	....	"	1	10	K & K S.	54.	"	K & K S 10 all day. Cool wind S.E. 1.
" "	" 27	6 00 a.m.	27 83	41.	.....	37.	Calm.	....	9	K S.	.....	Fog.	K S 10. Calm.
" "	" 27	7.00 p.m.	27 82	53.	.....	....	"	....	4	K S	55.	Fair.	Showery. K. 5-6. Warm sun.
" "	" 28	6.00 a.m.	27 93	43.	...	32.5	E.	1	1	C.	.....	Fog	K 4-0.
" "	" 28	7.00 p.m.	27 86	46.	.....	....	Calm.	...	1	K	54.	Fair.	Sunny. K. 3.
" "	" 29	6 00 a.m.	27.92	30	...	28.5	"	....	0	.....	.....	Fog.	Clear. Calm.
" "	" 29	7.00 p.m.	27.86	55.	.....	....	S.	1	6	K.	54.	Fair.	Fair wind S. 3. K S. 5-8.
" "	" 30	6.00 a.m.	.....	36.	...	23.5	Calm.	....	8	S & C K.	.....	Fog.	C K & S 6.
" " mouth of Tes-lin-too.	" 30	7.00 p.m.	27.72	55.	.....	....	S.W.	3	10	S & K S.	52.	Gloomy.	Showery. K & S 10. Wind S.3. Cold.
" " " "	" 31	7.30 a.m.	27.10	54		49.	S.	4	10	S & K S.	.....	"	" S & K S. 10 " 3.
" " " "	" 31	7.00 p.m.	27 72	57.	60.	....	S.	3	5	C K.	52.	Fair.	K S & C S 8. Wind S. 3 all day.
" " " "	Sept. 1	5.30 a.m.	27.72	52.	.....	49.5	Calm.	....	10	S.	.....	Light rain.	R S & C S 8. Wind S. 3 all dap. Showery. Wind died out last night.

Lewes River	Sept.	1	7.00 p.m.	27.63	57.			S. W.	2	8	S & K S.	52.	Fair.	Wind N.E. 1 a.m., S. 2 p.m.
" "	"	2	5.30 a.m.	27 78	32.		30.	Calm.		0			Fog.	Fair. Clear.
Foot of Lake Labarge	"	2	7.00 p.m.	27.88	41.			"		3	K.	53.	"	K. 1-6. Wind S. 2.
" " "	"	3	6.00 a.m.	27.92	33.5		27.5	N.	1	6	C S.		Fair.	Clear. Calm.
Lake Labarge	"	3	7.00 p.m.	27.71	54.5			S.	3	3	C.	51.5	"	C. & S. 1-5. Wind S. 3 all day. Hazy sunshine.
" "	"	4	5.30 a.m.	27.83	39.5		36.	Lt. var.		10	C S & K.		"	C. 5. Wind died out early last night.
Near head of Lake Labarge	"	4	7.00 p.m.	27.69	56.			W.	2	5	K & S.	49.5	"	C. clouds coming rapidly from W. p.m.
" " " "	"	5	6.00 a.m.	27.88	44.		42.	W.	1	10	K S.		Light rain.	Showery a.m. W. wind 3 for 1 hour.
Lewes Riv., below Tahkheena R.	"	5	7.00 p.m.	27.87	53.			Calm.		3	C S.	54.	Fair.	Fair. C.K. 3. Wind S. 1., p.m.
" " " "	"	6	6.00 a.m.	27 67	50.		49.	S.	3	10	S & K.		Gloomy.	" S. 10 wind latter part of night.
" " White Horse Rapid	"	6	7.00 p.m.	27 54	53.			Calm.		3	K & C.	53.5	Fair.	K.C. 1-4. Wind S. 4.
" " " "	"	7	6.00 a.m.	27.72	42.		41.	"		9	K S.		"	Calm. K. 2-6. Light rain this a.m.
" " below cañon	"	7	7.00 p.m.	27.65	48.5			S.	2	10	S.	53.	"	K. 0-5. Wind S. 1.
" " " "	"	8	6.00 a.m.	27.67	44.		42.5	Lt var.		6	K.		"	Fair. Wind S.W. 1.
" " head of "	"	8	7.00 p.m.	27.57	51.			S. W.	1	6	K S.	53.5	"	
" " " "	"	9	6.00 a.m.	27.49	38.		34.	Lt. var.		9	K.		Gloomy.	K. 2-0.
" "	"	9	7.00 p.m.	27.54	48.			N.W.	2	10	S.		"	Wind p.m. N.W. Cool day.
" "	"	10	7.00 a.m.	27.75	41.5		37.	Calm.		10	S.		Drizzling.	Rained a little. Calm. Snowed on mts.
Lake Marsh	"	10	7.00 p.m.	27.76	41.5			Lt. var.		10	S & K S.	52.	Gloomy.	Showery. Wind W. 1. Cool.
" "	"	11	6 20 a.m.	27.83	39.		32.	E.	1	10	S & K S.		"	Overcast all night. Calm.
Tagish Houses	"	11	7.00 p.m.	27 69	42.			Calm.		1	K.	49.5	Fair.	K S & K 8-2, a.m.; p.m., Wind W. 2. C. clouds.
" "	"	12	6 00 a.m.	27.60	29.		27.	"		10	S.		Gloomy.	K S 1. Calm. Clouded over this a.m.
Tagish Lake, Windy Arm	"	13	6.30 a.m.	27.69	36.		34.	Lt. var.		3	C S & K.		Fair.	Wind W. 3.
	"	13	7.00 p.m.	27.76	33.			"		1	K S.	48.5	"	K S 4-0. A.m. wind N. 1; p.m. calm.
" "	"	14	6.00 a.m.	27.88	26.5		25.	Calm.		0			"	Clear. Calm.
Bennett Lake	"	14	7 00 p.m.	27.83	36.			N.	1	0		46.5		K. 1. Hot sun. Wind S. 2 all day.
" "	"	15	6.00 a.m.	27.83	29.		26.	S.	1	1	K.		Fair.	Clear. Calm.
" "	"	15	7.00 p.m.	27.75	43.			N.	3	8	K.	45.5	"	K & C K 1 3. Low wind N. 2, high wind W.
" "	"	16	6 30 a.m.	27 75	40.5		39.	N.	1	10	K S.		Gloomy.	K 8. N. 2 wind all night.
Lake Lindeman	"	16	7 00 p.m.	27.75	40.			N.	1	10	K S.	45.		K S. 6-10. Wind S. 1, a.m.; N.1, p.m.
" "	"	17	7.00 a.m.	27.74	41.		29.	S. W.	1	8	K.		Fair.	K. 10-6. Calm.
" "	"	17	7.00 p.m.	27.72	37.	58.		S.	1	1	K.	45.	"	K. 10-4. High wind N., low wind S.1.
" "	"	18	7.00 a.m.	27.75	36.		19.	Calm.		0			"	Clear. Calm. Light fog on water.
" "	"	18	7.00 p.m.	27.71	32.	54.		N. E.	1	1	C.	45.	"	" all day. " var. wind.
" "	"	19	6.00 a.m.	27.75	21.		18.	N. E.	1	0			"	Fair; clear. " fog on water.

(2) OBSERVATIONS AT TELEGRAPH CREEK, STIKINE RIVER, B. C., DURING PORTIONS OF THE YEARS 1881 TO 1886, BY J. C. CALLBREATH.

Date.	Minimum Temperature.	Remarks.
1881.	°	
Oct. 2	23	Coldest night yet.
3	.....	Heavy frost last night.
8	12	
9	7	First ice running on river.
10	14	
11	22	
12	20	
13	.....	Little frost last night.
14	.....	No frost this morning.
15	25	
16	14	
17	10	
18	7	
19	10	
20	21	
21	30	
22	.....	No frost last night.
23	.....	Weather mild.
24	.....	" "
25	.....	" "
26	.....	" "
27	.....	" " 9 p.m., 45°
28	26	
29	25	
30	33	
31	23	
Nov. 1	20	
2	32	
3	26	
4	.....	No frost last night.
5	32	
6	25	
8	31	
9	26	
10	29	
11	24	
12	16	
13	12	2 in. snow on range at Tahltan.
14	8	
15	—13	3 or 4 in. snow on range at
16	—17	[Tahltan.
17	—4	
20	.....	Mild.
22	—7	
23	4	Mild all day.
24	8	8 in. snow on range at Tahltan.
25	32	
26	34	
27	20	
28	20	
29	15	
30	10	
Dec. 1	20	
2	20	
3	2	
4	0	
5	4	
6	12	
7	7	
8	3	
9	—2	
10	0	
11	—13	
12	—29	
13	—20	
14	—18	
15	—4	
19	6	
20	24	

Date.	Minimum Temperature.	Remarks.
1881.	°	
Dec. 21	2	
22	10	
23	—2	
24	—2	
25	15	
26	—2	
27	—2	
28	—2	
29	—7	
1882.		
Jan. 1	—4	
2	—17	
3	—14	
4	—13	
5	—2	
6	5	
7	6	
8	6	
9	8	
10	6	
11	8	
12	15	
13	.....	Heavy thaw.
14	8	
17	30	
18	22	
19	22	
20	15	
21	7	
22	—4	
23	—15	
26	—26	
27	—30	
28	...	Mild.
29	27	
30	6	
31	13	
Feb. 1	19	
2	5	
3	8	
4	15	
7	—1	
8	—9	
9	—12	
10	—28	
11	—28	
12	20	
13	0	
14	0	
15	—27	
16	—32	
17	—20	
18	.....	9 a.m., —2°
19	.....	Thawing.
20	4	
21	30	
22	12	
23	—8	
24	—1	
25	—2.	
26	0	
27	.....	Mild.
28	5	
March 1	10	
2	—6	
3	—16	
4	—22	
5	—13	
6	10	

Date.	Minimum Temperature.	Remarks.
1882.	°	
March 7	20	
8	23	
9	—4	
10	—4	
11	7	
12	22	
13	7	
14	6	
15	—6	
16	13	
17	—5	
18	—18	
19	—17	
20	—10	
22	—19	
23	2	
24	15	
25	22	
26	8	
27	15	
29	—8	
30	—12	
31	10	
April 1	14	
2	10	
3	20	
4	15	
5	14	
7	12	
9	22	
10	23	
11	24	
13	24	
14	25	
15	33	
16	29	
17	30	
20	9	
21	30	
22	16	
23	11	
24	27	
25	16	
26	17	
27	19	
28	26	
29	25	
30	26	
May 1	27	
2	28	
3	34	
4	34	
5	33	
7	32	
9	26	
10	33	
11	42	
13	26	
14	34	
15	30	
16	28	
17	35	
18	38	
19	26	
21	29	
22	29	
23	.....	No frost.
24	.....	" "
Sept. 29	22	Coldest night of season, bright clear day.
30	20	Wind N., bright and clear all day.
Oct. 1	24	Wind N.
3	19	

Date.	Minimum Temperature.	Remarks.
1882.	°	
Oct. 4	19	
6	.....	Bright, fine day.
7	21	
8	30	Cloudy, light sprinkle rain a.m.
10	33	" raining a little all day.
11	36	
13	30	
14	24	
16	30	Fine, clear day, strong wind up river.
17	30	Cloudy and calm.
18	32	Rained hard in eve., drizzling all day.
19	35	
21	32	Snowing this morn., melting as it fell.
28	.....	Mild and pleasant.
31	12	Ice running in river for first time.
Nov. 1	14	
2	20	Wind up river since noon.
3	24	Fine, mild day.
5	15	Mild and pleasant; bright all day: less than 1 in. snow fell yesterday
6	12	
7	17	Mild and calm all day.
8	18	Overcast, light mist; little or no ice in river.
9	3	
10	2	Calm, mackerel-sky clouds moving up river.
11	22	Mild and calm all day.
12	26	Snowed a little.
13	19	Clear and calm all day.
14	24	Light floating clouds: calm and mild all day,
15	17	Commenced raining 2 p.m.
16	32	Rained all night; snowed for 1 hour after daylight; cleared off.
17	30	Mild and pleasant all day; wind up river.
18	25	Mild and pleasant; light snow in evening.
19	20	Bright, calm day.
20	11	Partly clear.
21	—5	Clear and calm.
22	—10	" " "
23	—6	Partly overcast a.m., p.m. mild, calm, overcast.
24	6	Lightly overcast, calm.
25	7	Snowed a little this a.m.
26	20	Lightly clouded all day, mild.
27	8	Overcast, snowing a little, mild all day.
28	7	Clear and mild all night.
29	3	Misty, began snowing from N.E. 4 p.m.
30	15	Snowed 3 in.; river nearly closed.
Dec. 1	6	Lightly overcast.
2	7	Mild day.
3	14	Light overcast, calm all day.
4	14	Hazy and calm.
5	14	" " "
6	—1	
7	0	Mild and calm.
8	1	Mild, overcast; lt. snow p.m.
9	11	Lightly overcast, mild and calm.
10	8	Partly clouded; snow squalls.
11	—7	Cold all day; wind down river.

Date.	Minimum Temperature.	Remarks.
1882.	°	
Dec. 12	—11	
13	—28	Cutting N. wind; not above —20° all day.
14	.....	9 a.m., —16°; 5 in. fine snow all day.
15	—11	Snowed about 8 inches.
16	6	Little snow during night; growing warmer.
17	21	Overcast, wind E.
18	6	Overcast, as usual this mild weather.
19	—4	
22	.....	This evening 33°.
23	20	
24	12	Mild and pleasant all day.
25	.....	10 a.m., 34°.
26	23	Misty, sprinkle of snow, mild and calm.
27	12	Clear, mild and pleasant all day.
28	5	Clear; 15 in. snow on Tahltan range.
29	—10	Clear and calm.
30	—14	" " "
31	—4	Mild and calm.
1883.		
Jan. 1	4	" " "
2	0	
3	.....	9 p.m., —3°.
4	.....	8 a.m., —11°.
5	—16	Clear; wind N.
6	—20	Clear and calm.
7	—16	Mild all day; clear.
8	0	
9	—6	Overcast.
10	.....	8 a.m., 3°.
11	8	
12	—11	Mild and calm all day.
13	—9	
14	.....	8 a.m., 5°.
15	0	Calm.
16	—17	Clear and calm; cold all day.
17	—24	
18	—18	" " " growing milder.
19	—8	
20	2	Mild and calm.
21	17	Calm all day.
22	24	Lightly overcast, squally.
23	16	Mild and squally.
24	10	Misty overhead; calm.
25	5	Calm; lightly overcast.
26	—2	Lightly overcast and calm.
27	.....	11 p.m., 0°.
28	0	Mild and calm.
29	10	" " " partly overcast.
30	—3	
Feb. 1	.....	Weather milder.
2	.....	10 p.m., —24°; clear.
3	....	11 p.m., —22°.
4	.....	10.30 p.m., —10°; clear.
5	—13	Lightly overcast; cold and clear.
6	—10	Clear.
7	—4	
8	—3	Lightly overcast.
9	—2	Clear and calm.
10	—4	Clear; snowed a little.
11	12	Overcast a.m.; strong E. wind, clear and calm p.m.
12	0	Strong N.E. wind; clear.
13	—20	Clear; N. wind.
14	—23	Clear and calm.
15	—23	Lightly overcast and calm.
16	—10	" " sprinkling snow.
1883.	°	
Feb. 17	5	Overcast; a little snow.
18	10	Mild and calm; snowed 2 in. last night.
19	7	Calm.
20	—2	Clear and calm.
21	—3	Clear.
22	.....	10 p.m., 5°.
23	—1	Calm and partly clouded.
24	9	Cloudy.
25	—1	10 a.m., thawing—first thaw of season.
26	33	Thawing; clear all day.
27	35	Thawed all night.
28	22	Bright and warm.
March 1	9	Clear.
2	.....	Warm day.
3	25	Wind N.E.
4	11	Bright, clear.
5	11	Bright.
6	7	Clear.
7	15	Clear, warm day; thawing in shade.
8	21	Clear, bright; strong wind up river.
9	28	Clear.
10	18	Clear and warm.
11	22	
12	26	
13	26	
14	24	
Oct. 13	.....	Weather mild.
14	.....	" "
15	.....	" " overcast.
16	.....	Very mild.
17	.....	Mild and calm.
29	.....	About 12°; weather moderate; little ice running in river.
Nov. 1	—5	Coldest night of season; much ice in river.
2	5	9 p.m., 8°.
3	4	10 p.m., 32°.
4	27	Snowed 1 in.; mild day.
5	26	" 2 " last night.
6	27	
7	16	
8	10	
9	15	Snowing lightly a.m.; p.m. clear.
10	—3	Lightly overcast.
11	6	Mild, hazy, calm.
12	.....	8 a.m., —4°; clear, calm.
13	—12	Moderating; calm.
14	—3	Clear and calm.
15	10	Mild and calm,
16	12	Clear; wind down river.
17	.....	8 a.m., 27°; river closing fast.
18	25	Mild and overcast.
19	26	
20	28	Clear.
21	.....	8 a.m., 24°.
22	13	
23	—7	Clear; N. wind.
24	—16	" "
25	—20	Clear and calm.
26	—25	" " "
27	—27	Clear and calm a.m.; p.m. hazy.
28	—12	Snowed a little last night; clear day.
29	—11	
30	—3	Mild; overcast all day.
Dec. 1	14	Snowed and rained a little to-day.
2	31	

Date.	Minimum Temperature.	Remarks.
1883.	°	
Dec. 3	9	Hazy, calm.
4	9	Mild.
5	16	Mild.
6	—10	Calm, hazy, mild.
7	.....	8 a.m., 22°; snowed 1 in. last last night.
8	13	Calm and clear.
9	16	Misty; snowed a little.
10	26	Wind S.
11	26	Clear and calm.
12	21	Clear.
13	7	Mild all day.
14	12	Snowed a little all day.
15	.....	9 a.m., 22°; snowed a.m.; rain p.m.
16	.....	9 a.m., 42°; clear; strong S. wind.
17	.....	9 a.m., 34°.
18	.....	9 a.m., 24°; little snow.
19	14	
20	18	
21	9	Clear and calm.
22	—1	Clear and hazy.
23	.....	9 a.m., —4°.
24	.....	9 a.m., —11°.
25	—17	Clear and calm.
26	—14	
27	—9	Clear.
28	—26	Clear; N. wind.
29	—30	Clear and calm.
30	—33	
31	.....	6 a.m., —1°; wind N.E.
1884.		
Jan. 1	—6	Clear and calm.
2	—10	Clear.
3	—14	Clear; N. wind.
4	—20	Hazy all day; 10 p.m., —6°.
5	—6	Hazy; 10 p.m., —2°; lt. snow.
6	—15	
7	—6	
8	.....	9 a.m., 5°.
9	.....	" " 8°.
10	.....	" " 16°; snowed 1 inch.
11	.....	" " 22°; hazy, calm.
12	15	Snowed a little last night.
13	7	
14	20	
15	0	
16	37	Strong southerly wind; thawing.
17	9	Clear and calm.
18	0	Hazy, calm.
19	—10	Clear and calm.
20	0	Partly overcast.
21	14	Mild and hazy: a little snow.
22	20	Clear and calm.
23	22	Mild all day.
24	20	" " "
25	23	Snowed about 2 in. last night.
26	5	N.E. wind.
27	—17	Clear and calm.
28	—20	" " "
29	—21	Clear; wind up river.
30	—5	Thawing all day; 10 p.m., 30°.
Feb. 1	—5	Snowed 4 in. last night; strong N.E. wind.
2	—19	
3	—21	
4	—5	
5	—7	Clear.
6	—5	" and calm.
7	—7	" strong wind down river.
8	—15	" and calm.
9	—13	" " "

Date.	Minimum Temperature.	Remarks.
1884.	°	
Feb. 10	—18	Clear and calm.
11	—18	" " "
12	—17	" " "
13	—15	" " "
14	—9	" " "
15	—23	Calm.
16	—19	Strong north wind; clear.
17	—21	Strong N.E. wind; lt. snow; overcast.
18	—20	Clear; N. wind.
19	—30	Clear and calm; coldest night of winter.
20	—25	Calm.
21	—25	Clear and calm; p.m. overcast.
22	—5	Snowed a little.
23	10	Lightly overcast; little snow.
24	40	Strong S. wind; thawing.
25	24	
26	35	Rained hard during night.
27	30	Little hazy.
28	12	
29	10	Clear, calm.
March 1	15	" "
2	20	Clear.
3	20	Overcast; strong N.E. wind all day.
4	—2	Clear; N. wind.
5	—7	
6	—8	
7	10	
8	6	Clear and calm.
9	—3	" " "
10	—4	" " "
Oct. 18	.....	Ice commenced running in R.
19	12	
20	.....	Not much ice running to-day.
21	.....	More " " "
22	.....	Ice running thick; little frost last night; thawed all day.
23	.....	Ice running thick; froze a little last night; thawing this a.m.
24	.....	Snowing this evening.
26	.....	Mild; snowing a little; river almost clear of ice.
27	.....	Mild; no ice running.
28	20	Cloudy; light snow.
29	18	Overcast; light snow; good deal of ice running.
30	12	Much ice running; mild to-day.
31	12	Dry, mild and clear.
Nov. 1	7	Clear; coldest night of season so far.
2	14	Lightly overcast; mild and pleasant.
3	16	Mild and pleasant day.
4	22	Snowing this a.m.
5	30	Snowed 2 in. last night; thawing this morn.; snow at Thaltan range nearly 1 ft. deep.
6	24	Clear.
7	28	
8	29	
9	29	
10	30	
11	32	Snowing at noon; turned to rain and sleet.
12	38	Raining.
13	32	Clear; no ice in river.
14	24	Clear and calm.
15	14	
16	18	Overcast.
17	20	Misty and calm; snowed a little in evening.

Date.	Minimum Temperature.	Remarks.
1884.	°	
Nov. 18	32	Clear.
19	22	A little snow during day.
20	21	Overcast, calm.
21	11	Hazy and calm.
22	13	Mild " "
23	16	Clear.
24	14	Hazy and calm.
25	20	Snowed about 2 in. last night.
26	26	Nearly clear.
27	29	Hazy.
30	36	Rained hard all day.
Dec. 1	31	Clear a.m.; clouded and raining p.m.
2	....	8 a.m., 34°: 1 p.m., raining; 3 p.m., cleared.
3	30	Clear.
4	24	Snowed about 2 in. this eve.
5	24	Clear.
6	20	Misty and cloudy; wind S.W.
7	.....	10 a.m., 42°.
8	30	Clear and calm.
9	21	Lightly overcast.
10	21	Clear.
11	12	Clear: wind down river.
12	7	Clear,
13	3	Lightly overcast.
14	3	Clear; N. wind.
15	—15	Clear; N. wind; below —12° all day.
16	—16	Clear.
17	—4	Strong easterly wind.
18	—8	Clear; strong wind down river; crossing on ice to-day.
19	—12	Clear; N. wind.
20	—15	" " "
21	—20	Strong; N.W. wind a.m.; calm p.m.
22	—20	Little wind.
23	—10	Overcast.
24	—5	Clear.
25	—15	"
26	—22	Clear, strong north wind.
27	—22	
28	—33	Clear.
29	—20	Clear and calm.
30	—14	" " "
31	—7	Lightly overcast,
1885.		
Jan. 1	—3	Calm and hazy.
2	—3	Lightly overcast.
3	5	Partly clear.
4	—6	Overcast; snowing.
5	17	
9	.....	Mild and calm.
10	.....	Snowed 4 in. last night; light snow to day.
11	.....	Clear and colder this morning.
12	.....	10 p.m., —15°; below zero all day.
13	—22	
14	—30	Clear.
15	—32	" N. wind.
16	—32	" and calm.
17	—22	" "
18	—28	" " "
19	—5	Hazy; light snow last night.
20	3	Calm, misty.
21	10	Snowed about 3 in. last night; clear and calm.
22	—6	Hazy, calm.
23	6	" "
24	10	" "
25	16	Rained all p.m.
28	.....	Mild.

Date.	Minimum Temperature.	Remarks.
1885.	°	
Jan. 30	.....	Light snow.
31	.....	Mild and calm.
Feb. 1	19	
2	22	Calm
3	25	Lightly overcast.
4	30	Overcast, calm.
5	11	" "
6	10	Cloudy; E. wind.
7	—2	Clear and calm.
8	—9	" " "
9	—15	" " "
10	—5	Calm and overcast.
11	10	" " misty.
12	10	Clear and calm.
13	13	Hazy " "
14	14	" " " lt. snow in eve.
15	20	Clear
16	.....	10 p.m., 15°.
17	4	
18	—9	Clear and windy.
19	—16	" " calm.
20	—15	" " "
21	—5	Overcast.
22	19	Thawing in shade at noon.
23	29	Heavy thaw all day.
24	20	Clear and calm.
25	20	Clear; thawing all day.
26	27	" " " "
27	12	Wind N.E.
28	32	Sleet this p.m.
March 1	30	Clear: maximum temp. 40° in shade.
2	26	Clear and calm.
3	20	Clear all day.
4	10	Clear and calm.
5	10	Lightly overcast: clearing.
6	22	Overcast, calm; snowing at 2 p.m.
7	38	Raining hard.
8	34	Overcast, calm.
9	16	Murky, calm.
10	16	Snowed a little this evening.
11	21	Clear: strong S.W. wind.
12	26	Snowing all day.
13	24	8 in. snow fell yesterday; last night clear and calm.
14	26	Clear.
15	34	Clear: heavy thaw.
16	22	Clear and calm.
17	12	" " "
18	12	" " "
19	.....	" " "
20	20	" " "
21	.....	10 p.m., 28°.
22	10	Clear and calm.
23	16	" " "
25	32	
26	26	
30	.....	No frost last night: cloudy; strong wind up river.
31	34	Clear; wind up river.
April 1	30	Warm; S. wind all day.
2	33	Overcast in morning; raining p.m.
3	.....	Rained and snowed most of night; 2 in. went off this p.m.; bright.
4	.....	Frost last night.
5	35	Clear.
6	18	"
7	22	Cloudy.
8	.....	No frost last night; strong S.W. wind.
9	30	

Date.	Minimum Temperature.	Remarks.
1885.	°	
April 10	28	Clear: strong wind up river,
11	31	
12	31	High winds.
13	30	Little wind; some snow squalls.
14	.....	Not much wind to-day.
15	25	
16	16	
17	10	
18	..	Hard frost.
19	.....	No frost last night.
20	27	
23	28	
Nov. 4	20	
7	26	Strong S.E. wind.
8	22	First ice running in river.
9	5	Clear; good deal of ice running.
10	20	Calm.
11	22	Calm; spitting snow; cloudy.
12	18	Calm and clear.
13	14	Clear; snowed a little last night.
14	19	A little ice running.
15	22	Calm.
16	18	Overcast, calm.
17	22	" "
18	16	Calm; snowing a little.
19	14	Clear.
20	12	
21	7	Clear.
22	6	Clear; river open yet: very little ice running.
23	15	Hazy, calm.
24	21	River entirely free of ice; hazy.
25	12	Hazy.
26	10	Hazy. p.m. clear.
27	12	Clear and calm.
28	10	Hazy and calm.
29	31	Snowing 9 a.m., p.m. thawing.
30	28	9 in. snow fell during night.
Dec. 1	7	Clear, calm.
2	—2	
5	.....	Snowing a little.
6	22	Cloudy.
7	20	Overcast.
8	12	Clear.
9	—8	Clear and calm.
10	—18	" " "
11	0	Snowed a little.
12	8	Hazy, calm all day: snowed little in evening.
13	10	Snowed 5 in. last night.
14	20	
15	14	Hazy, calm.
16	12	Clear.
17	3	Clear and calm.
18	3	" " "
19	—6	Clear.
20	—10	Clear; river closing from edges.
21	—16	
22	4	Clear and calm.
23	—4	" " "
24	.....	8 a.m., —4°.
25	0	
26	10	Thawing; raining in evening.
27	36	
28	28	Cloudy.
29	13	Cloudy; snowed 1 in.: wind up R.: wind down R. in eve.
30	—6	Clear (?); snowing a little all day.
31	—13	Clear.
1886.		
Jan. 1	—4	Snowed 2 in.; strong wind up R.

Date.	Minimum Temperature.	Remarks.
1886.	°	
Jan. 2	18	Snowed 2 in.
3	—2	Wind N.E.
4	—9	Snowed 2 in.
5	—26	Clear.
6	—32	Clouded up p.m.; snowed 2 in.
7	—10	Clear.
8	—6	Calm.
9	4	Clear.
10	6	Overcast; snowed a little in evening.
11	16	Snowed about 2 in.
12	20	Snowed 1 in.; calm and clear.
13	—5	Clear and calm.
14	—17	" " "
15	.....	8 a.m., —16°; clear; wind N.W.
16	—14	
17	.....	8 a.m., 26°; clear.
18	—8	Very clear.
19	—14	N.E. wind all day; clear.
20	—23	Very clear; N. wind.
21	—26	Clear.
22	—30	Clear and calm.
23	.....	9 a.m., 14°.
24	—16	Blew a gale all night.
25	—31	
26	—36	Hazy.
27	—22	"
28	—6	
29	—10	Snowed 2 in.
30	—12	Clear.
31	—6	Clear and calm.
Feb. 1	—10	
2	—2	Overcast; a little snow.
3	0	Snowed about 4 in.
4	—2	" a little.
5	22	" 2 in.
6	34	Rained all night; snow in eve.
7	22	Clear.
8	18	misty.
9	20	Blowing a gale; snowed 6 in.; drifting badly.
10	—2	Clear; evening snowing.
11	.....	8 a.m., 12°; snowed a little; clear.
12	—2	Lightly overcast.
13	—10	
14	—10	Clear and calm.
15	—2	Snowed 2 in.; rained a little p.m.
16	.....	9 a.m., 28°; max., 42°; much rain.
17	34	Strong S.W. wind; much rain
18	.....	8 a.m., 36°; raining hard most of night and to-day.
19	.....	8 a.m., 36°.
20	38	Max., 44°; cloudy and raining.
21	36	Rained nearly all night; clear to-day.
22	27	Overcast; snowed a little.
26	.....	10 p.m., 9°; very clear.
27	0	Clear and calm.
28	0	
March 1	8	Clear.
2	18	Overcast; p.m. snowing.
3	28	Cloudy.
4	20	Overcast.
5	14	Hazy and calm; eve. clear.
6	8	Clear.
7	.....	10 p.m., 22°.
8	18	Cloudy and calm.
10	24	Thawing all day.
11	30	Clear.
12	30	Cloudy most of day.
13	24	

Date.	Minimum Temperature.	Remarks.	Date.	Minimum Temperature.	Remarks.
1886.	°		1886.	°	
Mar. 14	30	Heavy thaw.	April 6	18	
15	27	Wind N.E.; snowed 1 in.	7	20	
16	4	Clear; wind N.E.	8	30	
17	—4		9	31	Clear.
18	16		10	30	
19	12		11	.....	No frost.
20	10		12	27	
23	8	Cloudy most of day.	13	28	Clear.
24	12		14	.....	No frost.
25	18	Clear; freezing in shade.	15	20	Clear.
26	20	Strong N.W. wind; thawing.	16	30	Clear; clouded up in evening.
27	26	Wind up river; thawing.	17	.....	No frost.
29	.....	No frost; cloudy.	18	.....	" "
30	28	Calm.	20	.....	Frost last night.
31	28		21	.....	No frost last night.
April 1	30	Overcast.	22	.....	Finished ploughing.
2	.....	No frost; overcast and foggy.	23	.....	Pack-train off to range.
3	.....	No frost.	23	.....	Canoes arrived to-day.
5	20				

(3) OBSERVATIONS AT LAKETON, DEASE LAKE, B.C., DURING PORTIONS OF THE YEARS 1878 TO 1882, BY MR. J. CLEARIHUE.

Date.	Minimum Temperature.	Direction of Wind.	Remarks.	Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1878.	°			1878.	°		
Nov. 1	0	S.W.	Mild and cloudy.	Dec. 4	12	N.W.	Bright and clear.
2	0	S.W.	Mild and clear.	5	0	N.W.	Cloudy.
3	38	S.W.	Raining.	6	0	N.W.	"
4	22	N.W.	Heavy snowfall.	7	12	S.	"
5	0	S.S.	Mild and clear.	8	8	S.	Lake frozen in front of town.
6	0	S.	Mild and cloudy.				
	20	S.	Mild; sunshine.	9	1	N.W.	Bright and clear; skating on ice.
	14	S.	" "				
	0	S.	Rain in afternoon.	10	—8	N.W.	First arrival from McDames and Thibert Cr. on ice.
10	0	S.	Heavy snowfall at night.				
11	14	N.W.	Bright and clear.	11	12	S.W.	First arrival from head of lake on ice.
12	10	N.W.	" " "				
13	10	N.W.	" " "	12	16	S.W.	Cloudy.
14	12	N.W.	Cloudy, stormy afternoon.	13	18	S.W.	Heavy snow p.m.
				14	20	S.W.	" " last night.
15	16	N.W.	Bright and clear.	15	4	W.	Bright and clear.
16	14	N.W.	Light snowfall.	16	—4	N.W.	Snow.
17	18	N.W.	" "	17	1	N.W.	Bright and clear.
18	18	S.W. strong.	Drifting all day.	18	14	S.W.	Cloudy.
				19	24	S.	Very mild, bright and clear.
19	0	S.	Cloudy; mild in p.m.				
20	0	S.	Snowing.	20	20	S.	Heavy thaw; lake open in places.
21	20	S.	Cloudy.				
22	18	N.W.	Snowing.	21	12	W.	Cloudy.
23	10	N.W.	Cloudy.	22	6	W.	"
24	20	S.W.	Heavy snowfall.	23	—2	N.W.	Bright and clear.
25	10	S.W.	Mild, cloudy.	24	—4	N.W.	" " "
26	18	S.W.	" "	25	—8	N.W.	" " "
27	8	W.	Cloudy.	26	—4	N.W.	" " "
28	10	W.	Bright and clear.	27	—6	N.W.	" " "
29	10	W.	" " "	28	—7	S.W.	" " "
30	12	W.	" " "	29	—4	S.W.	" " "
1	12	S.W.	Snowing p.m.	30	—8	N.W.	" " "
2	20	S.W.	Mild, bright and clear; heavy snow at night.	31	—10	N.W.	" " "
				1879.			
	10	S.W.	Bright and clear.	Jan. 1	—4	N.W.	" " "

Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1879.	°		
Jan. 2	—1	S.W.	Bright and clear.
3	4	S.W.	" " "
4	6	S.W.	Bright and clear; light snow last night.
5	10	S.W.	Bright and clear.
6	6	S.W.	" " "
7	0	S.W.	Snowing.
8	8	S.W.	"
9	—22	S.W.	Bright and clear.
10	—26	N.	" " "
11	—32	N.	" " "
12	—36	S.	Snowing; at noon, —12°.
13	—30	S.	Bright and clear.
14	—22	S.	Snowing; at noon, —4°.
15	6	S.	Cloudy.
16	0	S.	Bright and clear.
17	4	S.	" " "
18	—2	N.	Snowing; very stormy.
19	—6	N.	Bright and clear.
20	—4	S.	" " "
21	—6	S.	Cloudy; stormy p.m.
22	—8	N.	Stormy all day.
23	—2	N.	Strong drifting.
24	—18	N.	Bright and clear.
25	—24	S.	" " "
26	—20	S.	Cloudy.
27	—2	S.	Bright and clear.
28	10	S.	Cloudy.
29	12	S.	Bright and clear.
31	12	S.	Bright and clear; snow last night.
Feb. 1	10	S.	Bright and clear.
2	—11	N.	" " "
3	—11	S.	" " "
4	6	S.	Storming.
5	16	S.	Storming; heavy snow last night.
6	10	N.	Bright and clear.
7	—6	N.	" " "
8	—27	N.	" " "
9	—29	S.	" " "
10	—18	N.	" " "
11	—26	S.	" " "
12	—26	S.	" " "
13	—24	S.	" " "
14	—23	S.	" " "
15	—20	S.	" " "
16	—10	N.	" " "
17	—19	N.	" " "
18	—17	N.	Stormy.
19	—20	N.	Bright and clear.
20	—15	N.	Stormy, drifting.
21	—25	N.	Bright and clear.
22	—26	N.	" " "
23	—16	N.	Stormy, drifting.
24	—24	N.	Bright and clear.
25	—30	N.	" "
26	—10	N.	Snow last night.
27	—10	N.	Heavy storm, snowing, drifting.
28	—8	N.	Snowing and drifting.
Mar. 1	—6	N.	Heavy wind, drifting.
2	4	N.	Storming.
3	0	N.	"
4	—12	N.	Bright and clear.
5	—23	N.	" " "
6	—12	R.	Cloudy, drifting.
7	6	N.	Bright and clear.
8	—6	N.	" " "
9	—4	N.	Bright and clear; strong wind.
10	—18	N.	Bright and clear.
11	—16	S.E.	" " "
12	—20	N.	" " "
1879.	°		
Mar. 13	—20	N.	Bright and clear.
14	4	N.W.	Stormy.
15	—9	N.	Bright and clear.
16	—19	N.	" " "
17	2	N.	" " "
18	—4	N.	" " "
19	2	S.	" " "
20	10	N.	" " "
21	2	.....	" " "
22	10	N.W.	" " "
23	2	N.W.	" " "
24	0	N.	Storming.
25	18	N.W.	Very mild.
26	22	N.	Strong wind.
27	22	N.	Snowing.
28	24	.....	
29	.....	.....	
30	14	.....	Bright and clear.
31	1	.....	
	*	*	* * * *
Nov. 18	2	N.	Snowing and drifting all day.
19	4	N.	drifting, cloudy.
20	12	N.	Light snowfall.
21	14	N.	Cloudy; clear towards evening.
22	4	N.	Cloudy.
23	14	S.	"
24	12	S.	Cloudy; north wind in evening.
25	3	N.	Mild: lake partially frozen over.
26	12	S.	Light snow; lake frozen over.
27	14	.....	Cloudy; light snow
28	—12	N.	Bright and clear.
29	—20	N.	" " "
30	—28	N.	" " "
Dec. 1	—30	N.	Cloudy; strong wind.
2	—22	N.	Storming.
3	—21	N.	"
4	—10	N.	Cloudy.
5	—10	N.	Bright and clear.
6	—10	N.	Cloudy.
7	—33	N.	Bright and clear.
8	—31	N.	Bright and clear; high wind.
9	—31	N.	Cloudy and storming; strong wind.
10	—30	N.	Cloudy and storming; strong wind.
11	—22	N.	Cloudy and storming; strong wind.
12	—14	N.	Cloudy and storming; strong wind.
13	—24	N.	Cloudy and storming; strong wind.
14	—12	N.	Cloudy and storming; strong wind.
15	—4	N.	Cloudy and storming; strong wind.
16	—26	N.	Bright and clear; strong wind.
17	—37	S.	Cloudy.
18	—28	N.	Bright and clear.
19	—32	N.	Cloudy.
20	—22	N.	Bright and clear.
21	—28	N.	" " "
22	—32	N.	" " "
23	—22	N.	" " "
24	10	N.	Cloudy; light snowstorm.
25	8	N.	Bright and clear.
26	—18	N.	" " "
27	—42	S.	" " "

Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1879.	°		
Dec. 28	—38	N.	Bright and clear.
29	—11	N.	Cloudy.
30	—3	N.	"
31	—5	N.	Snowing and drifting.
1880.			
Jan. 1	—18	N.	Bright and clear.
2	—27	N.	" " "
3	—33	N.	Cloudy, drifting.
4	—22	N.	" "
5	—29	N.	Bright and clear; at noon —36°.
6	—45	N.	Bright and Clear.
7	—43	N.	Cloudy.
8	—43	N.	Bright and clear.
9	—45	N.	" " "
10	—44	N.	" " "
11	—45	N.	" " "
12	—44	N.	" " "
13	—40	N.	" " "
14	—30	N.	" " "
15	—28	N.	Storming and drifting.
16	—25	N.	" " "
17	—41	N.	Bright and clear.
18	—26	N	Cloudy.
19	—10	S.	Cloudy; light wind.
20	8	S.	Bright and clear.
21	4	S.	Cloudy; light snow in p.m.
22	0	S.	Bright and clear; heavy S. gale last night.
23	—12	S.	Bright and clear.
24	—10	N.	" "
25	—30	N.	" " "
26	—40	N.	" " "
27	—43	N.	" " "
28	—14	S.	Light snow; 8 a.m., 0°.
29	—4	S.	Cloudy.
30	12	S.	"
31	14	S.	"
Feb. 1	16	S.	Bright and clear; light snow last night.
2	10	S.	Cloudy.
3	24	S.	Very soft.
4	0	S.	Very soft; at noon, 12°.
5	4	S.	Very soft.
6	—14	N.	Bright and clear.
7	—22	.....	" " "
8	8	S.	Cloudy.
9	2	.....	Bright and clear.
10	—16	.....	" " "
11	—12	.....	
12	0	N.	Cloudy; S. wind p.m.
13	—12	S.	Cloudy.
14	—14	N.	Bright and clear.
15	—14	N.	" " "
16	—38	N.	
17	—12	N.	Cloudy; light snowfall.
18	—12	N.	Bright and clear.
19	.....	.....	Heavy snowstorm.
20	12	S.	Storming all day; heavy snows last night.
21	12	S.	Heavy snowstorm last night.
22	18	.....	
23	—8	.....	Bright and clear.
24	.....	.....	
25	.....	.....	Bright and clear; high wind.
26	—42	N.	Bright and clear.
27	—16	N.	Cloudy, mild.
28	4	S.	Light wind.
29	0	N.	Bright and clear.
Mar. 1	—34	N.	Bright and clear; 4 p.m., —7°.

Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1880.	°		
Mar. 2	—39	N.	Bright and clear; 4 p.m., —2°.
3	—34	N.	Strong wind; bright and clear; 4 p.m., —8°.
4	—32	N.	Strong wind; bright and clear; 4 p.m., 12°.
5	—34	N.	Bright and clear; 4 p.m., —16°.
6	—44	N.	Bright and clear; 4 p.m., —12°.
7	—22	N.	Bright and clear; 4 p.m., 2°.
8	—12	S.	Storming all day; 30° above zero.
9	14	S.	Cloudy; strong wind last night.
10	8	N.	Bright and clear; strong wind.
11	—27	.....	Bright and clear.
Nov. 1	.....	.....	Mild; light snowfall.
2	.....	N.W.	" " "
3	.....	N.W.	Mild.
4	.....	S.	Very mild; raining.
5	.....	S.	Very mild; heavy rain.
6	.....	S.	Heavy fall of snow.
7	.....	S.	Very mild.
8	12	N.	Mild, cloudy.
9	0	N.	" "
10	0	N.	" "
11	12	N.	Mild; raining in evening.
12	.....	S.	Mild; rain.
13	.....	S.	Mild.
14	.....	S.	Mild; summer weather.
15	26	N.	Frosty, beautiful morning
16	14	N.	Cloudy; fine weather.
17	14	N.	Clear and bright.
18	14	N.	" "
19	8	N.	Cloudy; light snowfall.
20	11	N.	" " "
21	22	S.	Cloudy.
22	18	N.	Cloudy and mild.
23	13	N.	" " "
24	7	S.	Cloudy and mild; snowing in evening.
25	15	S.	
26	13	S.	Cloudy.
27	15	S.	Bright and clear.
28	10	S.	Cloudy; lake partially frozen.
29	18	S.	High winds; ice broken up.
30	21	N.	Strong wind.
Dec. 1	4	N.	Bright and clear; high wind.
2	—14	N.	Cloudy; lake partially frozen.
3	—15	N.	Cloudy; light snow; lake frozen over.
4	—6	N.	Cloudy; high wind.
5	—10	N.	Bright and clear; crossed lake on ice.
6	—20	N.	Bright and clear; strong wind.
7	—19	N.	Cloudy; strong wind.
8	—14	N.	Cloudy; drifting; light snow.
9	—13	N.	Storming and drifting.
10	—2	S.	
11	12	S.	
12	5	S.	Light snow.
13	4	S.	
14	15	S.	
15	—8	N.	
16	—14	N.	Cloudy; drifting.

Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1880.	°		
Dec. 17	—15	N.	Bright and clear.
18	—12	N.	Bright and clear; south wind p.m.
19	—11	N.	Bright and clear; 8 p.m., —20°.
20	—23	N.	Bright and clear.
21	—18	N.	" " "
22	—21	N.	" " "
23	—21	N.	Cloudy.
24	—13	N.	Bright and clear.
25	—14	N.	" " "
26	—21	N.	Bright and clear; very heavy wind.
27	—21	N.	Bright and clear; very heavy wind.
28	—22	N.	Bright and clear; very heavy wind.
29	—16	N.	Cloudy.
30	—10	N.	Bright and clear.
31	6	S.	Light snowfall.
1881.			
Jan. 1	14	S.	
2	16	S.	
3	14	S.	Light snowfall.
4	4	S	" "
5	5	N.	Light snowfall; cloudy.
6	6	N.	" "
7	4	S.	" "
8	9	S.	Bright and clear.
9	4	S.	Cloudy; snowfall last night.
10	—2	N.	Windy; drifting.
11	—17	N.	Bright and clear.
12	—24	N.	Bright and clear; 5 p.m., —25°.
13	—29	N.	Cloudy.
14	—28	N.	Bright and clear.
15	—20	S.	Cloudy; noon, 6°.
16	2	S.	Cloudy.
17	2	S.	Bright and clear.
18	2	S.	" " "
19	15	S.	Cloudy; light snow.
20	2	S.	Cloudy.
21	10	S.	Bright and clear.
22	20	S.	Cloudy.
23	10	S.	Bright and clear.
24	0	S.	" " "
25	—20	N.	" " "
26	—17	S.	Cloudy.
27	—1	N.	Bright and clear.
28	—28	N.	" " "
29	—39	N.	" " "
30	—34	S.	Cloudy.
31	—10	N.	Cloudy; light snow; drifting.
Feb. 1	—2	N.	Snowing and drifting.
2	—22	N.	Cloudy.
3	—14	N.	Snowing and drifting; heavy storm.
4	—19	N.	Bright and clear.
5	—14	N.	" " "
6	—10	N.	" " "
7	—14	S.	" " "
8	—18	N.	" " "
9	—12	N.	" " "
10	—12	N.	" " "
11	—11	N.	Cloudy.
12	—0	N.	Cloudy; clear p.m.
13	—8	N.	Bright and clear; windy.
14	—30	N.	Bright and clear.
15	—25	S.	Cloudy.
16	4	S.	Cloudy and light snow.
17	4	S.	Light snow.
18	6	N.	Light snow; drifting.
1881.	°		
Feb. 19	—1	N.	Heavy snow-storm; drifting.
20	—29	N.	Bright and clear.
21	—37	N.	" " "
32	—37	N.	Cloudy; drifting.
23	—4	N.	Heavy snowfall.
24	—15	N.	Bright and clear.
25	—37	N.	" " "
26	—38	N.	" " "
27	—6	N.	Cloudy.
28	—6	N.	Cloudy and drifting.
Mar. 1	—5	N.	Bright and clear.
2	0	S.	" " "
3	6	S.	Cloudy; light snow.
4	6	S.	Cloudy.
5	4	S.	Cloudy; snowfall p.m.
6	16	S.	Cloudy.
7	4	N.	"
8	2	N.	Cloudy; snow storm p.m.
9	2	N.	Cloudy; high wind.
10	0	S.	Bright and calm; light snow in evening.
11	8	S.	Light snow.
12	6	N.	" "
13	—18	S	Cloudy.
14	18	N.	Cloudy; light snow.
15	17	S.	Cloudy.
16	12	N.	"
17	7	N.	Snow-storm; drifting.
18	6	N.	Cloudy.
19	12	S.	Light snow; heavy thaw.
20	24	S.	Spring weather.
21	24	S.	
22	26	S	
23	—2	S.	
24	8	S.	Bright and clear.
25	—6	S.	" " "
26	0	S.	" " "
27	above zero.	S.	Cloudy; light snow.
28	"	S.	Snow-storm; drifting; strong wind.
29	"	N.	Snowstorm; drifting; strong wind.
30	"	N.	Rain in evening.
31	"	N.	
May 25	.....	.....	Creek commenced to rise.
30	.....	.....	Highest water.
June 4	.....	.....	First trip of steamer to Thibert Creek. *Very cold, wet summer.*
Sep. 27	.....	.....	Snowfall in evening.
Oct. 6	.....	.....	Light snowfall.
21	.....	.....	"
22	.....	.....	Rain.
23	.....	.....	"
26	.....	.....	Very mild.
Nov. 1	26	S.	Light snow.
2	26	S.	Heavy rain last night.
3	31	S.	Snow all gone.
4	25	N.	Very light snow.
5	25	N.	" " "
6	23	S.	" " "
7	23	S.	" " "
8	29	S.	" " "
6	30	S.	Strong wind.
10	23	S.	
11	18	S.	Heavy snow; storming all day.
12	8	N.	Heavy winds.
13	3	N.	Heavy winds; drifting.
14	—5	N.	Bright and clear.
15	—15	N.	" " "
16	—20	N.	Cloudy; at noon, —4°.

Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1881.	°		
Nov.17	—4	N.	Lake partially frozen over.
18	20	S.	Heavy snowfall.
19	12	N.	
20	21	S.	Light snow.
21	6	N.	Bright and clear.
22	3	N.	Lake frozen opp. town.
23	10	S.	
24	23	S.	At noon, 34°.
25	26	S.	At noon, 38°; rain.
26	34	S.	Raining.
27	13	S.	Bright and clear; Indian crossed ice.
28	18	S.	Snowstorm.
29	18	N.	Bright and clear.
30	2	N.	Cloudy: lake nearly all frozen.
Dec. 1	16	S.	Ice broken up between town and Thibert Cr.
2	13	S.	Strong wind.
3	3	S.	Cloudy.
4	3	S.	Bright and clear.
5	0	S.	Light snowfall.
6	1	S	Bright and clear.
7	5	S.	Heavy fog in morn.; p.m. clear.
8	—9	S.	Heavy fog in morn.; p.m. clear.
9	—0	S.	Light snow, drifting.
10	—14	S.	Bright and clear.
11	—23	S.	" " "
12	—41	S	" " "
13	—25	N.	" " "
14	—20	N.	Cloudy.
15	—20	N.	Light snowfall.
16	—15	S.	Light snowfall; drifting.
17	7	S.	Bright and clear.
18	5	S.	" " "
19	22	S.	Heavy wind; drifting; heavy snow-storm.
20	8	S.	Bright and clear.
21	—7	N.	Cloudy.
22	—6	N	Bright and clear.
23	—3	N.	Cloudy.
24	10	N.	
25	25	S	
26	23	S.	
27	—5	N.	Bright and clear.
28	—10	N.	" " "
29	—5	N.	" " "
30	—10	N.	Cloudy.
31	—10	N.	Heavy snow-storm; drifting.
1882.			
Jan. 1	—15	N.	Cloudy.
2	—23	N.	Bright and clear.
3	—14	N.	" " "
4	—17	N.	" " "
5	—20	N.	Cloudy.
6	—11	S.	Cloudy; light snow.
7	—4	S.	Cloudy.
8	1	S.	"
9	6	S.	Light snowfall.
10	—11	N.	Bright and clear.
11	—8	N.	Cloudy; light snowfall.
12	5	S.	Beautiful morning, like spring.
13	25	S.	Bright and clear; heavy rain last night.
14	—17	N.	Bright and clear.
15	—20	N.	Cloudy; light snow.
16	29	S.	Heavy rain, turning to snow.
17	25	S.	Heavy rain; light snow.
1882.	°		
Jan. 18	7	S.	Cloudy; snowfall.
19	20	S.	Cloudy, snowfall; rain in evening.
20	—11	N.	Cloudy; snowfall.
21	—13	N.	Cloudy.
22	—15	N.	Bright and clear.
23	—29	S.	" " "
24	—13	N.	Drifting.
25	—16	N.	Bright and clear.
26	—47	N.	" " "
27	—47	S.	Cloudy.
28	—20	S.	"
29	15	S.	Strong wind.
30	10	S.	
31	5	S.	Strong wind; drifting.
Feb. 1	3	S.	Bright and clear.
2	—1	S.	" " "
3	6	S.	Cloudy.
4	6	S.	Bright and clear.
5	—4	S.	Drifting.
6	—3	S.	"
7	—12	N.W	Very heavy drifting and snowing.
8	—13	N.	Drifting.
9	—25	N.	Bright and clear.
10	—20	N.	Cloudy; drifting.
11	—42	N.	Cloudy.
12	—20	N.	Light snow.
13	—10	N	Heavy snow, drifting.
14	—14	N.	Storm.
15	—41	N.	Bright and clear.
16	—52	N.	" " "
17	—26	S.	" " "
18	—21	S.	Cloudy; weather changed.
19	—11	S.	Strong wind.
20	1	S.	Cloudy.
21	28	S.	Cloudy; strong wind.
22	12	S.	Cloudy.
23	—26	N.	Bright and clear.
24	—14	N.	Cloudy.
25	—3	N.	"
26	—11	N.	Very strong wind; drifting.
27	—15	N.	Heavy wind; drifting.
28	—6	N.	Cloudy.
Mar. 1	—1	N.	Storming.
2	—26	N.	Bright and clear.
3	—31	N.	" " "
4	—3	N.	" " "
5	—25	S.	Cloudy.
6	4	S.	Bright and clear.
7	9	S.	Very fine.
8	13	S	" "
9	—18	S.	Bright and clear.
10	—14	S.	Very fine.
11	0	S.	Rain in evening.
12	15	N.	Cold wind.
13	2	N	
14	—3	N.	Bright and clear.
15	—26	N.	" " "
16	—4	N.	High wind.
17	—22	N	Very cold wind.
18	—29	N.	Bright and clear; strong wind.
19	—33	N.	Bright and clear.
2	—31	N.	Drifting; cold wind.
21	—16	N.	" " "
22	—40	N.	Bright and clear.
23	—8	N.	Heavy storm; snowing and drifting.
24	5	N	Heavy fall of snow.
25	14	N	Storming; snow.
26	8	N.	Cloudy.
2.	10	N.	Heavy snowfall all day.

Date.	Minimum Temperature.	Direction of Wind.	Remarks.	Date.	Minimum Temperature.	Direction of Wind.	Remarks.
1882.	°			1882.	°		
Mar. 28	—17	N.	Bright and clear.	Apr. 12	—2	S.	Cloudy; cold wind.
29	—39	N.	" " "	13	—5	S.	" " "
30	—39	N.	" " "	14	14	S.	" " "
31	—20	N.	High wind; drifting.	15	23	S.	" " "
April 1	2	N.	Cloudy; drifting.	16	27	S.	" " "
2	2	N.	Cloudy.	17	20	S.	Snowing and storming.
3	5	N.	High wind; drifting.	18	20	S.	Snowing in evening.
4	11	N.	Cloudy.	19	23	N.	Cloudy; cold wind.
5	11	N.	"	20	7	S.	Cloudy; storming in eve.
6	14	N.	Light snowfall all day.	21	22	W.	Storming; cold wind.
7	12	N.	Fine day.	22	24	S.	Bright and clear.
8	15	N	Raw, cold wind.	23	2	S.	Cloudy; light snow drifting.
9	12	N.	Cloudy.			N.	
10	20	S.	Bright and clear.	24	7		Bright and clear.
11	—1	S.	Cloudy; cold wind.			S.	

(4.) RECORD OF TEMPERATURE AT LAKETON, DEASE LAKE, B. C., DURING PORTIONS OF THE YEARS 1886 AND 1887, BY MR. ROBERT REED.

Date.	Minimum Temperature.	Date.	Minimum Temperature.	Date.	Minimum Temperature.	Date.	Minimum Temperature.
1886.	°	1886.	°	1887.	°	1887.	°
Nov. 20	—14	Dec. 22	—30	Jan. 23	—30	Feb. 26	—40
21	—21	23	—44	24	—28	27	—30
22	—11	24	—38	25	—34	28	—31
23	—14	25	—39	26	—29	Mar. 1	—55
24	—2	26	—41	27	—40	2	—49
25	—4	27	—40	28	—61	3	—13
26	—3	28	—34	29	—61	4	—9
27	Stormy.	29	—43	30	—52	5	—15
	19	30	—36	31	—52	6	—45
28	16	31	—35	Feb. 1	—42	7	—32
29	14			2	—47	8	—28
30	7	1887.		3	—56	9	—15
Dec. 1	6	Jan. 1	—32	4	—48	10	—41
2	—4	2	—25	5	—37	11	—31
3	—7	3	—13	6	—38	12	—22
4	7	4	—13	7	—5	13	—12
5	13	5	—10	8	—31	14	—13
6	12	6	—23	9	—49	15	—7
7	12	7	8	10	—27	16	—10
8	3	8	10	11	—23	17	—5
9	—2	9	11	12	—3	18	—12
10	3	10	—5	13	—31	19	2
11	—1	11	—6	14	—32	20	2
12	—5	12	8	15	—1	21	18
13	1	13	—7	16	—14	22	25
14	—2	14	—28	17	—33	23	2
15	7	15	—35	18	—2	24	—20
16	—9	16	—54	19	—21	25	—9
17	Lake frozen.	17	—32	20	—32	26	—2
	—18	18	—27	21	—35	27	8
18	—16	19	—23	22	—5	28	11
19	—10	20	—29	23	—23		
20	—8	21	—46	24	—43		
21	—6	22	—39	25	—45		

APPENDIX VII.

SUMMARY OF ASTRONOMICAL OBSERVATIONS BY DR. G. M. DAWSON, EMPLOYED IN THE CONSTRUCTION OF THE MAP ACCOMPANYING THIS REPORT.

NOTE.—The angular instrument employed was a sextant of seven inch radius, Cary, No. 938. The longitudes of places on the map depend on two small chronometers, Frodsham, No. 06859, and Arnold, No. 9699, running mean and sidereal time respectively. The first-mentioned was employed in taking time in all the observations, and has been given double weight in longitude determinations beyond Telegraph Creek, as it was an instrument of higher class than No. 9699, and proved to be extremely trustworthy. The chronometers were rated wherever possible, as shown in the annexed note. No. 9699 changed its rate suddenly on one occasion, in consequence apparently of a slight jar received on Finlayson Lake, but subsequently recovered a satisfactory rate. The longitude of the site of Fort Selkirk on the map depends entirely on that brought round by our route from Wrangell, as we are still in possession of the preliminary plotting only, of Mr. Ogilvie's Lewes River traverse. (See foot note on p. 276 B.)

The chronometers, in their cases, were packed together in a padded leather-covered box, which was invariably handled and transported with the greatest care. Comparisons were made throughout the journey on every second day at 8 P.M., approximate local mean time.

General Note on Rates of Chronometers, determined at Esquimalt, Dease Lake, Frances Lake and Camp near site of Fort Selkirk.

Frodsham, No. 06859, running mean time.

Rate determined on board H. M. S. *Triumph*, at Esquimalt, May 4-9	·2	seconds	daily,	losing.
Dease Lake, June 5-7 by obsn	·37	"	"	"
Frances Lake, July 11-16 by obsn	·48	"	"	"
Camp near site of Fort Selkirk, Aug. 13-17, by obsn	·625	"	"	"

Arnold, No. 9699, running sidereal time. Rate given on mean time, and including the daily difference between sideral and mean time (=3 m. 56.555 s.)

Rate determined on board H.M.S. *Triumph*, at Esquimalt, May 4-9....	3′ 53″·45	seconds daily, losing.	
Dease Lake, June 5-7, by obsn.....	3′ 54″·078	"	"
Frances Lake, July 11-16, by obsn....	3′ 54″·82	"	"
Camp near site of Fort Selkirk, Aug. 13-17, by obsn.....	3′ 52″·6	"	"

(Chronometer received a slight shock since last determination of rate, which accounts for its sudden change.)

Wrangell, Alaska, May 19, 1887.

	h.	m.	s.				
Frodsham, 06859.....	1	12	51·5	Obs. alt. $\bar{\odot}$.....	88°	5′	20″
	1	15	03·5		88	34	30
	1	17	24.5		89	5	10
	1	18	12·5		89	15	30
	1	20	0		89	38	30
	1	21	42·5		90	1	30
	1	23	20·5		90	21	55
Index error and eccentricity.....						−2	9

Taking latitude of observation spot as 56° 28′ 18″, from U. S. Pacific Coast Pilot, Alaska, Part I, 1883.

Chron. 06859 fast ..... 3h. 49m. 03s.

River-bank near site of H. B. Co.'s old post, Stikine R., May 21, 1887.

	h.	m.	s.				
Frodsham, 06859.....	1	5	17	Obs. alt. $\bar{\odot}$.....	86°	57′	35″
	1	7	16		87	24	10
	1	8	26		87	38	50
	1	9	44		87	56	20
	1	10	41		88	8	30
Index error and eccentricity.....						−2	31

Chron. 06859 fast ..... 3h. 46m. 33·4s.

	h.	m.	s.			
Frodsham, 06859.....	3	48	28·5	106°	48′	0″
	3	50	10·5	106	46	40
	3	51	15	106	45	10
Index error and eccentricity.....					−1	52·5
Resulting latitude from above two series of observations..				57	8	1
Longitude by Frodsham, 06859.....				131	46	45

Glenora, Stikine River, May 23, 1887.

Jupiter, obs. merid. alt.....	46°	4′	5″
Index error and eccentricity.....		−3	49
∴ Latitude	57	50	16

Telegraph Creek, Stikine River, May 27, 1887.

Jupiter, obs. merid. alt.....	46°	7′	25″
Index error and eccentricity.....		−3	44
∴ Latitude.....	57	55	0

Telegraph Creek, May 28, 1887.

	h.	m.	s.				
Frodsham, 06859.....	12	27	16·5	Obs. alt. $\bar{\odot}$.....	79°	55′	0″
	12	28	21·5		80	10	40
	12	29	49		80	31	40
	12	31	29		80	55	30
Index error and eccentricity.....						—2	48
∴ Frodsham, 06859, fast.....					3h.	44m.	06·1s.

Telegraph Creek, May 29, 1887.

	h.	m.	s.				
Frodsham, 06859.....	2	0	22	Obs. alt. $\odot$.....	99°	25′	0″
	2	2	28·5		99	45	10
	2	4	3		100	0	0
	2	6	12		100	20	0
	2	8	23		100	40	10
Index error and eccentricity.....						—2	39
∴ Frodsham, 06859, fast.....					3h.	44m.	04·5s.

Telegraph Creek, May 29, 1887.

Obs. meridian alt. $\bar{\odot}$.....	108°	5′	50″
Index error and eccentricity.....		—2	23
∴ Latitude	57	54	56

Telegraph Creek, May 29, 1887.

	h.	m.	s.				
Frodsham, 06859.....	5	25	39	Obs. alt. $\bar{\odot}$.....	99°	0′	50″
	5	26	37		98	41	10
	5	27	51		98	28	50
	5	29	32·5		98	11	55
	5	30	44·5		97	59	20
Index error and eccentricity.....						—2	42
∴ Frodsham, 06859, fast.....					3h.	44m.	07·2s.

Telegraph Creek, May 30, 1887.

	h.	m.	s.				
Frodsham, 06859.....	6	37	51·5	Obs. alt. $\bar{\odot}$.....	84°	34′	50″
	6	39	51·5		84	6	30
	6	41	26		83	44	55
	6	43	3·5		83°	22′	10″
	6	45	2·5		82	54	0
Index and eccentricity.....						—2	42
∴ Frodsham, 06859, fast					3.h.	43m.	56·4s.

Telegraph Creek, Stikine River (summary).

Diff. in long. between Fort Wrangell and Telegraph Creek, by comparing two a.m. sets of observations :

Frodsham, 06859			1° 13′ 40″
∴ Chron. long. of Telegraph Creek			131 10 20
Latitude adopted			57 55 58

NOTE.—By Hunter's surveyed line, continued by that of McConnell to Telegraph Creek, the longitude, depending on observation point at Wrangell, (long. 132° 24′ 00″) is 131° 10′ 05″. As the chronometers were subjected to exceptional conditions while ascending the Stikine by steamer, this longitude is adopted for Telegraph Creek in preference to that resulting from observations.

Head of Dease Lake, June 5, 1887.

	h.	m.	s.		
Frodsham, 06859	6	32	22	Obs. alt. $\bar{\odot}$	85° 45′ 40″
	6	33	44		85 27 0
	6	34	55·5		85 11 0
	6	36	2·5		84 55 20
	6	37	23		84 37 5
	6	38	30		84 21 50
Index error and eccentricity					—2 53
∴ Frodsham, 06859, fast					3h. 39m. 18.5s.

Head of Dease Lake, June 5, 1887.

	h.	m.	s.		
Frodsham, 06859	3	29	34	Obs. alt. $\bar{\odot}$	108° 57′ 15″
	3	30	38		108 58 10
	3	31	59		108 58 40
	3	33	45·5		109 0 20
	3	34	56		109 0 55
	3	36	8		109 1 5
	3	37	27		109 1 25
	3	38	21·5		109 1 30
	3	39	25·5		109 1 15
	3	41	11		109 0 35
	3	42	53		108 59 10
	3	44	14		108 58 30
	3	45	52		108 57 35
	3	47	14		108 56 40
Index error and eccentricity					—2 2
∴ Latitude					58 28 17·3

Head of Dease Lake, June 7, 1887.

Obs. merid. alt. $\bar{\odot}$			109° 13′ 15″
Index error and eccentricity			—2 1·5
∴ Latitude			58 28 6

	h.	m.	s.		
Frodsham, 06859	6	56	34	Obs. alt. $\bar{\odot}$	80° 33′ 30″
	6	57	47		80 15 20
	6	58	38·5		80 2 50
	6	59	40		79 48 10
	7	0	40		79 33 25
Index error and eccentricity					—2 50
∴ Frodsham, 06859, fast					3h. 39m. 17·8s.

Head of Dease Lake (summary).

Diff. in long. between Telegraph Creek and head of Dease Lake:

Frodsham, 06859	1°	10′	34″·5
Arnold, 9699	1	9	54·5
Adopted diff.	1	10	20

NOTE.—Here, and subsequently throughout, double value is assigned to Frodsham, 06859.

∴ Chron. long. of head of Dease Lake = 130° 0′ 00″

NOTE.—This longitude depends directly on Wrangell by chronometers. Taking into consideration the corrected longitude for Telegraph Creek, and assuming a mean value as between chronometer longitude and longitude by paced traverse from Telegraph Creek to head of Dease Lake, the longitude of head of lake is found to be 130° 2′ 0″, which is adopted. Subsequent longitudes along the line of traverse are made to depend fundamently on this position.

Adopted latitude, from series of circum-meridian altitudes, June 5, 1887, 58° 28′ 17″·3.

Laketon, Dease Lake, June 17, 1887.

	h.	m.	s.				
Frodsham, 06859	1	18	2	Obs. alt. $\bar{\odot}$	93°	55′	5″
	1	21	33		94	37	0
	1	23	35		95	1	30
	1	25	44		95	26	30
	1	29	5·5		96	5	20
	1	30	2		96	16	0
	1	31	56		96	37	45
Index error and eccentricity						—2	19
∴ Frodsham, 06859, fast					3h.	39m.	26s.

	h.	m.	s.				
Frodsham, 06859	3	42	31·5	Obs. alt. $\bar{\odot}$	109°	57′	30″
	3	43	51		109	57	0
	3	45	16·5		109	56	20
	3	46	47		109	55	35
Index error and eccentricity						—1	50

	h.	m.	s.				
Frodsham, 06859	8	14	20·75	Obs. alt. $\bar{\odot}$	62°	24′	50″
	8	16	10·5		61	56	40
	8	17	16·5		61	39	5
	8	19	2·75		61	12	0
	8	20	1·5		60	56	50
	8	21	1·3		60	36	0
Index error and eccentricity						—3	9
Resulting adopted lat. from second and third series of observations					58	42	20

By last observation:

Frodsham, 06859, fast	3h.	39m.	16s.
Diff. in long. between Laketon and head of lake by long bearings		3′	32″
∴ Resulting adopted long. of Laketon	130°	5′	32″

Sta. I, Dease River, June 19, 1887.

Obs. merid. alt. $\overline{\odot}$	109°	34′	15″
Index error and eccentricity		—2	3
∴ Latitude	58	56	38·9

Sta. U, Dease River, June 20, 1887.

Obs. merid. alt. $\overline{\odot}$	109°	13′	50″
Index error and eccentricity		—2	03
∴ Latitude	50	7	25·6

Sta. E, Dease River, June 21, 1887.

Obs. merid. alt. $\overline{\odot}$	108°	49′	45″
Index error and eccentricity		—2	0
∴ Latitude	59	19	35·2

Sta. M, June 22, 1887.

	h.	m.	s.				
Frodsham, 06859	10	17	13	Obs. alt. $\overline{\odot}$	50°	38′	40″
	10	19	17		51	0	50
	10	20	18		51	26	0
	10	21	2·25		51	37	0
Index error and eccentricity						—3	1
∴ Frodsham, 06859, fast					3h.	36m.	16s.
Lat. for above observation from traverse					59°	34′	0″
Diff. in long. between place and head of Dease Lake, Frodsham, 06859						44	0
∴ Chron. long. of place					129	18	0

Sta. U 2, Dease River, June 22, 1887.

Obs. merid. alt. $\overline{\odot}$	108°	4′	15″
Index error and eccentricity		1	57·3
∴ Latitude	59	42	5·8

Lower Post, mouth of Dease River, June 25, 1887.

	h.	m.	s.				
Frodsham, 06859	1	21	35	Obs. alt. $\overline{\odot}$	93°	55′	25″
	1	22	46		94	8	0
	1	23	25·5		94	15	35
	1	24	8		94	23	50
	1	25	37		94	40	5
	1	26	41·5		94	51	30
	1	27	22		94	58	30
	1	28	6		95	6	20
	1	29	2		95	16	20
Index error and eccentricity						—2	16·5
∴ Frodsham, 06859, fast					3h.	32m.	0·8s.

NOTE.—This series of observations was not employed in determining long., the sun being too near meridian.

	h.	m.	s.				
Frodsham, 06859.....	3	19	34	Obs. alt. $\bar{\odot}$.....	107°	17′	20″
	3	20	24		107	18	50
	3	21	24		107	20	40
	3	22	44·5		107	22	5
Index error and eccentricity						—1	51
By a.m. obsn. and last, with interval of time.							
Latitude					59	55	56·7

	h.	m.	s.				
Frodsham, 06859.....	3	37	31	Obs. alt. $\bar{\odot}$.....	107°	30′	10″
	3	38	30		107	29	20
Index error and eccentricity						—1	51
By a.m. obsn., and this, with interval of time.							
Latitude					59	55	55

Difference in long. between place and head of Dease Lake:

Frodsham, 06859.....	1°	32′	24″	
Arnold, 9699.....	1	30	40·5	
Mean, (giving double value to Frodsham)	1	31	50	
∴ Chron. long. of place.....	128	30	10	
Long. ascertained by bearings carried through by Dease River.....	128	35	10	adopted

Sta. I, Cañon on Upper Liard River, June 26, 1887.

Obs. merid. alt. $\bar{\odot}$.....	107°	16′	20″
Index error and eccentricity		—1	58
∴ Latitude.....	60	1	6·2

Sta. P, Upper Liard River, June 27, 1887.

Obs. merid. alt. $\bar{\odot}$.....	107°	6′	30″
Index error and eccentricity		—1	58·5
∴ Latitude.....	60	3	43·7

Sta. Y, Upper Liard River (confluence of Frances R.), June 29, 1887.

Obs. merid. alt. $\bar{\odot}$.....	106°	29′	10″
Index error and eccentricity		—2	19·5
∴ Latitude	60	16	35·3

Sta. F, Frances River, June 30, 1887.

	h.	m.	s.				
Frodsham, 06859.....	9	10	54	Obs. alt. $\bar{\odot}$.....	47°	30′	25″
	9	11	49·5		47	17	10
	9	12	38·5		47	5	15
	9	13	25·5		46	53	45
	9	14	12·5		46	41	50
	9	15	1·5		46	30	0
	9	16	21		46	10	50
Index error and eccentricity						—3	19
∴ Frodsham, 06859, fast					3h.	35m.	38·8s.
Lat. for above obsn. by traverse.....					60°	26′	0″
∴ Long. by Frodsham, 06859.....					129	11	46

Sta. H, Frances River, July 1, 1887.

	h.	m.	s.				
Frodsham, 06859.....	3	42	45·5	Obs. alt. $\bar{\odot}$.....	105°	53′	0″
	3	44	9·5		105	52	30
	3	45	23·5		105	52	10
	3	46	12·5		105	51	20
Index error and eccentricity.....						—2	0
With time by last observation and long. of traverse,							
Latitude.....					60	27	28

Sta. W, Frances River, July 3, 1887.

Obs. merid. alt. $\odot$.....	105°	10′	45″
Index error and eccentricity.....		—2	0
∴ Latitude.....	60	39	15·1

NOTE.—Observation fair only.

Sta. E, Frances River, July 4, 1887.

Obs. merid. alt. $\bar{\odot}$.....	104°	41′	50″
Index error and eccentricity.....		—2	15·5
∴ Latitude.....	60	47	53·4

Sta. P, Frances River, July 7, 1887.

Obs. merid. alt. $\bar{\odot}$.....	103°	24′	35″
Index error eccentricity.....		—2	18
∴ Latitude.....	61	9	25

Câche Camp, Frances Lake, near mouth of Finlayson River, July 11, 1887.

	h.	m.	s.				
Frodsham, 06859.....	12	45	32	Obs. alt. $\bar{\odot}$.....	81°	15′	30″
	12	46	41		81	28	50
	12	48	23		81	49	20
	12	49	15		82	0	0
	12	50	55		82	20	0
	12	52	36		82	40	0
	12	54	18		83	0	0
	12	56	1		83	20	0
Index error and eccentricity.....						—3	17
∴ Frodsham, 06859, fast.....					3h.	37m.	23s·9.

Câche Camp, Frances Lake, July 7, 1887.

	h.	m.	s.				
Frodsham, 06859.....	3	35	33 5	Obs. alt. $\bar{\odot}$.....	101°	43′	40″
	3	36	32		101	44	25
	3	37	19		101	44	50
	3	38	16·5		101	45	0
	3	39	26		101	45	20
	3	40	24·5		101	45	40
Approx. app. noon					101	45	50
	3	43	20		101	45	30
	3	45	26		101	45	10

h.	m.	s.			
3	46	36·5	101	45	5
3	47	58	101	44	30
3	49	1·5	101	44	0
3	50	53	101	42	40
Index error and eccentricity				—2	38
∴ Latitude			61	29	22

Câche Camp, Frances Lake, July 11, 1887.

	h.	m.	s.				
Frodsham, 06859	6	29	1·5	Obs. alt. $\bar{\bar{\odot}}$	83°	20′	0″
	6	30	44		83	0	0
	6	22	23		82	40	0
	6	34	7·5		82	20	0
	6	35	45		82	0	0
	6	38	20		81	28	50
Index error and eccentricity						- 3	16
∴ Frodsham, 06859, fast					3h.	37m.	29s.

Câche Camp, Frances Lake, July 16, 1887.

	h.	m.	s.				
Frodsham, 06859	10	55	18	Obs. alt. ⊙	55°	5′	50″
	10	56	18·5		55	20	45
	10	57	35		55	38	30
	10	58	31·5		55	52	10
	10	59	11		56	2	35
	11	0	6		56	14	45
	11	1	31		56	34	30
Index error and eccentricity						—3	40
∴ Frodsham, 06859, fast					3h.	37m.	22s.

Diff. in long. between place and head of Dease L. by mean of two first obsns.

Frodsham, 06859	0°	23′	36″
Arnold, 9699	0	21	22·5
Mean. (giving double value to Frodsham)	0	22	51·5
∴ Chron. long. of place	129	39	8·5 adopted.

Sta. P, Frances Lake, July 12, 1887.

Obs. merid. alt. $\bar{\bar{\odot}}$	101°	46′	30″
Index error and eccentricity		—2	34
∴ Latitude	61	21	7·9

Sta. T, Finlayson Lake, July 24, 1887.

Obs. merid. alt. $\bar{\bar{\odot}}$	96°	53′	30″
Index error and eccentricity		—2	37·6
∴ Latitude	61	40	12·9

Correction for temp. and pressure,—6.″

St. U, Finlayson Lake, 14″ south of last, July 24, 1887.

Frodsham, 06859	9	43	48	Obs. alt. $\bar{\odot}$	36°	0′	35″
	9	44	47		35	46	25
	9	45	40		35	34	0

	h.	m.	s.				
	9	46	37		35	20	50
	9	47	37·5		35	8	20
	9	48	20		34	56	30
	9	49	0		34	47	10
Index error and eccentricity						−3	34
∴ Frodsham, 06859, fast					3h.	40m.	29s.

St. V, Finlayson Lake, July 25, 1887.

	h.	m.	s.				
Frodsham, 06859	12	51	45	Obs. alt. ☉	77°	0′	0″
	12	52	47·5		77	12	5
	12	53	36·5		77	21	50
	12	54	25·5		77	31	0
	12	55	25		77	42	40
	12	56	13		77	52	10
	12	57	6·5		78	2	30
	12	57	47		78	10	25
	12	58	45		78	21	10
Index error and eccentricity						−3	23
∴ Frodsham, 06859, fast					3h.	40m.	46s.

Obs. merid. alt. ☉	96°	28′	10″
Index error and eccentricity		−2	38
Correction for temp. and pressure, −6.			
∴ Latitude	61	40	0·6

Sta. V, Finlayson Lake (summary).

Mean of last obsn. and that of July 24, reduced to this point, gives,

Latitude	61°	40′	0″	adopted.
Diff. in long. between place and Cache Camp, Frances Lake:				
Frodsham, 06859		50′	12″	
Arnold, 9699		46	51	
Mean, (giving double value to Frodsham)		49	5	
∴ Chron. long. of place	130°	28′	13″.5	
Long. of place by traverse between Frances Lake and Pelly Banks	130	28	52	
Mean of this and chron. long.	130	28	32·7	adopted.

Pelly River, First Camp, near site of Fort Pelly Banks, July 29, 1887.

	h.	m.	s.				
Frodsham, 06859	7	4	59	Obs. alt. ☉	70°	54′	30″
	7	6	46		70	32	35
	7	7	41·5		70	20	50
	7	8	33.5		70	10	0
	7	9	23		69	59	10
	7	10	14·5		69	48	30
	7	12	17		69	23	10
	7	13	15		69	11	10
	7	13	58		69	2	10
Index error and eccentricity						−3	22
∴ Frodsham, 06859, fast					3h.	42m.	45s.

Pelly River, First Camp, July 29, 1887.

	h.	m.	s.				
Frodsham, 06859.....	7	57	32·5	Obs. alt. $\bar{\odot}$.....	59°	1′	40″
	7	58	58·5		58	42	0
	7	59	46·5		58	31	10
	8	1	11		58	12	0
	8	2	19		57	55	50
	8	3	17		57	43	10
	8	3	58		57	33	30
Index error and eccentricity.....						—3	30
∴ Frodsham, 06359, fast					3h.	42m.	46s.

Pelly River, First Camp, July 31, 1887.

	h.	m.	s.				
Frodsham, 06859.....	12	36	49	Obs. alt. $\dot{\odot}$.....	70°	54′	0″
	12	37	53		71	7	0
	12	38	56·5		71	19	30
	12	39	46		71	30	0
	12	40	31·5		71	38	40
	12	41	28		71	50	40
	12	42	31		72	2	55
	12	43	25·5		72	14	0
	12	44	23		72	25	20
Index error and eccentricity.....						—3	21
∴ Frodsham, 06859, fast					3h.	43m.	42s·9
Obs. approx. merid. alt. $\bar{\odot}$.....					93°	23′	10″
Index error and eccentricity.....						—2	42
∴ Latitude.....					61	48	59

	h.	m.	s.				
Frodsham, 06859.....	3	54	7·5	Obs. alt. $\bar{\odot}$.....	93°	21′	50″
	3	55	12		93	21	20
	3	56	34		93	20	40
	3	57	50		93	19	15
Index error and eccentricity.....						—2	42″·5

Frodsham, 06859.....	7	45	57.5	Obs. alt. $\bar{\odot}$.....	61°	11′	40″
	7	47	1		60	57	5
	7	48	19·5		60	39	10
	7	49	10·5		60	27	55
	7	50	8·5		60	15	10
	7	50	45·5		60	6	45
	7	51	25·5		59	57	50
	7	52	7·5		59	48	5
	7	53	5·5		59	35	30
Index error and eccentricity.....						—3	29
∴ Frodsham, 06859, fast				3h. 42m. 45s·8			

Pelly River, First Camp (summary).

By last two obsns., with interval of time:

Latitude..... ... 61° 48′ 52″ adopted.

Diff. in long. between Câche Camp, Frances L. and place by mean of sets of obsns.

Frodsham, 06859	1	22	7·5	
Arnold, 9699	1	21	39	
Mean, (giving double value to Frodsham)	1	21	58	
∴ Chron. long. of place	131	1	6·5	adopted.

Sta. X, Pelly River, Aug. 2, 1887.

Obs. merid. alt. $\overline{\odot}$ (fair only)	92°	30′	20″
Index error and eccentricity		—2	44
∴ Latitude	61	44	52·5

Sta. G, Pelly River (Head of Hoole Cañon), Aug. 3, 1887.

Obs. merid. alt. $\overline{\odot}$	91°	48′	0″
Index error and eccentricity		—2	41·5
∴ Latitude	61	50	28

Sta. H, Pelly River (lower end Hoole Cañon), Aug. 4, 1887.

	h.	m.	s.				
Frodsham, 06859	9	49	41·5	Obs. alt. $\overline{\odot}$	30°	17′	50″
	9	50	31		30	30	0
	9	51	26·5		30	42	30
	9	53	8		31	5	40
	9	54	41·5		31	27	25
	9	55	35		31	40	10
	9	56	26		31	52	10
Index error and eccentricity						—3	25
∴ Frodsham, 06859, fast					3h.	46m.	47s·5

Note.—For above obsn., lat. employed determined by paced line from Sta. G. 61° 50′ 48″·8

Long. by chronometers (giving double value to Frodsham) 132° 1′ 51″

Sta. B, Pelly River, Aug. 5, 1887.

Obs. merid. alt. $\overline{\odot}$	90°	4′	5″
Index error and eccentricity		—2	45
∴ Latitude	62	10	20

Sta. L, Pelly River, Aug. 6, 1887.

Obs. merid. alt. $\overline{\odot}$ (passing clouds, approx.)	89°	2′	15″
Index error and eccentricity		—2	54
∴ Latitude	62	24	53

Sta. C, Pelly River, Aug. 7, 1887.

Obs. merid. alt. $\overline{\odot}$	87°	57′	10″
Index error and eccentricity		—2	54
∴ Latitude	62	40	41

Sta. N, Pelly River, Aug. 8, 1887.

Obs. merid. alt. $\overline{\odot}$	87°	12′	10″
Index error and eccentricity		—2	41
∴ Latitude	62	46	4

Sta. T, Pelly River (6 m. above Macmillan River), Aug. 8, 1887.

Frodsham, 06859.....	9	31	23·5	Obs. alt. ☉.....	37°	8′	10″
	9	32	21·5		36	55	10
	9	33	25		36	40	50
	9	34	18·5		36	28	20
	9	35	7·5		36	17	10
	9	35	59		36	5	30
	9	36	39		35	56	0
	9	37	34·5		35	44	0
	9	38	9		35	36	0
Index error and eccentricity.....						—3	19
∴ Frodsham, 06859, fast					4h.	1m.	29s.
NOTE.—For above obsn. lat. employed determined by traverse					62°	48′	10″
Long. by chronometers (giving double value to Frodsham)					135	44	25·5

Sta. O, Pelly River, Aug. 10, 1887.

Obs. merid. alt. ☉ (approx.).....	85°	52′	25″
Index error and eccentricity.....		—2	58
∴ Latitude.....	62	51	10

Observations near site of Fort Selkirk.

Three-quarters of a mile below Fort Selkirk, Aug. 11, 1887.

	h.	m.	s.				
Frodsham, 06859.....	4	1	8·5	Obs. alt. ☉.....	85°	19′	0″
	4	2	0		85	19	40
	4	2	52		85	20	20
	4	3	58		85	21	10
	4	5	28		85	22	5
	4	7	3		85	22	55
	4	8	15·5		85	23	30
	4	13	17		85	24	25
	4	14	43		85	23	50
	4	16	47·5		85	23	35
	4	17	45·5		85	23	0
	4	18	38·5		85	22	40
	4	19	43		85	22	20
	4	20	50		85	21	35
	4	21	45		85	20	55
Index error and eccentricity.....						—3	4
Correction for temp. and pressure, —6.″							
∴ Latitude.....					62	47	32

Camp opposite Fort Selkirk, Aug. 11, 1887.

	h.	m.	s.				
Frodsham, 06859.....	8	12	7·5	Obs. alt. ☉.....	54°	37′	30″
	8	13	16·75		54	22	30
	8	14	2·5		54	12	40
	8	14	53·5		54	1	50
	8	15	30		53	54	5
	8	16	36		53	39	10

	h.	m.	s.				
	8	17	35·5		53	27	0
	8	18	16		53	18	0
	8	18	58·5		53	9	10
Index error and eccentricity						—2	39
∴ Frodsham, 06859, fast					4h.	7m.	42s·3

Camp opposite Fort Selkirk, Aug. 12, 1887.

	h.	m.	s.				
Frodsham, 06859....	7	35	59·5	Obs. alt. $\bar{\odot}$.....	61°	30′	50″
	7	38	18		61	2	30
	7	39	22·5		60	50	20
	7	40	10·5		60	40	10
	7	40	58·5		60	30	55
	7	42	5		60	17	30
	7	43	20·5		60	2	10
Index error and eccentricity						—2	35
∴ Frodsham, 06859, fast					4h.	7m.	46·5s

Camp opposite Fort Selkirk, Aug. 13, 1887.

	h.	m.	s.				
Frodsham, 06859.....	0	58	46·5	Obs. alt. $\bar{\bar{\odot}}$... .	63°	0′	0″
	1	1	22		63	30	0
	1	3	8·5		63	50	0
	1	4	52·5		64	10	0
	1	7	33·5		64	40	0

	h.	m.	s.				
Frodsham, 06859.....	4	4	10·5	Obs. alt. $\bar{\bar{\odot}}$.....	84°	6′	55″
	4	5	33		84	7	35
	4	7	57		84	8	15
	4	9	7		84	8	25
	4	10	4·5		84	8	40
	4	10	59·5		84	9	10
	4	12	44		84	9	0
	4	13	32·5		84	8	50
	4	14	39		84	8	40
	4	16	35		84	8	10
	4	17	46		84	7	40
	4	18	44		84	7	25
Index error and eccentricity						—3	7
Correction for temp. and pressure, —6·7							
∴ Latitude					62	47	32·4

	h.	m.	s.				
Frodsham, 06859.....	7	16	30·5	Obs. alt. $\bar{\bar{\odot}}$.....	64°	40′	0″
	7	19	9·5		64	10	0
	7	20	54		63	50	0
	7	22	40		63	30	0
	7	25	16·5		63	0	0

By the above series of observations, paired with a.m. series by equal altitudes, Frodsham, 06859, fast..... 4h. 7m. 47·5s

Camp opposite Fort Selkirk, Aug. 15, 1887.

	h.	m.	s.				
Frodsham, 06859.....	1	17	56·5	Obs. alt. ☉.....	65°	30′	0″
	1	19	48·5		65	50	0
	1	21	41·5		66	10	0
	1	23	32·5		66	30	0
	1	25	25·5		66	50	0
	1	27	20·5		67	10	0

	h.	m.	s.				
Frodsham, 06859.....	6	55	55	Obs. alt. ☉.....	67°	10′	0″
	6	57	48·5		66	50	0
	6	59	42·5		66	30	0
	7	1	37		66	10	0
	7	3	29·5		65	50	0
	7	5	19		65	30	0

By the above sets of equal alt. obsns. Frodsham, 06859, fast 4h. 7m. 46·5s

Camp opposite Fort Selkirk, Aug. 17, 1887.

	h.	m.	s.				
Frodsham, 06859.....	0	39	16·5	Obs. alt. ☉.....	57°	0′	0″
	0	40	55·5		57	20	0
	0	42	35		57	40	0
	0	44	16		58	0	0
	0	45	56·75		58	20	0

	h.	m.	s.				
Frodsham, 06859.....	4	7	38	Obs. alt. ☉.....	81°	36′	40″
	4	9	10		81	37	10
	4	11	5		81	37	20
	4	12	0·5		81	37	5
	4	13	29		81	36	30
	4	16	30		81	35	55
	4	17	32·5		81	35	20
Index error and eccentricity.....						−2	0
Correction for temp. and pressure, −5·3							
∴ Latitude					62	47	29

	h.	m.	s.				
Frodsham, 06859.....	7	36	25	Obs. alt. ☉.....	58°	20′	0″
	7	38	5		58	0	0
	7	39	46		57	40	0
	7	41	26		57	20	0
	7	43	7		57	0	0

By the above series of observations, paired with a.m. series by equal altitudes, Frodsham, 06859, fast ..... 4h. 7m. 45s.

Camp opposite Fort Selkirk, Aug. 17, 1887.

Obs. merid. alt. Altair.....	71°	35′	30″
Index error and eccentricity*.....		+1	8
Correction for temp. and pressure, −4·1			
Latitude	62	47	28·3

* The adjustments of the sextant were changed here.

Site of Fort Selkirk (summary).

Reducing the foregoing latitude observations (taken at two different points) to the ruins of Fort Selkirk, we find:—

From obs. of 11th	62°	47′	12″	adopted.
" " " 13th	62	47	12·4	
" " " 17th	62	47	9	
" " " 17th (on Altair)	62	47	8·3	

Diff. in long. between Cache Camp, Frances L. and Camp opp. Fort Selkirk, by directly comparing two equal alt. obsns.:—

Frodsham, 06859	7°	40′	9″	
Arnold, 9699	7	42	34·5	
Mean, (giving double value to Frodsham)	7	40	57·5	adopted.
∴ Long. of Camp opposite Fort Selkirk	137	20	6	
Or reduced to site of Fort Selkirk	137	20	22 *	

Lower end Lake Labarge, Sept. 4, 1887.

	h.	m.	s.				
Frodsham, 06859	12	20	54	Obs. alt. Arcturus	48°	58′	30″
	12	23	29		48	21	30
	12	25	35		47	51	40
	12	27	18		47	26	20
	12	28	38·5		47	7	30
	12	30	14·25		46	44	30
Index error and eccentricity						+1	2
∴ Frodsham, 06859, fast					3h.	58m.	46s.
∴ Long. of place					135°	5′	45″

	h.	m.	s.				
Frodsham, 06859	12	36	22	Obs. alt. Polaris	122°	46′	10″
	12	39	7		122	47	55
	12	41	11		122	49	20
	12	43	35		122	50	55
	12	45	44		122	52	30
	12	47	38		122	53	35
	12	49	57		122	55	25
Index error and eccentricity						+2	56
∴ Latitude					61	25	13

Employing local time obtained from observations on Arcturus.

	h.	m.	s.				
Frodsham, 06859	1	2	1	Obs. alt. Altair	74°	20′	10″
	1	4	28		74	18	25

* The longitude thus determined for Fort Selkirk, depends directly upon Wrangell, and my line of traverse by the Stikine, Dease, Liard, Frances and Upper Pelly rivers. It is that used on the accompanying map. Since the map has been engraved, and after this Appendix was in type, a first computation (still subject to possible small corrections) has been made of Mr. Ogilvie's winter observations near the 141st meridian and of his instrumental traverse from Fort Selkirk to that point. His resulting longitude for Fort Selkirk is 137° 22′ 45″, the difference between the two independently determined positions being 2216 yards only. It is therefore probable that all intermediate places on my line of traverse are correct in longitude within small limits of error.

	1	5	52·5	74	17	40
	1	7	21·5	74	16	20
	1	8	59	74	15	10
	1	10	59	74	13	10
Index error and eccentricity					+1	20
∴ Latitude				61	25	0

Employing local time obtained from observations on Arcturus.

Observations for Magnetic Variation.

Mag. variation observed at head of Dease Lake.
Lat. 58° 28′ 17″·3. Long. 130° 2′ 0″

June 5, 1887, 3.40 p.m., obs. var. E ..... 30° 26′ 0″

Mag. variation observed at Frances Lake.
Lat. 61° 29′ 22″. Long. 129° 39′ 8″·5.

Date and time.	True bearing of object.	Mag. bearing.	Obs. variation.	
July 12, '87, 6 a.m.	127° 37′	93° 45′ compass 1	33° 52′	mean 33° 45′·5
" " " " " ..	127° 37′	93° 0′ compass 2	33° 47′	

Mag. variation observed at First Camp on Pelly River.
Lat. 61° 48′ 52″. Long. 131° 1′ 6″·5.

Date and time.	True bearing of object.	Mag. bearing.	Obs. variation.	
July 30, '87, 5.40 p.m.	202° 59′	167° 45′ compass 2	34° 24′	mean 34° 30′
" " " " "	202° 59′	168° 45′ compass 3	34° 36′	
" " " 6.40 p.m.	308° 18′	273° 30′ compass 2	34° 0′	

Mag. variation observed opposite site of Fort Selkirk.
Lat. 62° 47′ 30″. Long. 137° 20′ 6″.

Date and time.	True bearing of object.	Mag. bearing.	Obs. variation.
Aug. 12, '87, 4 p.m.	169° 27′	134° 15′ compass 2	35° 12′*
" " " " "	169° 27′	135° 30′ compass 3	34° 0′*

Determined by Mr. Ogilvie at same place (with transit) .... 34° 21′·5
" " " " " " at Fort Selkirk ... 34° 5′

* The differences between these obsns. and Mr. Ogilvie's at same place, were assumed as index error of instruments and applied to the obsns. at other places.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE GEOLOGY OF THE

MINING DISTRICT OF CARIBOO,

BRITISH COLUMBIA,

BY

AMOS BOWMAN, M.E.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To Alfred R. C. Selwyn, Esq., C.M.G., F.R.S., LL.D.,
Director Geological and Natural History Survey of Canada.

Sir,—The first part of my report on the mining district of Cariboo, British Columbia, is herewith respectfully submitted. The second portion will include details and detailed plans of mining developments.

I have the honor to be, Sir,

Your obedient servant,

AMOS BOWMAN.

NOTE.—The bearings throughout this report are given with reference to the true meridian, unless otherwise specially noted.

REPORT

ON THE GEOLOGY OF THE

MINING DISTRICT OF CARIBOO, BRITISH COLUMBIA.

By AMOS BOWMAN, M.E.

Part I.

The work in the Cariboo District of British Columbia, here reported upon, was carried out during the seasons of 1885 and 1886, under the control of the Director of the Geological Survey, but with the assistance of a money grant from the Government of British Columbia, and on a plan agreed upon beforehand. The enlightened policy of the Government of British Columbia has thus rendered possible the completion of the map work in a comparatively short space of time, the demands upon the funds of the Geological Survey being such as to make it impossible to devote more than a certain sum annually to work in each province or district. The call for special assistance in the Cariboo district arose principally from the absence of any trustworthy map, and the necessity of undertaking a geographical as well as a geological survey, while the decline in product of the placer mines, and the efforts being made toward the development of "quartz mining" appeared to deserve such immediate assistance and guidance as might be afforded by a systematic study of the district and a reasonably accurate delineation of its features.

Joint, Provincial and Dominion surveys.

Cariboo has not only been the mainstay of gold mining in British Columbia for many years, but has proved, for its area, one of the richest placer mining camps in the world; and it would therefore appear reasonable to assume the existence in it of rich quartz lodes, from which, by natural processes of waste, the alluvial deposits have been supplied. The importance of the Cariboo district will be understood when it is stated that probably half the gold product of British Columbia since 1860, or not less than $15,000,000, was derived from it, and chiefly from a few miles in length of auriferous drift in several valleys, of which those of Williams, Lightning and Antler creeks have been the most productive, and have made Cariboo famous.

Importance of Cariboo gold fields.

Limits of Field.

On plateau region of the Upper Fraser.

Politically, Cariboo district embraces a complete section across the northern interior plateau, from the coast mountains to the Rocky Mountain region, north of the Canadian Pacific Railway, and within the drainage basin of the Fraser. This is bisected in a north and south line by Fraser River. Popularly, "Cariboo" includes only the eastern half, or the gold country north of Lake La Hache. To the principal mining developments of this area our investigations were accordingly confined, and the map herewith presented does not include all the outlying portions even of the area thus limited.

The south-eastern limits of the Cariboo mining district include the valley of the Horsefly, and country extending eastward of it to the water-shed of the Clearwater and North Thompson rivers.

The most northerly mines of importance within this area are those of Hixon Creek, a tributary of Cañon Creek, between Quesnel and Fort George; and the newly-discovered mines of Goat River, a tributary of the Upper Fraser (probably identical with "Shuswap River" on Trutch's map), on the eastern slope of the Cariboo Range.

The lower half of it has been explored by prospectors, and has become tolerably well known by report, to many of the residents of the district beyond present mining localities.

The eastern Alpine region, and the low-lying northern parts, where Bear and Willow rivers join the Fraser, are little known even to the residents of Cariboo, and may be set down as scarcely explored, economically or otherwise. Geographical explorations in these little-known regions have been confined to the lines of survey on the Upper Fraser and Clearwater rivers, by the Government railway parties in 1872–76.

Between the Upper Fraser (Tête Jaune Cache) and the well-known Cariboo mining country of Harvey and Cunningham creeks, the distance is but 50 miles; yet very few prospectors or explorers besides Mahood, of the railway exploration party in 1872, and Isaacs' prospecting party in 1886, have been through it.*

* The best map in existence, which included Cariboo, was that known as Trutch's Map, drawn by J. B. Launders in the Lands and Works Department of British Columbia, under the direction of the Hon. J. W. Trutch, scale 25 miles to the inch; a creditable and well-executed compilation of the surveys of the Admiralty, and surveys and explorations of the Royal Engineer corps under Col. Moody, and above all of the geographical information collected by the Hudson Bay Company's officials from Indians, including the reports of intelligent prospectors and miners, a few of whom had been surveyors. A later map on the same scale was that compiled by E. Mohun, C.E., and published under the direction of the late Hon. W. Smythe, adding to Trutch's map such corrections as had been developed by the Dominion Railway surveyors and the explorations of the Geological Survey; none of them, however, in the mining region of Cariboo. The scale however was much too small for our purpose, and the information was mostly sketched.

Work in 1885.

The work of this season was necessarily for the most part of a geographical and topographical character, the geological and mining problems being assigned a secondary place till the main outlines of the map had been laid. My assistants during the year were Messrs. James McEvoy, B. Ap. Sc., S. P. Tuck, C.E., and L. R. Voligny, C.E. Adjacent to roads and trails.

Barkerville, in the centre of the Cariboo mining district, was, in the first place, connected by an odometer survey along the waggon road with Quesnel; and from Barkerville as a centre traverses were extended by measuring-wheels along the principal roads and trails of the district.

Work in 1886.

During this season I was assisted by Mr. McEvoy. We entered the southern edge of the Cariboo district map near Beaver Lake on the 6th of July, and work was actively prosecuted in the district till the 30th September. The whole time spent in the field this season was four months and a half, but this included time spent in going to and returning from the district, as well as that consumed in making various necessary arrangements. Pack animals were employed in moving from place to place, wherever possible, but some parts of the district could only be reached on foot; and for the purpose of making a micrometer survey of Quesnel Lake and examining its shores, boats were utilized. Some topographical work was included in the operations of this season, but much of my time was devoted to the detailed examination of mines and auriferous creeks. Mountain and outlying areas.

The results of field work in 1885 and 1886 included eighty-one plotted sheets, forty panoramic topographical sketches, and ninety-seven smaller sketches of the same kind, chiefly intended to show the topography, and relief of the country.

The mountainous, and often almost inaccessible character of portions of the district included in the maps, presented us with many difficult problems in transportation, and in the execution of the work. These were successfully overcome by the ready and efficient co-operation of my assistants and men.

Dr. Hugh Watt, of Barkerville, obligingly undertook the reading of the mercurial station barometer on which the reduction of our observed altitudes depended. To Messrs. John Bowron and W. Stephenson, Provincial Government Agents at Barkerville and Quesnel Forks respectively, we are indebted for innumerable favors; and, in fact, all the residents of the district, including even the Chinese, seemed to take an interest in our work, and to assist us whenever possible.

Country Surveyed.

The profitable gold fields.

Evidently this vast region could not have been adequately explored in one or two seasons, nor during the progress of systematic surveys in the old placer mining region. Directing our attention, therefore, to a narrower area, as distinguished by profitable mining operations,—included within the limits of the Cariboo District map,—the country topographically surveyed lies within the parallels of 52 deg. 45 min., and 53 deg., 45 min., and the meridians of 120 deg., 45 min., and 122 deg., comprising, thus limited, an area of 3,137 square miles. This block extends into the alpine region mentioned, while it covers the whole of the placer mining country which has been found specially noteworthy on account of its yield of gold.

The first step in our work was to enter the larger field first referred to, and to make the necessary reconnaisance surveys, in order to discover the extent of the gold-bearing country, and its relations to the surrounding country, with a view to narrowing the field. The second was to make a systematic geographical and geological survey of the smaller area.

Survey Operations.

Outside work.

While our survey operations were chiefly confined to the smaller area, the road traverse measured from Lake La Hache to Lightning Creek Meadows, at Beaver Pass, belongs to the wider field. A great deal of both geological and general survey work had to be done outside of the limited area, in order to arrive at necessary results in the mining region itself. It includes reconnaissance surveys of all approaches to the mines, by horse trail and by projected railway; of Quesnel River, including its mines, situated between the forks and the mouth; of the Cottonwood River mines (between Cottonwood Bridge and the Hixon Creek trail-crossing); the trail from Quesnel Mouth to Hixon Creek, about forty miles; and a small area of country at the junction of Hixon and Government creeks, the site of important mining operations.

Bases measured.

The geographical work included the measuring with the steel tape of two independent base lines fifty miles apart, situated respectively on Snowshoe Plateau and at Quesnel Mouth.

Areas mapped in detail.

Detailed maps of all the important mining localities were also completed. The geographical foundation (embracing from one to three miles on the paying creeks,) having been procured during the first season of field work, the details and geological features remained to be obtained during the second.

Accuracy.

The accuracy of the creek maps must not be understood to be equal

to that of a transit survey carried out into all these details; nor is that of the Cariboo district map to be understood as including transit intersections to the minor points, many of which were not in sight from the transit stations. The detail maps were based on compass surveys, and, generally, wheel measurements; but parts of them were filled in by track or reconnaissance surveys, where such information could not be procured in any better shape.

Topography.

The topographical details of the District map were plotted from the sketches described. Where immediate intersections could not be had, the objects were located relatively to fixed points, in such detail as the sketches permitted.

Check work.

I deemed it necessary to occupy a number of transit stations outside of the smaller area, for the purpose of connecting our triangulation system in the mining region with a point on Fraser River at Quesnel Mouth. This served as a check of the waggon road survey. Its principal object, however, was to ensure the accuracy of the triangulation system, by the measurement of a second, or check base, in the neighborhood of Quesnel Mouth.

Positions.

Taking our departure in 1886 from Ashcroft, 8·4 miles south south-east from Cache Creek, the position of that place was fixed by Ogilvie's railway traverse, and Klotz's telegraphic and astronomical observations, under the direction of Captain Deville, the same season, as follows:—

Ashcroft siding, latitude 50° 52′ 50″.
" " longitude 121° 16′ 36″.

Longitude by traverse.

From Cache Creek to a point marked by a stake on the north shore of Lake La Hache, near the 125 mile-post, the Lands and Works Department measured a line following the waggon-road nearly, placing the latter point north of Cache Creek 78¼ miles, and west of it 16⅜ miles. The accuracy of this survey, however, Mr. Gore, the Surveyor-General of British Columbia, considers cannot be guaranteed to be closer than 1-10th of a mile in a measured mile, it having been run by compass, and chained by Indians. Assuming it to be in the main correct,—the point so fixed being the nearest fixed point of the Provincial Land Surveys,—we have for its position:—

Stake on Lake La Hache, lat. 52° 00′ 53″.
" " " long. 121° 16′ 35″.

Thence to Barkerville by our own Survey, with prismatic compass and wheel measurement—courses calculated by latitudes and departures—the position of Barkerville was obtained independently of our own and Lieut. Palmer's astronomical observations. The minus or east departures were found to be in excess of the plus or west departures by just six miles, giving us as the longitudde of Barkerville 121° 33′ 24″.

Longitude.

Latitude. Its latitude by a series of sextant observations taken by myself and Mr. McEvoy in 1885 as 53° 4′.

Independent observations. This position agrees very closely both in latitude and longtitude with Lieut. H. S. Palmer's determinations from independent observations, so that the position of the central point of the mining region may be considered as satisfactorily established within the limits of accuracy required.

Skeleton map. *Triangulation.*—The diagram on the opposite page shows the triangulation framework of the Cariboo District Map, with primary and calculated triangles.

By the old steamer and waggon road route, followed by us into the country in the working season of 1885, Barkerville, the trading centre of the mining region, was reckoned to be distant from Victoria 550 miles.

Communications.

Distances. The following table of distances by steamer and waggon road route is compiled from Williams Directory of British Columbia, 1885, p. 243:

From Victoria to

	Westminster.	Sumass.	Hope.	Yale.	Lytton.	Spences Bridge.	Cache Creek.	Clinton.	Soda Creek.	Quesnel.	Stanley.	Barkerville.
	Miles.	Mil's.	Mil's.	Mil's.	Mil's.	Miles.	Miles.	Mil's.	Miles.	Mil's.	Mil's.	Miles.
	75	40	41	19	57	23	30	26	132	60	35	12
Total ...	75	115	156	175	232	255	285	311	443	503	538	550

By the old Douglas route, used before completion of the waggon road:—

From Lillooet to	Clinton.	Soda Creek.	Quesnel.	Stanley.	Barkerville.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*
	47	179	239	274	286

DIAGRAM OF TRIANGULATION POINTS IN CARIBOO DISTRICT.

Road and Trail Distances.

The following is a table of distances obtained with the wheel :—

GOING EASTWARD FROM QUESNEL (H. B. CO'S corner) TO—

	Miles.
Four-mile Creek	3.8
Wallace's Ranche	13.3
Bohannon's, Cottonwood	20.0
Cottonwood Ranche	21.5
Boyd's "Cold Spring House"	25.2
Beaver Pass House	38.3
Stanley Post Office	44.8
Eagle Creek Bridge	47.5
Barkerville	56.5

GOING SOUTH-EAST FROM BARKERVILLE, VIA SAW-MILL FLAT, TO—

	Miles.
Grouse Creek	4.0
Antler Creek Bridge	8.0
Porter's (old Antler Town)	10.5
Littler's cabin, Saw-mill Flat	13.0
Veith's store, Little Snow-shoe	24.4
Junction Little Snow-shoe and Keithley	27.0
Veith & Borland's, mouth of Keithley	32.1
Quesnel Forks	49.0

GOING SOUTH-EAST FROM BARKERVILLE, VIA CUNNINGHAM CREEK, OVER SNOW-SHOE PLATEAU, TO—

	Miles.
Sharp's cabin, Cunningham Creek	16.9
Harvey's Creek Forks	25.3
Veith & Borland's, mouth of Keithley	35.4

GOING NORTH FROM BARKERVILLE TO—

	Miles.
Mosquito Creek	6.2
Cornish Creek	8.4
Hardscrabble Creek	10.5
Walker's mine Sugar Creek	1.5

Geological Field Work.

Method.

During the first season, the method pursued in regard to geological work was simply that of reconnaissance, with a view to observing the accessible features of the district. In places not likely to be revisited, all the necessary geological observations were completed. During the second season, the distribution of the rocks, and the mining features of the country governed, not only my own movements, but largely the movements also of the geographical party, whose work was narrowing towards completion. A section was made from the limestone rocks of

Beaver Lake, through the gold bearing series, to the water-shed of the Cariboo Range between Mitchell's Lake and Canoe River, ending opposite to, and not far distant from Tête Jaune Cache. Subsequently, the chert rocks of Bear River, which occupy a prominent position in Cariboo, were intersected at various points, and in different directions.

Quartz ledges, especially those adjacent to the placer mines, were everywhere noted, and in many instances carefully examined, and sampled for assay.

The most important areas in connection with mining operations within the district, which have been examined in greater detail, are indicated by rectangular blocks, outlined upon the accompanying map. Of these special maps have been drawn, and lithographed on scales, to accompany the descriptive details forming Part II of the present report.

Physical Features.

Details connected with mining.

Mountains and Valleys.—The relief of the district surveyed is shewn upon the accompanying map by means of contour lines, having a vertical interval of 250 ft.; every fourth one, accordingly, representing 1,000 ft. A heavy contour carried throughout the region represents a datum-plane on a level with the mouth of Williams Creek, near Jack of Clubs Lake, 4,000 ft. above the sea. Each 1,000 ft. contour, is marked by pairs of dots, for easy reference to the datum plane.

Relief.

A closer examination of the featurers of the region under consideration, establishes the fact that the north-westerly trends so remarkable for continuity and regularity in the region of the upper Columbia, are here carried out in all the geological and physical details. The Cariboo Range, forming the north-eastern limit of the Cariboo country, is the north-westerly continuation of the Selkirk Range. The crystalline schist or "gold belt," seen on Quesnel Lake, is represented by similar rocks on Shushwap Lake and in Eagle Pass.

Mountain axes.

The region of Mount Agnes and Snowshoe Plateau is an expanse of smooth and rounded flat-topped schistose hills, having the same uniform north-westerly trend, and rising in Cariboo District to an altitude of a little over 6,000 feet. To the right and left of it, following the same trend, are low-lying valleys forming the present drainage channels of the country. These are occupied by recent deposits. Lying along side of them are ranges of hills occasionally rising into mountains, which represent valleys of an older date, *i. e.* synclinals, or troughs occupied by rocks newer than the gold-bearing series. The valley of Quesnel River on the left or south-west side, is 4,000 feet lower

The gold range. than Snowshoe Plateau; while the valley of Bear River and Bear Lake on the right or north-east side is 3,000 ft. lower than the gold range.

Transverse breaks. Two remarkable breaks cross the schist or gold belt, connecting the two valleys described. These valleys are occupied by streams characteristic of the present drainage system, and by lakes. Cariboo Lake, and Quesnel Lake, extend, or formerly extended, entirely through and across the axis of the gold belt. These lakes, and the low-lying valleys connecting them, are accompained by narrow belts of level land, much of it in the form of terraces or benches. At the lower levels of the country, generally, terraces are frequent. The smooth rounded character of the mountains of the schist belt is, however, itself, due to

Terraces. the presence of these terraces at higher altitudes, and their continuations over the mountain flats and summits, forming plateaus of which Snowshoe Plateau and Bald Mountain Plateau are examples.

On the west, Quesnel River valley becomes a part of the plain. Going eastward, and beyond the axis of the Bear Lake valley, the aspect suddenly becomes alpine.

The reader imagining himself located upon the summit of Mt. Agnes on the map, sees, in the accompaning panoramic sketch looking south-west, that half of the horizon embracing the rolling plains of the interior. Turning around and looking north-west, he sees the gold region at his feet; the alpine region, and other featurers herein de-

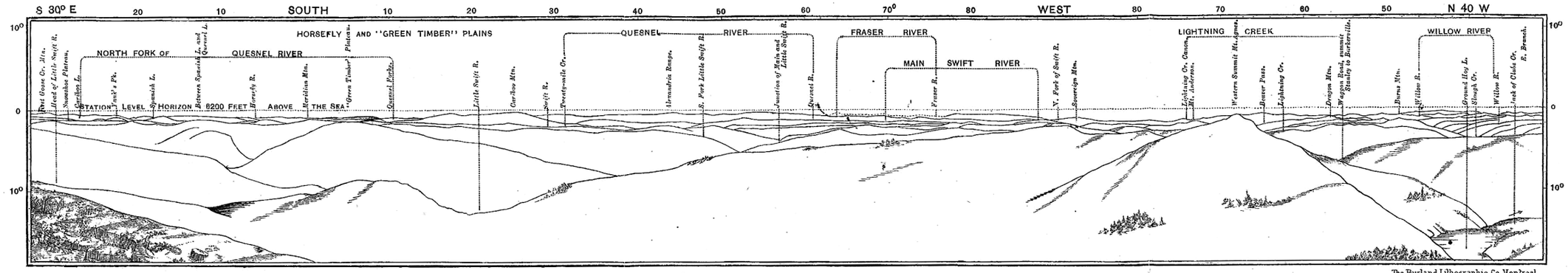
Panoramic views. scribed, beyond. By noting the horizontal and vertical angles written along the margins of these sketches, he will be able to identify each point upon the map, or in the country itself.

From Mt. Barker (six miles east of Cariboo Lake) looking west, he can see the half horizon of another sketch, made to exhibit the character of Snowshoe Plateau, and the cross cutting valley of Cariboo Lake.

Forest. The forest covered portion of the country ceases, going eastward, with the boundary line between the Mesozoic rocks and the gold bearing schists—approximately along a line drawn from the middle of Quesnel Lake to the head of Swift River—and further east generally at altitudes above 3,000 feet.

Thrifty forests exist above that level only in clumps, on sheltered uplands, or on slopes where both soil and shelter are favourable. Such forests and clumps of trees as exist on the higher mountains are often very attractive to the eye, especially on the plateaus of the gold-bearing belt. On the southern slope of Mount Mitchell, in the Cariboo Range, a handsome forest of cedars and firs having an undergrowth of Devil's club, rises to a level of 4,000 feet above the sea.

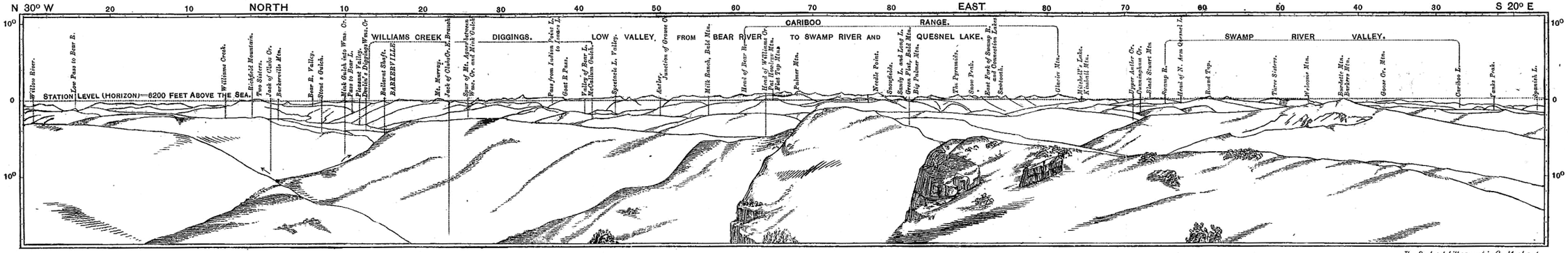
Snow. Perennial snow lies on the summits of the eastern or Cariboo range, eastward of Bear Lake valley, only between 7,000 and 8,000 feet



The Burland Lithographic Co Montreal

PANORAMIC SKETCH FROM MOUNT AGNES, (4½ MILES S.S.W. FROM BARKERVILLE.)

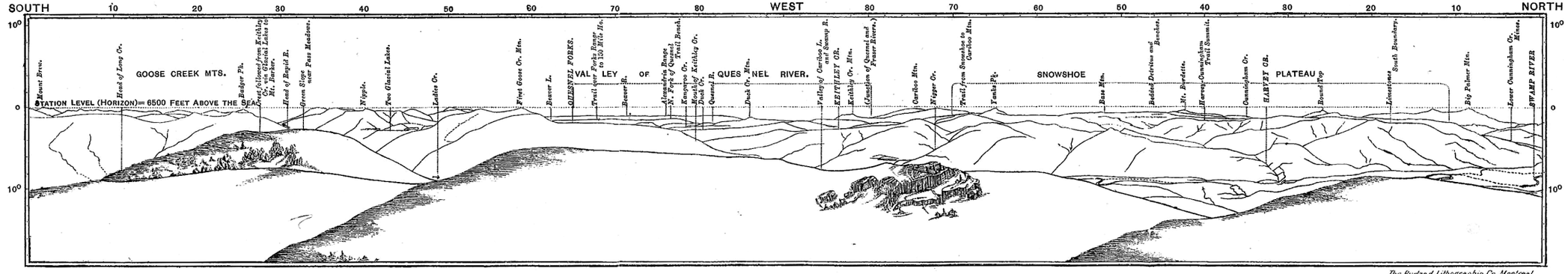
LOOKING SOUTH-WEST TOWARD THE PLAINS.



The Burland Lithographic Co. Montreal.

PANORAMIC SKETCH FROM MOUNT AGNES, (4½ MILES S.S.W. FROM BARKERVILLE.)

LOOKING NORTH-EAST TOWARD THE ROCKY MOUNTAINS.



The Burland Lithographic Co. Montreal.

PANORAMIC SKETCH FROM MOUNT BARKER, (6 MILES EAST OF CARIBOO LAKE.)

EMBRACING THE WESTERN HORIZON, AND SHOWING THE CHARACTER OF SNOWSHOE PLATEAU AND THE CROSS-CUTTING VALLEY OF SWAMP RIVER.

above the sea. While westward, the surface contour of the country is smooth and pleasing. East of Bear Lake valley all the mountain tops appear rugged, and snow-fields are common and extensive, frequently terminating in glaciers, which descend to a level of 5,000 feet above the sea.

Three-fourths of the territory of the Cariboo map lies above the 3,000 feet contour. Snow lies on the ground above that altitude for four months in the year. Quesnel Lake is closed by ice from November to March.

Geology of Cariboo District.

Approaching the Cariboo country from Ashcroft on the Canadian Pacific Railway, the traveller passes over a region, extending from Câche Creek to Clinton, of chert rocks and limestones, which have yielded fossils of Carboniferous age,* and which occupy the plateau in parallel undulations between the Rocky Mountains and the Coast Ranges. Passing over the plateau of the "Green Timber," these undulations are seen to have been completely buried in places by a series of Tertiary clays, sands, and gravels, capped by volcanic matter, and covered by drift of glacial origin and date. Underneath the Tertiary, represented by the gravels and volcanic matter of the Green Timber, are clays and lignites. These have usually been found to be restricted to narrow basins scattered over the plateau of the Cordillera, and have yielded fossils of Miocene age.† Approach.

Leaving the waggon-road at the 150-mile house, we reach the south-west corner of the Cariboo Map on Guy's mountain, at 2,500 feet above the sea, being one of the undulations mentioned. It is composed, like many of the Clinton and Hat Creek mountains, of limestone.

Descending from Guy's Mountain into the valley of Beaver Lake, at the low level of 2,200 feet above the sea, we see benches skirting the hill-sides, and beneath the gravels seen in these benches, throughout the region of Cariboo, are found at the lowest levels, occasional croppings of the lignites of the middle Tertiary.‡

Having thus entered our field of survey at its nearest point to the Canadian Pacific Railway, and Cariboo waggon-road, we are prepared for the transition from the formations heretofore examined, to those now to be described. Formations observed.

*Reports of Dr. Selwyn and James Richardson, 1871-72, pages 56-62; and of Dr. G. M Dawson, 1875-1876-77.

† Reports of Dr. G. M. Dawson for 1875, 1876, and 1877.

‡ The fossils obtained nearest to this locality are from Quensel Mouth, described in Dr. Dawson's Report for 1875-76. The nearest lignite is at Boyd's Cold Spring house, on Lightning Creek, a little above its junction with Swift River, mentioned in the Report of 1876.

Exclusive of the superficial deposits, the rocks met with in the Cariboo district may, according to our present knowledge of them, be classed as follows in descending order:—

Pre-glacial gavels, Pliocene? Basalts Clay-shales, etc., with lignite, Miocene	Cainozoic.
Quesnel River Beds, argillites, agglomerates, etc. In part at least Lower Cretaceous	Mesozoic.
Bear River Beds, Limestones, cherty quartzites and beds of volcanic materials, probably in part Carboniferous	Palæozoic (Upper.)
Cariboo Schists, rocks more or less completely crystalline, of very varied character	Palæozoic (Lower.)
Quesnel Lake Crystalline Series	Archæan.
Granites and granitoid rocks.	

Recent.

Valley and surface deposits.

The low-lying valleys of Beaver River, Quesnel River, and Bear River, and the higher valley of Willow River, are observed to have flats, which are frequently a mile, to two miles, in width. Still higher lying meadows than those of Willow River, are found in places on nearly all the tributary branches, at various altitudes. Usually these occur where the configuration of the country has led to the formation of basins in the interrupted descent of the streams. The recent deposits of these valleys are indicated by a yellow coloring on the map.

The material of the recent deposits consists of the ordinary thin stratum of humus, or loam, overlying very extensive bodies of sand, and gravel. The latter were washed down from higher deposits of gravel and sediments of an older date, and were bedded in the flats by the present streams.

Soil.

A soil that would be classed as good agricultural land, extends over the low or level portions of the hills and plateaus, yielding excellent crops of grass. Indeed no better grazing country can be found than the mountain meadows of Snowshoe and Bald Mountain plateaus in July, August, and September. These meadows situated at altitudes from 3,000 to 6,000 feet, afford opportunities for summer grazing in in connection with a varied agriculture, and the wintering of cattle at lower levels.

Post Tertiary and Tertiary.

The formations of the Post Tertiary and Tertiary, are unimportant as to area covered, since such areas are usually otherwise colored to represent the underlying rocks. These formations are superficial in character. Where rendered important by their product of gold, and occurring in the form of narrow belts of gravels accompanying the valleys of streams, they are indicated by hachures in red on the map.

But in point of fact the entire surface of the country is covered by Post Tertiary detritus, blending into still older gravels partly Tertiary, of as great or greater economical importance. All these gravels will be appropriately considered and delineated in connection with the details of mining as shown upon the mining maps.

Volcanic. The volcanic rocks of Tertiary age, which are so widely distributed elsewhere over the plateau of British Columbia, were noted only at two points within the area of the Cariboo map, viz.: on the north arm of Quesnel Lake, (in association with Tertiary gravels), and at Guy's Mountain. In both cases they cover limited areas. Lignite. The lignite clays, although present, can be seen only in localities situated near the bottom of the lowest valleys, and are usually covered or hidden by the Tertiary and post Tertiary gravels. They represent a notable feature in the drainage of the country related to middle Tertiary history, and will be further referred to in that connection.

Mesozoic.

Quesnel River Beds.

Foot hills. A large area which can be definitely referred to the lower Cretaceous, accompanied by an older series of rocks, (which may be Jurassic,) is delineated by a green coloring, occupying the trough of Quesnel River valley. They cover the entire lower and left hand margin of the Cariboo District map.

This belt is crossed in travelling from Beaver Lake to Quesnel Forks, and thence to Kangaroo Creek—along the usual travelled trail from the 150-mile house to the mines. It has an average width of sixteen miles, within the area of the map. All along Quesnel River and at Cedar Creek on lower Quesnel Lake, this formation has yielded auriferous gravels. These were the first "pay gravels" discovered; and the first to be profitably mined in the Cariboo country.

Volcanic and sedimentary rocks. The prevailing habitus of the series is that of mixed volcanic and sedimentary rocks. Massive beds succeed each other with great regularity. The dip is flattish rather than steep, but frequently at a greater angle than 45 degrees. Their strike corresponds with the general

trend of the formation, which is that of the troughs and ridges generally.

Boundaries. The limits of the formation are: along Beaver River valley, on their south-west side; and along a line from Upper Swift River to Spanish Lake valley on the north-east side. The latter boundary extends in a north-westerly direction to Lightning Creek, below the Bonanza mine, where it forms Red Cañon of Lightning Creek between the Bonanza and Boyd's Cold Spring house. In the opposite or south-easterly direction, it continues to Quesnel Lake, striking the Lake a few miles above Lynx Peninsula. Thence eastward it forms the south shore of Quesnel Lake.

Aspect. The hills composed of these rocks are much lower than those of the underlying gold bearing schists, on the north-east. Their surface is rough and craggy. Trees appear to have a precarious footing. In a large area on the south-side of Quesnel River the winds and fires together have prostrated most of them before attaining any considerable size. In the valley of Hazeltine Creek, however, the soil derived from this formation is deeper, and the forest is luxuriant. The hills in general have a characteristic even, flattish surface contour. They can be recognized from a distance as belonging to the formation of the trough of Quesnel River valley. Generally they are from two to three thousand feet lower than those of the gold schists.

Localities examined. They were examined at several places on Cottonwood Cañon; between the Cottonwood Ranch and Hixon Creek trail-crossing; at the Donaldson Bridge in the Cañon of the Quesnel ten miles above Quesnel mouth; at Wallace's Mountain, and on the dividing ridge between Quesnel and Cottonwood Rivers; at Morehead Creek; and at several places along the south fork of Quesnel, as well as on the north, and on the shore of Quesnel Lake. Mr. McEvoy noted them along his track-survey from Quesnel Forks to Quesnel Mouth.

Lithological features. There is a lithological resemblance throughout of the rocks of the above named localities, as shown by the specimens collected, which testifies to a history distinct from anything elsewhere observed in the district.

Among them were found the characteristic conglomerates of the "Shasta Group." The cementing material is often a brownish, or greenish mass. From conglomerate to breccia, with the same cementing material, they pass into a compact rock, consisting of the cementing material alone. Sometimes this is crystalline, and in massive beds, less frequently thinly bedded. Of the mineral ingredients aside from hornblende and felspar, the crystalline varieties are frequently fine in grain, and not readily determined without the microscope.

Metamorphism These rocks have been subjected to considerable metamorphism. In small outcrops it is often difficult to recognise any definite strike or

dip, jointage and cleavage planes being more prominent than those of bedding. In the larger exposures the latter can, however, generally be detected.

The bulk of the strata constituting the group are clearly the result of sedimentary deposition, while others are as clearly of contemporaneous volcanic origin, both molten and fragmental.

Cretaceous. Fossils were collected on the south shore of Quesnel Lake, near Hazeltine Creek; and at Big Wheel Flat, two miles below the outlet of Quesnel Lake. Of three species collected, two appear to be undescribed. The third is the well-known *Aucella Piochii*, of Gabb, indicating the horizon as probably equivalent to the upper part of the Shasta group of California.

Thickness. By reference to the accompanying section, it will be seen that there is a great thickness of these strata overlying some that are auriferous, southward of Quesnel River; and that these latter come to the surface mostly along that stream, and northward of it.

Jurassic? Reasons for supposing that Jurassic rocks may be represented in the district, exist in the occurrence of slaty and certain other beds observed immediately below these holding fossils, on the south shore of Quesnel Lake; and in similar slaty beds observed a little above the Falls of the South Fork of Quesnel River, near Quesnel Forks. The latter consist of soft and perfectly black carbonaceous slates of a character also observed in some of the beds in the Cañon of Lightning Creek. These slates differ from those of the older gold schists in possessing no perceptible crystalline ingredients.

Placer mining. The placer mining carried on between the outlet of Quesnel Lake and the town of Quesnel Forks, owes its wealth of gold to the rocks described. If any rocks of Jurassic age occur here they may be supposed to come to the surface unconformably with the Cretaceous. Recent published evidence indicates that the rocks holding *Aucella Piochii*, which have been referred to the Neocomien, may be as new as the Dakota group.

Californian resemblances. We have here a repetition of gold-bearing rocks exhibiting in several particulars conditions peculiar to the foot-hills of the Sierra Nevada, in California, viz: the occurrence of the Shasta group of Shasta county, with an Aucella allied to that characteristic of the gold-bearing shales in Mariposa county, on which the geological position of the California gold-bearing shales has been based; the association with Carboniferous limestones, in Shasta and Sierra counties, and again, the formation in which these fossils occur flanking a higher range of crystalline schists, containing no fossils, but intimately associated with adjacent older crystalline and granitic rocks, in Cariboo District, as in the Sierra Nevada.

Upper Palæozoic.

Bear River Limestone and Cherty Series.

Carboniferous.

Allusion has been made to the geological position of the small patch of limestone and associated rocks seen at Guy's Mountain, in the south-west corner of the Cariboo map. This is supposed to be identical with the Carboniferous limestone of Cache Creek and other localities.

Leaving the limestones of Guy's Mountain and the Quesnel River rocks just described, and continuing our route in a north-easterly direction along the line of section marked upon the map—which cuts across these different formations nearly at right angles—we ascend to the plateau of the gold bearing schists, commonly known as the "Slate Belt," near its north-eastern boundary on Round Top Mountain. The usual route of travel is a little to the right of our imaginary line, following the western shore of Cariboo Lake and the valley of Swamp River as far as Harvey Creek, where it ascends Snowshoe Plateau, to our line of section.

Limestones.

Standing on Round Top, and facing north-east, we look across the second geological valley or trough, described as an existing valley, viz., that of Bear Lake, and Upper Swamp River. On Swamp River again, there is an immense white cliff of limestone, in a mountain rising opposite Harvey Creek, a thousand feet above the valley. Similar white cliffs of limestone are seen to the eastward and northward, within a radius of 160 degrees, as far as the eye can reach, for fifty miles, on both sides of the Bear River valley, embracing generally the formation coloured grey upon the map.

Cherts and volcanic rock metamorphism

This formation is remarkable not only for its limestones, but for its cherty rocks, and differs in these respects from any other in the district. Among the chert rocks are occasional beds of volcanic origin, and limestones do not always accompany the cherts. The formation was intersected at many different points, and traversed in many different directions, before its identity and continuity could be ascertained. In contrast with the crystalline schists of the gold belt, none of the characteristic crystalline rocks are to be found init. To this, some of the limestones are an exception. The rocks in general are more compacted and more altered than those of the Mesozoic area of Quesnel River. It forms part of several distinct ranges of mountains; amongst which the Two Sisters (6,800 feet above the sea) are the highest in the vicinity of the gold region, being exceeded in height only by the alpine peaks of the Cariboo Range; the culminating points within the area of this formation averaging about the same height as those of Snowshoe and Bald Mountain plateaus, in the auriferous belt.

On the north-east side, the boundary of the formation is near the western foot of the Cariboo Range, at the lowest levels of the Bear River basin. The south-western boundary is not so distinctly marked by physical featurers. It rises to the same heights, and in many places coalesces with the gold-bearing schists, on the flanks of prominent mountains of its own, or of schist formation.

Boundaries.

From Swamp River, at a point a few miles above the junction of Harvey Creek, the line between it and the gold schists crosses over the northern slope of Round Top, and continues thence westward to the Great Bend of Cunningham Creek without having given rise to any decided bounding valleys of erosion. From the last mentioned point continuing westward, it keeps close to, without precisely following, another north-westerly trending chain of valleys, represented by the Cunningham-Antler Pass Creek, a tributary of Cunningham Creek, and by a portion of Antler Creek, Pleasant Valley Creek, Sugar Creek, Valley Creek and Willow River.

Width.

It is thirteen miles in width opposite Barkerville and above Bear Lake. It widens towards the north-west, and narrows in the opposite direction to five miles and a half at the head of the North Arm of Quesnel Lake.

Aspect.

In appearance the mountains of this formation are generally smooth. On the summits and higher slopes they are bald and grass covered. They show a brown colouring of soil, visible from a distance of many miles. Their outlines show an intimation of rocky ribs, more apparent than in the mountains of the gold bearing schists. At the same time their regularity sets off, and in rounded and graceful curves contrasts with the rugged peaks of the Cariboo range beyond. Their lower slopes and foot-hills are covered, in all favorable places, by dense and luxuriant forest.

The rocks of this formation were examined at Wiley's Mountain, at the head of Sugar Creek, at the Two Sisters Mountains, at points along the trail from Barkerville to Bear Lake, at Mount Murray, along lower Antler Creek, on the Palmer Mountains at Antler-Cunningham Pass, and at the head of the North Arm of Quesnel Lake.

Green cherts and jasper.

The most striking peculiarity of these beds is the prevalence of greenish cherts, and of jaspery silicious rocks. Older volcanic sediments occur in all gradations of fragmentation, from breccia to sandstone and from sandstone to shale. The cementing material is usually of a greenish cast, as are the rocks themselves, when compact.

The degree of metamorphism has been plainly much greater than in the Mesozoic area, and distinctly less than in the area of the gold schists. The limestones, for example, are only occasionally and locally altered to a perfectly crystalline condition. Pressure has produced

in some instances, that faint appearance of schistosity which is peculiar to the schists. It has nowhere produced the perfectly crystalline characters universal in the schist belt proper.

At Eight-mile Creek Cañon, on the trail from Barkerville to Bear Lake, along with other characteristic rocks of the series, there are grey schists and sandstones more altered than elsewhere seen within the limits of this formation. It was first thought that these were older than the typical cherts of the Bear River series. A tendency towards a crystalline slaty character is apparent in the mineral ingredients, which, nevertheless, show distinctly on their weathered surfaces, their original fragmental character.

The position of these altered rocks is probably low in the series. They may represent transition beds, rather than the underlying gold schists, from which they differ in uniting distinctly fragmental, with some of the characters of the crystalline rocks. Situated in the axis of the Sisters range, the lower strata of which they represent, a local metamorphism under greater pressure, may sufficiently account for their aspect as described. A tendency to silky foliation in the softer shales is a further characteristic.

Regular bedding.

Another feature notable in the rocks of this formation is their regularity of bedding. The rocks are often seen in massive beds, only moderately inclined.

Fossils.

A series of fossils was collected near one of the mining camps on lower Antler Creek, situated about three miles below the junction of Pleasant Valley and Antler creeks. Crinoids are preserved in the limestone, but unfortunately too imperfectly for determination. Their rounded forms afford only presumptive testimony,—along with the stratigraphic and lithologic evidence—of an age not newer than Upper Palæozoic.

Gold.

The placer mines of Lower Antler Creek have derived their gold from rocks of this formation. The yield has been sufficiently good to indicate the presence of the precious metals in their accompanying veins, in quantities that render them worthy of the attention of the prospector.

Lower Palæozoic.

Schists of the Cariboo Gold Belt.

Axial range.

We come next in descending order to the gold schists; a series of crystalline rocks, which are low down in the geological scale.

The gold range of Cariboo, lying between the two troughs described, has an average width of twenty miles, from Swift River on the west,

to the two Valley Creeks on the east;—or from Spanish Lake, nearer the eastern border of the map, to the head of the North Arm of Quesnel Lake.

Its boundaries are: on the south-west side, the north-eastern boundary of the Mesozoic rocks of the Quesnel River series, already described in detail; on the North-eastern side, that of the Palæozoic rocks last considered, along with which they form the mountain system of the gold region, or the gold range of Cariboo. Boundaries.

This implies a geological relationship. These gold schists are, as already stated, much more highly altered than any of the rocks in the Bear River series. Their junction, as observed on Antler Creek below Pleasant Valley Creek, exhibits, however, a similarity of strike and dip suggestive of conformability. But the greater degree of metamorphism is apparent at a glance and is alone good evidence of their greater age. Their inferior contact with gneissic and granite rocks points to the same conclusion, and the presumption is that they constitute some part of the lower Palæozoic—perhaps even pre-Palæozoic—system. Apparent conformability. Relative ages.

There is a certain individuality in the appearance of the gold belt superficially. The soft and friable schists readily decompose under atmospheric influences, and there is consequently a disposition to rounded forms in the outlines of the hills. Round Top Mountain, dominating Snowshoe Plateau by some hundreds of feet, contains quartzite beds, which have resisted weathering. Mount Agnes, Richfield Mountain, Yank's Peak, and Cariboo Mountain, are prominences due to the ability of the rocks there coming to the surface, to resist weathering. Aspect.

The northern slopes of these mountains are frequently steeper than the southern. The fact is usually attributable in Cariboo district, as it is elsewhere, to the inclination of the beds, in connection with the eroding operations of adjacent streams, facilitated and sometimes directed by the jointage of the rock. More rarely cliffs may have been determined by lines of fracture and displacement. Escarpments.

The strike of the rocks, as in the formations heretofore described, is usually in the direction of the mountain ranges. The entire schist or "slate belt" is furthermore characterized by an abundance of quartz-veins; and on the higher mountains these rise above the surface, and generally follow in direction the strike of the slates. Strike.

In the folding to which the schists have been subjected—by a pressure exerted at right angles to the trend of the ranges—there appears to have been a tendency to fractures in a north-westerly and south-easterly direction. Abundance of quartz veins.

The fissures resulting have afforded facilities for the percolation of

alkaline and silicious waters, the presence and prolonged action of which forming quartz, served as nature's healing agency of the fractures. Large veins are more frequent, and more remarkable on the mountain tops—Richfield Mountain, Mount Agnes, Mount Burdell, etc.—than in the valleys.

Lithological. Lithologically the Cariboo schists are altered sediments—clays and sandstones, with occasional small bands of limestone and calcareous shales, comprising popularly the characteristic "slate rock," where gold is looked for, in veins, and placers, by the experienced miner.

The "slate" varies from a black or bluish shale, cleaving, commonly, in the direction of the bedding, to a more or less foliated grey or green chloritic, or talcose schist; the varieties ending with typical mica-schist. The latter is the most characteristic and most widely disrtibuted of the varieties of the Cariboo "slate."

Bands of silicious and calcareous ingredients can be traced. Also bands of more or less decidedly marked mica schist, containing several varieties of mica.

In the gold region, eruptive rocks occasionally occur in the form of dykes. A dyke on the eastern slope of the Round Top summit is of hornblende rock. Dykes of "porphyry" are not uncommon.

Thickness. As it would be unsafe, where the rocks are so frequently on edge, to draw conclusions regarding their thickness from any general section, however accurate, attention may be directed to the following distances on the Cariboo Map, where a constant dip in the same direction was observed. On Williams Creek such uniformity occurs for five miles; on Antler Creek, it occurs for four miles and a half; and along the crest of the Goose Creek Mountains, from Goose Creek to Barker's Mountain, six miles.

In Devlin's Diggings at the foot of the Williams Creek section, and again at Mink Gulch above Richfield, the attitude is vertical. Above these points are seen the usual gentler northerly dips. There is probably a repetition of beds on Williams Creek, such as is indicated on that part of the general section corresponding to it.

In that part of the section corresponding to the crest of the Goose Creek Mountains, it will be better in accordance with the facts to conclude that some beds have been inverted, than it would be to assume a thickness of 30,000 feet. The total thickness of the schists is probably as has been indicated on the section, from five thousand to eight thousand feet.

Schist belt and more crystalline, older rocks. In delineating the schist belt, two shades of coloring are used: that of the main body (Payne's Grey) representing the gold schists on the north and west; and that of the more highly crystalline area to the south-east, exhibited on the North Fork of Quesnel River, and again

along the shores of the North Arm of Quesnel Lake, which is represented by a lighter shade of the same color.

These two areas possess certain rocks and other characteristics in common. Others are peculiar to each. The more crystalline of the schists characteristic of the gold region occur also in the eastern area, in association with coarser crystalline felspathic and quartzose ingredients. In the western area no granitic or gneissic rocks are anywhere found in place. In the eastern area, on the other hand, the Mount Stevenson group of mountains is a granitic core of the highly crystalline series.

The characteristic rocks of the western and eastern areas respectively, are seen in close proximity at Shoal Bay, a little westward of the junction of the two Arms of Quesnel Lake. They are in association with each other at several places between that and the head of the North Arm. They appear to be related, and separable only by regarding the more crystalline as an older and underlying member, re-appearing in folds in the gold region.

Where observed.

A belt of the eastern and older rocks was recognized on the North Fork of Quesnel River. Similar coarse crystalline rocks were observed at Cariboo Mountain; and near the wing-dam on the waggon road between Boyd's and Beaver Pass. They occur at other places in the schist belt, where their presence might be accounted for by folds of the older series accompanying the schists, although it is impossible at present to trace such connection throughout the district.

Resemblance to Archæan rocks.

Among the rocks of this eastern area are granites, gneisses, quartzites, and other of the characteristic Archæan rocks. The surface features of the country, although rounded, are rougher and more craggy than those of the gold region.

Rocks of the Alpine Region of Cariboo.

Limestones overlying schists.

Belonging to the Cariboo Range, east of the Bear Lake trough, the rocks of Mount Mitchell were examined, and were found to be the same as the gold schists of the western area above described. Limestones occur in large masses near by, overlying the schists unconformably and with their accompanying rocks forming the crests of the range.

The latter exhibit a contrast to the schists, in their more rugged and alpine character, as well as in their greater regularity and the moderate inclination of their bedding.

Less rich in gold.

Neither in the Cariboo Range, nor in the crystalline region of which Mount Stevenson is the representative, has gold been found in quantity corresponding with that of the area described as the gold region

proper. And though gold has been found in all the creeks, and has been more or less mined on the easily accessible ones, the fact remains that it has not been found in profitable quantities in any other part of the country under consideration, nor elsewhere than in the area of the folded schists.

Lithological resemblances.

The entire crystalline series of the gold region of Cariboo is lithologically identical, as near as can be described in general terms, with the rocks of the Pre-Cambrian and Cambrian gold regions of eastern Canada. The gneissic and schistose type of rocks of the Mount Stevenson group especially (supposed to represent the lowest horizon, on account of their association with granite in a central and massive mountain group) finds lithological representatives in the Pre-Cambrian rocks of the eastern provinces of the Dominion, and in the Appalachian axis.

Section from Guy's Mountain to the Cariboo Range.

Succession of formations.

The line of section drawn from Guy's Mountain across the schist belt of the Snowshoe Plateau, to the summit of the Cariboo Range, a distance of sixty miles, is constructed on a scale, horizontal and vertical, of two miles to the inch; the base being sea level. On it is shown the succession of the formations represented in the district; their attitude as seen at different points, in travelling across them, and their thickness, as deduced from the dips and distances along the line of section. Its course is north 40° east, therefore not exactly at right angles to the average strikes, and the mountain trends of the district.

Mining Geology.

Dip and Strike of the Country-rock.

In practical importance not second to distribution, are the dips and strikes of the several rock-formations, which have been summarized in the accompanying section. In order that the data from which the section was drawn may be further available to the miner interested in tracing quartz veins, a large number of strikes in each of the formations are shown upon the district map. All the bearings are from the astronomical meridian, the magnetic meridian being N. 26½° E.

Significance of dips and strikes.

The general agreement of the strikes with the trend of the hills and streams, in a south-easterly and north-westerly direction, has already been mentioned. It is not difficult to obtain from the attitudes of

G. CACHE CREEK ROCKS.

UPPER PALÆOZOIC.

K. QUESNEL RIVER ROCKS.

bedded volcanic agglomerates, argillites etc. Lower Cretaceous in part

MESOZOIC.

B. CRYSTALLINE ROCKS OF NORTH FORK OF QUESNEL RIVER & LAKE.

Gneisses mica schists, granular and silicious micaceous schists of Duck Creek, Round Top etc, probably ARCHÆAN.

B TO C. CARIBOO SCHISTS.

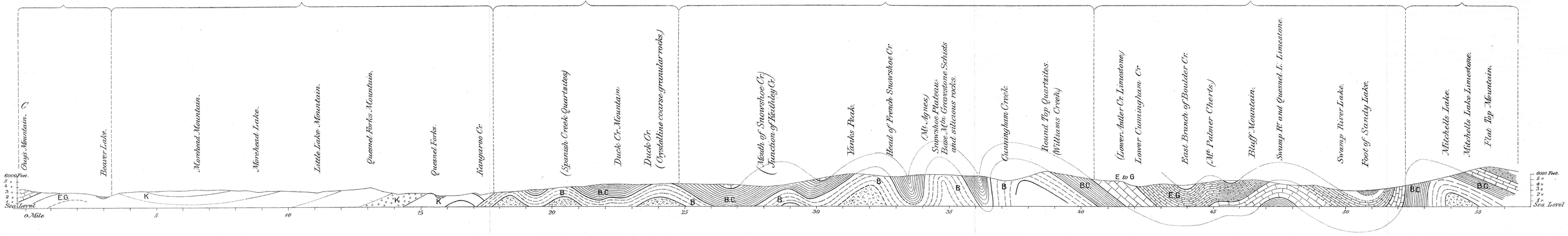
("gold bearing" slates) black, grey and greenish metamorphic schists – silken, talcose, and micaceous. LOWER PALÆOZOIC.

E TO G. BEAR LAKE ROCKS.

limestone cherts and quartzites probably UPPER PALÆOZOIC.

B TO C. CARIBOO SCHISTS.

overlain by massive limestones.



SKETCH SECTION FROM GUYS MOUNTAIN TO THE CARIBOO RANGE, VIA SNOWSHOE PLATEAU.

Vertical and Horizontal Scale 2 miles to 1 inch.

the rocks exhibited in the section, an intelligible idea of their history as off-shore sediments of an ancient Archæan ridge, or archipelago of the Cordilleran region. Facts of importance to the quartz miner are developed by a comparison of the dips and strikes of the rocks on the several profitable placer-mining creeks. They will be more precisely shown on the creek maps, which are on larger scales. The positions and areas of the several creek maps are outlined on the general district map, along with other details which cannot be shewn upon the scale of the district map.

The dips and strikes plotted on the district map suffice to show the existence of an axial line C D which marks the position of a saddle, or anticlinal in the gold slates and schists. It lies close to some of the prominent mountains of the region, but seldom strikes through their highest points. The dips on either side of it are usually nearly vertical, though occasionally they are nearly horizontal, as if occupying the unbroken summit of an arch. The line is nearly parallel to the general strike of the schists, and equidistant from the massive limestones of the Bear Lake series, on the north-east. Anticlinal axis.

In tracing a line of this description through a country where there is a succession of wavy folds, it is not easy to distinguish the continuation of the axis of one fold from that of the next one in the series, on account of their frequent interruption by cross fractures, and by valley erosions. One such cross fracture is indicated by the dips of Beaver Pass and Ruchon Creek. It runs in a north-north-easterly direction, and corresponds with the course of one of the vein systems of Burns and Island Mountains. Another is seen in the transverse-cutting valley of Swamp River, Cariboo Lake, and of the north fork of Quesnel River, which has deflected all the strikes adjacent to that valley from their normal direction. A similar disturbance of the Mesozoic rocks occurred, judging from the plotted dips and strikes, on Quesnel Lake between its outlet and the narrows. Folds. Transverse breaks.

A clue to the identity of beds, and accompanying veins on Williams and adjacent creeks, is afforded by the limestone bands. They occur to a limited extent in the gold schist series. In the folds of the rocks exhibited upon the general section of the country in a broader manner, the limestones are seen repeating themselves in widely different attitudes. The limestones of Jack of Clubs Creek on the northern slope of Mount Agnes, those of Black Jack Cañon, and of the lower part of Barkerville on Williams Creek, as well as those of Antler Creek, and Cunningham Creek, similarly repeating themselves, will be found susceptible of identification, and correlation by means of their dips and strikes. Identity on different creeks.

Dip and Strike of Veins.

Quartz veins are represented on the Cariboo map by a heavy red line, drawn in the direction of their strike; the dip being indicated in the same manner as that of the country-rock.

Their general correspondence in strike with that of the country-rock has been alluded to. A glance at those parts of the district map which are covered by the outlines of the creek maps will show the geological features bearing on their continuations through intervening ridges and approximately their identity on the different creeks. Such identity may often be of little consequence at the distances in question, but it is noteworthy wherever traceable, especially as it is found to have a certain relation to the quantity of gold in the placer diggings of the vicinity.

Related to placers.

Openings on ledges.

Early in the history of these mines, attention was directed to the croppings of ledges noticed between Lowhee Creek, Proserpine Mountain, and the head of Grouse Creek. Openings were made on the Enterprise ledge on Lowhee Creek; on the Bonanza, Black Jack, and Steadman ledges on Williams Creek; on the Wilkinson ledge, on Proserpine Mountain; and on the Dufferin and Fountain-head ledges on Grouse Creek; all approximately in the same line of strike.

Relationship of veins to placers.

The dotted line E F is drawn along the upper edge of the richer placer diggings, from Red Gulch via Mosquito Creek, Lowhee Creek, Stouts Gulch, Williams Creek, Grouse Creek and Antler Creek to Cunningham Creek, showing a close enough relation to the series of veins which are plotted, near the same line of strike, to render additional details regarding them of interest. The depth of the superficial soil and gravel has prevented their connection being actually traced on the surface, between these different creeks. The testimony of accompanying rocks, their relative position geographically, their geological position between the top and bottom of the series to the north of the axial line of Mount Agnes, and the dip of the ledges themselves are the factors throwing light upon the question of their relations on the different creeks. Finally the contents of the ledges as given, may be investigated.

Differing dips.

A comparison of the dips and strikes of the ledges with those of the country-rock, reveals the fact that while they agree remarkably in strike, they do not agree in dip. This fact holds good in some of the principal ledges throughout the mining region. The identity of strike, and not of dip, is readily explained by the supposition that the quartz veins filled fissures which were influenced in direction by that of the bedding and the lines of disturbance during uplift. They happen to be parallel to the strike, though they are often independent of the

Vein fissures.

bedding. Veins of this description do not necessarily continue downward within the bedding to any depth; though a coincidence of the plane of bedding with the direction of the fissure or vein, doubtless frequently produced conditions favourable thereto.

Among the series of veins enumerated, the Island Mountain ledges show a southerly dip, of from 60° to 80°. The Enterprise, Steadman, and Proserpine ledges are vertical. The Bonanza, Dufferin, Fountain-head, and Nugget Gulch, and Antler Creek ledges have a northerly dip, of from 50° to 80°. All of them are in a country rock which has a prevailing northerly dip. If they belong to one system, a remarkable twist would have to be accounted for. Elsewhere at Island Mountain the northerly dips may very probably occur also. Island Mountain ledges.

The persistency of the strike of the principal ledges of Cariboo in the direction of the trend of the mountain system, co-incident with that of the schists, must be ascribed to a common original cause, that of the uplift and folding, therefore it is only incidentally related to the bedding of the schists. Causes.

Other peculiarities of these veins, including the character of their contents, are referred to below, and will be considered hereafter in giving further details of the creeks. Vein contents.

The cross-vein system of Burns Mountain is different from that last described in general direction, being north-north-easterly and nearly vertical. The adjacent country rocks dip to the south-eastward 30°, finding a parallel to their strike in the rocks of Beaver Pass and Ruchon Creek, which dip to thewestward at a similar angle. Transverse system.

On Snowshoe Plateau the ledges show an agreement in strike with that of the country-rock, yet with notable variations in dip. The ledges of Duck Creek, the North Fork of Quesnel, and of Spanish Creek vary from the country rock both in strike and dip.

Distribution of the Placers.

It is found that those parts of the Cariboo country which have a record in placer mining, can be included within the red lines G. G. and H. H., forming a circuit with a diameter of forty miles, of which Cariboo Mountain is the centre. The periphery is represented by a circular belt of about ten miles in width. It includes the diggings,—beginning at the north-west, and following the hands of a clock,—on Lightning Creek, Ruchon Creek, Willow River, Sugar Creek, Hardscrabble, Slough Creek, Red Gulch, Mosquito Creek, Lowhee Creek, Williams Creek, Grouse Creek, Cunningham Creek, Harvey Creek, Snowshoe and Keithley Creeks, Goose Creek, Duck Creek, Spanish Creek, the north Fork of Quesnel, Kangaroo Creek, Cedar Creek, the south Grouping of placers according to erosion.

Fork of Quesnel, Morehead Creek, and the main Quesnel River; and covers all of the formations described in the district; that of the gold schists being the only one remarkable for the wealth and permanence of its diggings.

A feature attending the entire list of creeks, embracing the placer mining country generally, is the width and depth of the erosions peculiar to the placer area.

Accumulated wealth in the form of placers, is simply representative of a great thickness of the country-rock, including quartz-veins, disintegrated and removed. Its metal has been concentrated, and retained, along with the heavier rocks and the harder gravels which resisted disintegration.

Higher portions of the creeks, reaching up into the mountains or into the plateaus in their vicinity, within the placer belt, it is frequently observed, have not proved correspondingly rich. This fact should not be placed in evidence against the wealth of ledges not adjacent to the richer placers, or outside of the limits of the principal placer belt. These ledges simply happen to be visible where erosion has not had the opportunity to do its work. Had the streams done an equal amount of cutting away and concentration upon them, there might have been placers in their vicinity, perhaps equally rich. Concentration by denudation being thus duly allowed for, the placer deposits will generally prove to be the most reliable indication of the wealth of the adjacent ledges.

Nature's assays.

Indications

It is well understood that angular boulders and coarse gold cannot have suffered such attrition and hammering as are incident to much travelling in the course of a stream bed. Thus the placer mines indicate first, the belts of auriferous country-rock, the streams will indicate the direction, and the transported matter itself shows the distance we have to go to the ledges, whether large or small, from which the placer gold was derived. They may justify mechanical exploitation or not, according to circumstances peculiar to the district, such as transportation, etc., quite apart from their character.

The lines of strike, accompanied by the axial line C.D., and the area of deep erosions included between the lines G.G. and H.H., furnishing respectively, the elements of identity of the rock, and of the value to be attached thereto from the testing of it by erosion, will be found to contribute materially towards confirming a judgment from nature's own hand, of the promise of the ledges on the different creeks.

Quartz Ledges Examined.

Williams Creek.—Among the ledges which have attracted the attention of the placer miners, and later of quartz prospectors, in a few instances succeeded by systematic underground mining,—are the following, with their principal features, and assay values, as found:— Quartz.

Proserpine Ledge.—At Wilkinson shaft house. Strike and dip, etc., not visible on account of the filling up of the shaft; supposed to be in line with Mason Avenue, which runs N. 47° W.; bearing to Bonanza ledge N. 43° W. The strike of the soft black slates, taken 200 feet west of the Wilkinson shaft, was found to be N. 43° W.; dip about vertical. Hence the ledge here may be considered as between beds. Body not visible. *Contents*, quartz, pyrites, ferric-hydrate, carbonaceous matter, and a little siderite. The shaft is 50 feet deep; it was sunk in 1864-66, by Wilkinson. Vein between beds.

At the Proserpine shaft house, 700 feet east from last, the attitude is about the same, the vein dipping S. $<75°$; body, 10 feet. *Contents:* galena, iron pyrites, quartz, chlorite, brown oxides, and a bluish felspar. An assay by Mr. Hoffmann, of specimen containing iron pyrites and galena, in a gangue of quartz and chlorite, gave gold, 0.787; silver, 20.738 ounces to the ton. Another (No. 54) yielded only a trace of gold, and no silver. Pyrites in "slate" is said to have assayed very high. The shaft is 97 feet deep. (Filled with water.) Galena.

At a distance of 630 feet W.S.W. from the Wilkinson shaft house is the "supposed Steadman Ledge," a body of quartz striking east and west, with a southerly dip of 75°. It is in slates striking N. 33° W., and dipping north-eastward $< 65°$; showing local irregularity in the attitude of the country rock, and an intersecting vein system. Vein across beds.

Steadman Ledge, Richfield. A body of about four feet in width can be seen near the bed of the creek, where it has been exposed by an open cut. Strike, N. 48° W., standing about vertical. Fifty feet from it the slate rock strikes S. 35° E. and dips north-easterly $< 70°$; apparently in broken ground, as a hundred yards above it, and about the same distance below it on Williams Creek, the slate rocks strikes S. 65° E. and dips northward from 70° to vertical. *Contents:* A specimen sent to me by James Reid in December, 1886, obtained from a depth of 30 feet, assayed by Mr. Hoffmann, contained gold, a distinct trace; silver, none.

Hines Ledge, above Richfield. Quartz with pyrites and mineral resembling limonite. A body of quartz several feet or more in width was sunk upon by the occupant of the adjacent cabin. Depth of shaft, six feet; body of ore, four feet; direction of strike and continuity unknown. It is at the head of the profitable placer mining on Williams Creek. Contained little or nothing.

Stout's Gulch Ledge, Hydraulic Diggings, near Barkerville. An assay, by Dr. Harrington in 1876-77, of a specimen collected by Dr. Dawson, from a five-feet cross vein, containing white quartz with iron pyrites, gave gold, ·335 oz.; silver, ·131 oz. to the ton.

Vein between beds.

Bonanza Ledge, situated near the divide between Stout's Gulch and Lowhee Creek, near Barkerville. Strike of ledge N. 48° to 63° W.; dip northward < 45° to 60°; strike of slates in tunnel, N. 65° to 80° W.; dip northward < 45° to 60°. The above are repeated trials at different places. Taking an average, that of the ledge would be N. 55½° W., and of the rock N. 72½° W. The strike of a large body of quartz on the surface several hundred yards east of the tunnel known as the "Big Blowout," agrees in the main with that of the ledge in the tunnel. It is plotted on my track survey as W. N. W.; but Mr. Craib, who observed instrumentally at my request, reports its strike, N. 49° W. On the whole, I am inclined to think the Bonanza ledge runs in the bedding of the rock. Country rock, slate; showing evidences in places of fragmental origin. *Contents:* Quartz, with polished "slickenside" wall, iron pyrites, graphite, etc.

Country-rock and contents of ledges.

An assay of south casing of Bonanza ledge by Dr. Harrington (Report of 1876-77, p. 477), gave gold, ·064 ounces; silver, ·023 ounces to the ton; of north casing, only traces of gold; and of blue quartz containing slaty matter, only traces of gold.

Specimens received at the Survey Office in 1878, containing white quartz, pyrites, and some carbonaceous matter, gave gold, ·554 ounces ($11.45); silver, ·335 ounces to the ton. It had been reported as containing $90 (Rep. 1876-77, p. 478).

Mr. Forrest states that this rock was assayed in 1878, and was reported to contain $90 a ton, but that subsequently the assays were reported erroneous. Mr. Harper, who worked some tons at Nason's Mill, claimed that it paid $3 to $4 a ton, but did not get gold enough to make a bar. No rock from the Bonanza was crushed in Riotte's time, beyond test samples.

Erroneous assays.

A tunnel several hundred feet in length strikes the ledge 55 feet below the surface, and a shaft from its inner end 50 feet deep, shows the ledge to a depth of 105 feet below the surface. Counting in the side stringers it is estimated to be 22 feet in width. Some galena is found in the hanging wall; in the foot wall the ore is all pyrites.

Development work.

Home Rule Ledge, Barkerville Mountain, half-a-mile west of lower end of Barkerville. The opening on this ledge is a hole less than ten feet wide and deep, leaving the strike and dip uncertain. Mr. Dooley, the first locator, considered it as running east and west. Mr. O'Neil, subsequently owner, considered it as running north and south, basing his conclusions on appearances in the opening. These would indicate

Uncertain strike.

a ledge of about five feet in width, dipping east $< 80°$, having porphyry in the foot and hanging walls. There is, however, a stringer of quartz extending through this porphyry in an easterly and westerly direction, dipping S. 75°, which may represent the Dooley ledge. At a distance of 250 feet south of Mr. O'Neil's opening there is a body of mineralized quartz from five to six feet in width, striking N. 41° E., and dipping north-westerly $< 80°$. Twenty feet to the east of that there is a confused body of quartz separated from it by porphyry. In a southerly direction from the Home Rule opening, Mr. O'Neill found other similar croppings between these and the mouth of Stout's Gulch. *Contents:* Iron pyrites, limonite, and galena; yellow earthy oxides, ferric hydrate, accompanying pitchy looking limonite. In places along with galena, also a reddish brown, a yellow, and a white oxide. The principal characteristics of the Home Rule is its abundance of mineral in the shape of galena, limonite, pyrites, and their oxides; in which respect it is not excelled by any ledge seen by me in the district. An assay by Hoffmann of a specimen containing an association of galena, iron pyrites and limonite, gave gold, ·020 ounces; silver, 6·562 ounces to the ton.

Lead sulphide and oxide.

Dooley Ledge, an easterly extension of the last. Mr. Dooley's principal opening is about 500 feet east of the Home Rule opening, and the body of quartz disclosed strikes N. 75° W., dip S. $< 70°$; width, three feet. It does not show as much mineral. What there is resembles that of the Home Rule opening, except in lesser degree of decomposition. The country rock in the vicinity, a spotted slate, strikes N. 80° W., and stands vertical. Probably, on further development, the ledge will be found to run with the slate. On the brow of the hill, back of Sincox's dwelling, the latter strikes N. 75° W., and dips N. $< 75°$.

Probably between beds.

Sergeant Lindsay Ledge, Richfield Mountain. Strike of main ledge, N. 69° to 76° W.; side ledge, N. 81° W. Width of main ledge, $4\frac{1}{2}$ feet; side ledge, $2\frac{1}{2}$ to $5\frac{1}{2}$ feet. The main ledge dips S. $< 50°$, and the side ledge is vertical. These two bodies form a single ledge at the foot of the hill, (where the ledge has been opened), and diverge at a small angle to the westward. Country rock, grey slate, with an apparently flattish dip. It has a cleavage striking S.S.E., dip easterly $< 60°$. Great bodies of similar quartz crop on all sides near this ledge, and show a continuance in many different directions by smaller croppings. *Contents:* quartz with ferric hydrate and a little pyrites. A uniformly whitish barren-looking quartz, occasionally fragmental, and showing brown iron oxides in bands. Assay by Hoffmann yielded gold a trace; silver, 1·808 ounces per ton.

Veins across beds; pyrites.

Lowhee Creek.

Veins between beds; free gold.

Enterprise Ledge, 1½ mile west of the Bonanza watershed. Close to it on the west, and parallel to it in course, is Jack Pinkerton's ledge so similar in attitude, body and other characteristics that it might be described as a repetition of the Enterprise. Strike of Pinkerton ledge, N. 59° W.; dip northerly < 85°; width, nine feet. The ledge is about 200 feet from the Enterprise; both striking with the slate, which dips however, S. 70°. They cross Lowhee Creek about 2,000 feet below the Victoria upper shaft house, which would strike near the position of the Ralph ledge, on Barkerville Mountain. The country rock is finely laminated chloritic slate.

Not same as Bonanza.

Strike of Enterprise ledge, N. 62° W. vertical; body eight to ten feet. These ledges, accordingly, do not appear to lie in the extension of the Cariboo or Bonanza ledge. On Lowhee Gulch, where the Enterprise and Pinkerton ledges cross it, the slates hold the same strike, S. 60° E.; showing an unbroken country between; but the dip is less, being only about < 40°, while the colour of the rock is more greyish. George Byrnes & Co., in 1878, drifted in quite a distance on a ledge at or near this crossing. *Contents:* Quartz not containing any mineral visibly; remarkable for their perfectly polished slickensides. An assay of a specimen of "Enterprise ore," sent by W. Pollard to the Survey office in 1878, contained white quartz, pyrites, iron oxide, and slaty matter, and yielded gold, 20·096 ounces; silver 4·929 ounces to the ton. Opened by a tunnel about 350 feet long.

Intersecting galena.

Victoria Shaft Ledge.—Peculiar quartz crystals, encased in galena. Supposed by Mr. Forrest to be the western extension of the Bonanza. The Victoria was tapped 100 feet west of the shaft-house, by a tunnel running magnetic north, which cut a body of sulphurets two feet in width, but broke off abruptly to east-ward, in the direction of the Bonanza.

Sam Crane's Old Store.—Stringers yielding $20 a ton.

Island Mountain.

"*Lady of the Lake*" *Ledge*, on west shore of Jack of Club's Lake. Pyrites, and quartz, with carbonaceous matter. Assay—gold, a trace; silver, none. A tunnel was run in by Forest Dunlevy & Co., some years ago; course, W. to N.W.; continuity undetermined; body in places, eight feet. Vein lost.

Following the strike of the John's ledge from the John's tunnel eastward about 1200 feet, in sight of Jack of Club's Lake, and 300 feet back from it, bodies of quartz have been found having a similar strike, but no continuity in developments so far made. This supposed

extension of the Island Mountain or Walker Ledge, is claimed by Robert J. Walker. The rock near the lake strikes S. 65° W., dipping northward $< 45°$; accordingly agreeing with that of the John's tunnel.

The John's or Island Mountain Ledge, one-third to one half mile west of Jack of Club's Lake. Strike, as observed in tunnel, N. 83° W.; dip, southward $< 60°$ to 75°. Mr. Walker gives the strike as S. 50° W. magnetic, S. 75° W. true, or 22° more to the south than I found it in the John's tunnel. The rock strikes W.S.W. to S.W.; dip to northward, < 25 or 30 degrees. A well defined pyrites ledge of 41 to 51 inches has been followed in about 50 feet. *Contents:* Iron pyrites, and quartz. A working test of a sample lot from the John's tunnel, I am informed, yielded Mr. Craib in 1887 $30 to the ton. This ledge has been supposed to be identical with the Walker ledge. It is 830 feet east of the Walker opening, and within 1500 feet of Jack of Club's Lake. The John's tunnel or Island Mountain ledge however varies in strike from that in the neighbourhood of the Walker ore-house to the extent of 20°.

Strike with rock, dip contrary.

Pyrites.

Strike changes.

The Island Mountain Company's operations during 1886-87 included the purchase of the Lane and Kurtz Mill, and the grading of a mill site on Jack of Club's Lake, at a point where the course of the western portion of the ledge would strike the Lake. From the John's tunnel it was proposed to deliver, during the winter of 1886-7, 1000 tons of quartz; and to add to the mill, concentrators, and roasting and leaching appliances for its treatment.

Development.

For several thousand feet the quartz here opened to sight, it will be observed, while not departing widely in strike from that of the slates, distinctly does not follow their bedding. The ledge shows every appearance of regularity and continuity.

Contrary dips.

Walker Ledge, 830 feet west of last. The ledge strikes S. 75° W., and dips to southward $< 60°$. Strike of rock in cut near ledge, S. 60° to 65° E.; dip N. $< 45°$. A heavy body of quartz is in sight, varying in thickness from three to six feet. The cut into the Walker ledge runs S. 50 feet, striking the ledge nearly at right angles. *Contents:* Honey-combed quartz, and brown iron oxide from decomposition, with glistening white talcose mineral resembling mica. From same locality, quartz, iron pyrites, and greenish talc. A quantity of rock milled by Riotte in 1887 (imperfectly roasted) yielded $19.03 to the ton. The bulk of the rock worked by Mr. Riotte was hauled to the Lane and Kurtz Mill, and not roasted at all. Being mostly iron pyrites, with very little or no free gold, it yielded only a few dollars to the ton. During the winter of 1885-6 Mr. Nason worked 3000 lbs. of ore from this ledge taken from the dump at the

Tests.

ore-house, and obtained $19.70. Mr. Walker reports a sample of the tailings sent to Pittsburgh for assay which yielded $61 to the ton.

Contrary dips. West of the Sadou ledge crossing, another cut ending in a short tunnel, has been run into the Walker ledge. It is 420 feet westward from the ore-house. The slate rock strikes N. 75° W., and dips northward $<45°$; perhaps is a little disturbed. A bearing taken along its strike, as indicated by Mr. Walker from his developments here and elsewhere, was S. 79° W. About 500 feet further west in this direction, the ledge is again opened by a cut which discloses a body three feet and a half in width, nearly vertical, or dipping slightly to the south. Mr. Dunlevy owns an extension here of 1500 feet. The ledge is traced another 1500 feet west, where it is known as "Joe Mason's extension." About a mile beyond that, to the westward, are the ledges elsewhere noted having a similar strike, at the head of Mosquito Creek.

Veins across beds: pyrites *Sadou Ledge*, near last; strike, S. 30° to 45° W.; attitude, nearly vertical. Mr. Walker observed it as S. 14° W., magnetic, which agrees approximately. Strike of country rock, S. 55° W.; dip, northward $<45°$. The Sadou ledge is opened by a short tunnel, several hundred feet to the westward from Walker's opening. It is a ledge crossing the above named; body, 2 to 4 feet. *Contents:* A milk-white quartz coated with hydrated peroxide, having pyritous cavities gave, gold, ·658 ounces; silver, ·233 ounces to the ton. Assay by Harrington, in 1876-7, of rusty quartz, with mica slate, from the Sadou ledge gave gold, ·175 ounces; silver, ·802 ounces to the ton.

The Sadou claim runs 600 feet in the general direction of the ledge up into the mountain, taking in a width of 100 feet. It is owned in Paris. At the bottom of the cut there is evidence of a fault, in quartz lying near to, if not belonging to the ledge.

Fault.

Veins across beds. *Fox Ledge.*—Near last; strike, W.S.W., dip, southward $<85°$. Country rock, slate; strike, S.W., dip, N.E., $<40°$. An irregular broken ore body of considerable extent. *Contents:* An abundance of iron pyrites, and iron oxides containing free gold. Yielded colors of gold after roasting. An assay of selected ore is said to have yielded $60. 00 and $70.00 to the ton.

Veins across breakage. *Wright Ledge.*—Near last; strike, south-westerly, nearly vertical. Strike of country rock, S.W., dip, N.W. $<30°$. Body, $2\frac{1}{2}$ feet, and less. *Contents:* Pyrites &c. Assays are said to have yielded $50.00 to the ton. The ledge lies along the tunnel, which is in the strike of the rock, for the first twenty feet; then diverges it on the right hand of the tunnel. The tunnel runs S.W. 150 feet; then S.S.W. 170 feet; total, 320 feet.

Galena. *Atcheson Ledge.*—A small ledge between the Fox and Wright. *Contents:* galena, with other ore.

The Fox, Atcheson and Wright ledges have some appearance of breakage, which may also affect the Sadou and Walker ledges.

About 200 feet eastward from the mouth of the Wright and Atcheson openings, Mr. Walker, in 1869, ran a tunnel south, 124 feet in length, nearly at right angles to these ledges, without striking them; showing that they pass more to the north; and further proving, that the Walker ledge does not, as it should not, pass in that vicinity.

Soda Co.—Mr. Walker informed me that about 2,000 feet west of the Dunlevy cut above mentioned, Flynn & Co. under the name of the Soda Co., have located a ledge which crosses the Walker, striking N.W magnetic, (W.N.W. true), is four feet wide, and yields an assay of $38.00 to the ton. Vein across beds.

The Sadou ledge, and some bodies of quartz showing on the mountain near the "Lady of the Lake" facing Jack of Club's Lake, correspond in course and attitude with some of the ledges of Burns' Mountain, four miles further south.

Mosquito Creek.

Ledge in Saunders placer diggings.—Strike, N. 62° E., dip, north-westerly, very steep. Strike of country rock, S. 75° W., dip northward $< 80°$. Body, one foot to two feet and over. *Contents:* Quartz, and felspar, with ferric hydrate, and a little iron pyrites. Chlorite and white mica with nests of pitchy iron oxides are also characteristic. An assay by Hoffmann yielded a trace of gold; no silver. Vein between beds. Altered strike.

Ledge near Flynn's lower diggings, where float galena in large masses, from adjacent ledges not identified, gets into the sluices. Assay by Hoffmann yielded, gold, 0.182 ounces; silver, 36.458 ounces per ton. Galena.

Ledge in Flynn's upper diggings, 500 feet above last, large irregular bodies of quartz are seen in place. *Contents:* a little pyrites, and a white talcose mineral. An assay by Hoffmann yielded a trace of gold; no silver. These are the uppermost placer diggings on Mosquito Creek.

Six hundred feet further up Mosquito Creek forks; in the forks a tunnel has been run into the hill 500 feet, intersecting two or three quartz ledges of moderate size. Their course is easterly and westerly. One contains a great deal of galena, and is probably the source of the numerous specimens of that mineral found in Flynn's placer mine. The other contains sulphuret of iron. Normal strike.

Ledges at the head of Musquito Creek.—One mile from Flynn's cabin. Supposed Island Mountain or Walker Ledge. Course, E. and W. magnetic=N. 64° W., dip S. Body about five feet. *Contents:* Galena, with white and yellow oxides. Dip contrary.

Lightning Creek.

Veins across beds.

Beede or Perkins' Ledge, on Burn's Mountain, one mile and a quarter north of Lightning Creek. Strike, N. N-E., vertical; differing from that of the slate. The country rock graduates from slate to shale; in some places it is plainly unaltered from sandstone. It is a soft chloritic rock, in places; silicified, in others, and in the Burns' Mountain Company's tunnel it is hard to drill. Strike, N. N. W.; dip, eastward $<30°$. Body from six to eighteen inches, sometimes widening to three feet or more. There are several ledges of this sort near each other. *Contents:* Quartz, with galena, ferric hydrate and iron pyrites. The quartz is usually honeycombed from decomposition of the pyrites, resulting in dark brown, bluish and blackish oxides. Accompanying the galena there are white and dirty yellow oxides. An assay by Mr. Hoffmann of quartz carrying a little galena, gave gold, 2.625 ounces; silver, 3.033 ounces to the ton. Another, holding more galena, yielded gold, 0.365 ounces; silver, 29.896 ounces per ton. Free gold shows in fine particles after roasting and washing. Development work consists of a tunnel (the Reid) about three hundred feet long, and several shafts, fifty to seventy feet deep, with connecting drifts and stopes. Several hundred yards north of the Perkins shaft is *the Laura Ground*, on one of the Beede series of ledges which has been extensively opened by the Cohen incline, etc.

Development.

Striking with rock, dip contrary.

Burns' Mountain Company's Ledge, on Burns' Mountain, two miles north of Lightning Creek. Strike of ledge, N. 36° E. (as traced on the surface by Mr. Jacques), attitude, vertical. Strike of country rock, N. 35 E., dip, south-easterly $<30°$. Body in main shaft, two feet and a half to five feet. *Contents:* Iron pyrites and galena, with yellow oxides. Assays various, including some visible free gold.

At their principal shaft the Burns's Mountain Company has sunk on a ledge five feet wide at the surface, to a depth of about fifty feet. In the last half of that distance the ledge suffered a break; the quartz diminished to two feet and a half; pinched out, came in again in considerable force, but its further continuity has not been determined. Selvedge lines and gangue, with broken rock, filled the place of the vein where broken.

Breakage.

From a point on the northern slope of the mountain, one hundred and seventy-four feet lower than the shaft house, a tunnel has been brought in, over eight hundred feet in length, to a point vertically under the shaft. Two series of veins were intersected, running N.E. and N. 30° to 36° E. respectively. During the season of 1886 they were drifted on, and prospected under the superintendence of Mr. Jacques.

Development.

Silver Ledge, Burns' Mountain Company. Galena and pyrites.

Strike, N. 30° E.; body two feet; in tunnel, very small. Assay by Hoffmann gave gold a distinct trace; silver, 3·442 ounces per ton.

Ledges near junction of Van Winkle and Lightning Creeks.—On the north side of Lightning Creek, opposite the old Van Winkle Company's headquarters, there is a small ledge which strikes N.W.; dip, N.E. <55°; thickness, two feet, with parallel seams of smaller size. This is on an island of bed rock, between the Point claim and the present Van Winkle Creek. In the rich Placer ground of the Point claim, in 1875, four men, working in two shifts, took out five hundred ounces of gold a week. *Contents:* Quartz with chlorite and a little ferric hydrate. An assay by Hoffmann gave a trace of gold; silver, none. Veins between beds; pyrites.

On the south side of Lightning Creek, nearly opposite to the last, a little lower, and directly opposite to the Van Winkle dump, is a small ledge or stringer which strikes S. 72° W., and dips southerly < 40°, following the strike and bedding of the country rock. Body, six inches. *Contents*, quartz with chlorite and ferric hydrate. An assay by Hoffmann gave a trace of gold; silver, none. Striking with rocks, dips contrary.

From this point for three hundred feet down Lightning Creek, was the richest placer ground on the creek. David Edwards, who cleaned the bed rock in drifting, states that quartz was visible in considerable quantities under-ground. A large mass of it was found on a bench on the north side, about two hundred feet below first mentioned. No ledge was visible under the creek, so far as he knows.

Above the junction of Van Winkle Creek, three or four small ledges cross Lightning Creek, between Van Winkle and Eagle creeks. Vein across Lightning Creek.

Sam. Montgomery's Ledge, quarter of a mile above Stanley. Strike (from information), about S. 30 E. Body, two to four feet. *Contents:* Quartz with a little chlorite and limestone. Barren-looking. Assay by Hoffmann gave a trace of gold; silver, none.

Mr. Montgomery reports a ledge uncovered in the diggings at this place about 1876, which had a strike of S. 30° E., as nearly as he can recall it, and a width of four feet. It is probably indentical with the ledge from which my specimens were obtained,—cropping under the bluff on the south side of the Creek, a little above Montgomery's cabin.

At the timber shaft, about 100 feet farther up, a "rotten ledge" was uncovered, from four to six inches in width, which crossed the creek in the same direction. The diggers sunk into the rotten ledge four feet, all along its course, and washed the loose stuff, which yielded the best prospects in the claim. Montgomery got coarse gold out of it, $4.00, $6.00, and an ounce ($18.00) in weight. About six hundred ounces of the coarsest gold in the claim was taken out of this rotten ledge. Rotten ledge.

Stringers.

Chisholm Creek.—One mile and a third north of Stanley. Lowest ledges or stringers found near rich placer ground just above Sam Montgomery's old placer diggings. Small veins of barren-looking quartz. Strike E.S.E., dip northerly <50 degrees; body ten to twenty inches. *Contents:* Quartz with a small quantity of chlorite and ferric hydrate. Assayed by Hoffmann, gave a distinct trace of gold; silver, none.

Vein across beds.

The diggings were worked in 1863–4, and paid $50.00 a day to the hand—the richest on the Creek. While these ledges may have contributed to the results in part, the probability is that most of the gold was from ledges further up.

Two or three series of ledges with a similar strike are found between this locality and the junction of Oregon gulch. Here a narrow vertical ledge crosses the gulch at its outlet, in a northerly and southerly direction, showing excellent ore.

"*The Foster Ledge*" is in this vicinity. It is tapped by a tunnel running W. to S.W., a hundred feet above the junction of Oregon gulch, not now accessible. It was at one time the subject of much attention, founded on finds in the placers of its vicinity. Its strike is said to be south-westerly.

Sugar Creek.

Cooper's Gulch.—A little over half a mile above its mouth. A two feet and a half vein containing plenty of mineral, pyrites and galena, with ferric hydrate, chlorite, felspar and quartz. An assay by Hoffmann gave a trace of gold.

Galena Ledge.—Two thousand five hundred feet up Cooper's gulch. This may be identical with the Galena ledge crossing Sugar Creek a mile above Cooper's Creek; striking in that direction. Body two feet and a half, weathering into a hollow in the hill side. *Contents:* Quartz with a little galena, (often coated white) and iron pyrites. Assay by Hoffmann yielded distinct trace of gold; silver, 0·525 ounces per ton.

Forks of Cooper's Gulch.—Near last. Barren-looking quartz with white talc. Strike, S. 80° E., dip, N., nearly vertical.

Up the S.S.E. branch one quarter mile, another ledge crosses, striking S. 50° E., and dipping southward $<70°$ in which there is nothing visible at the point of crossing. Mr. Wiley thinks it is the same ledge which shows on the point of the mountain about half a mile to W.N.W. in good body, containing at that place an abundance of iron sulphurets.

Vein across beds.

Ledge in Wiley's Old Diggings, at mouth of Cooper's Gulch on Sugar

Creek, (containing conglomerate cement boulders). Strike S.W. A ledge of good body, two or three feet, and fine looking ore, but undetermined continuity. *Contents:* Quartz, pyrites, and brown oxide. Assay by Hoffmann gave a distinct trace of gold; silver, none. The placer ground was rich in its vicinity. Mr. Wiley attributes it to the ledge.

Upper Ledge in Cañon above Wiley's house; strike of ledge N. 80° E., dip northward $<75°$. On the north-side of Sugar Creek a body of quartz six to eight feet in thickness stands above the surrounding surface. *Contents:* Quartz with iron pyrites and a little copper pyrites. Assay by Hoffmann gave a distinct trace of gold; silver, none. Vein across beds.

Fifty feet above the creek on the north side there is a bench which was worked by Mr. Wiley ten years ago. It yielded $4.00 a day near this ledge, and $2.00 away from it.

Lower Ledge in Cañon, 150 feet below last. This strikes N.W. and S.E., and dips to southward $<70°$; accordingly crossing the last mentioned on the bench. At the edge of the creek on the E. side there is a body three feet in width, which appears to be a bunch—continuity doubtful. Country-rock, slate, strikes N.W., dip northward $<70°$. *Contents:* Quartz with reddish weathering siderite, and ferric hydrate. Assayed by Hoffmann yielded distinct trace of gold; silver, none. Another specimen showing, along with quartz, siderite, and ferric hydrate, also chlorite, and a small quantity of blende, yielding on assay, a distinct trace of gold; silver, none. Veins across beds. Carbonates.

This ledge crossing the last mentioned on the bench described, at or near the crossing contains copper pyrites, malachite, and a pitchy ore probably a copper sulphuret. Copper.

Ledge at Ditch waterfall, near Wiley's cabin. Strike with slates S. 55° E.; but not following their bedding. It dips southerly $<60°$, while the slates dip northerly about the same amount. Body, two feet. *Contents:* Brown iron oxide in moderate quantity. It yielded gold appreciably, in the sluices of the adjacent placer mines, although not containing much mineral visible to the eye. Strike with rock: dip contrary.

Ledge at Wiley's cabin, (passing under woodshed). About 200 feet below last, striking with the slates. Body, 2 to 2½ feet. Continues through the diggings; east of the creek enters hydraulic diggings near the Walker tunnel. *Contents:* Quartz with iron pyrites coated black, ankerite, ferric hydrate, chlorite, and a small quantity of blende. Specimen assayed by Hoffmann yielded gold, a trace; silver, none.

Dirt from its vicinity thrown into Wiley's sluices, yielded a different gold from that of the placers overlying it. Gold is invisible to the eye in specimens.

Lower Diggings Ledge.—Still another ledge crosses the creek about the middle of the lowest placer bench worked to bed-rock, a quarter of a mile below Wiley's house. Strike, N. W. & S. E., vertical; body, 2½ to 4 feet. It contains an abundance of sulphuret.

On Mustang Creek, which enters Sugar Creek half-a-mile below Wiley's, there are several quartz ledges seen crossing Isaac's placer diggings diagonally. These diggings are two miles above the mouth. Wiley supposes these ledges to be the continuations of those of upper Cooper's Creek.

Grouse Creek.

Vein between beds; iron sulphide.

The Clear Grit Ledge, situated on Canadian Creek, two miles east of Barkerville, strikes apparently with the slate country rock, N.W., and is, like it, vertical in attitude. Body, five feet. *Contents:* Iron pyrites with the usual accompaniments, in abundance.

The Fountain Head Ledge, on Grouse Creek, is situated at the head of the placer diggings above Cañon Ravine, and strikes N. 52° W. dip northward $< 65°$; having nearly, if not precisely, the same attitude as the country rock. Body, ten feet, running in parallel stringers, which are separated by selvedges. The vein does not show on the East side, but ought to go through the Ottawa Company's placer claim. *Contents:* Quartz with a little chlorite and ferric hydrate; iron pyrites weathered out of a honey-combed quartz. An assay by Hoffmann gave a distinct trace of gold; silver, none.

It has been little more than touched; while its position and appearance would seem to warrant prospecting it. Notable on account of paralellism of quartz deposits.

The Lady Dufferin Ledge at the head of the creek, strikes S. 65° E.; dip northward $< 70°$, with the country rock. Width, five feet nine inches. *Contents:* Iron pyrites with oxides, quartz, and carbonaceous matter. It contains rather a barren-looking quartz. Iron sulphurets in stringers are seen running into the slate hanging wall. Assay by Hoffmann yielded gold, 2.042 ounces; silver, 0.292 ounces per ton.

The ledge has been exposed by a tunnel sixty-five feet long, running S. 75° W. The ledge is named the Lord Dufferin on the east side of the creek. Here its strike, as seen at the surface, appears to be S. 25° E., dip northward $< 60°$; but on entering the tunnel it is S. 80 to 85° E., dipping from nearly vertical to $< 50°$ northward—showing a displacement by a twisting movement. A porphyry streak of six inches divides the ledge. From stray pieces it is supposed that additional porphyry dykes exist which had, probably, a good deal to do with these disturbances. The country rock is a spotted bluish slate, which falls down in large angular blocks, often knotty in appearance. It has been exposed by a tunnel run S. 25° E. to a depth of 175 feet.

Twist and breakage.

Porphyry.

Antler Creek.

Porter's Ledge on middle Antler Creek is a little below the old town of Antler, on the west side. Two ledges here show, within 50 feet of each other. The upper one is best seen above the trail and several hundred feet back. Strike E. S. E., dip to southward $< 80°$. These ledges show also in the creek, and beyond it, several hundred yards E. S. E. Body, unknown. *Contents:* Quartz and a little chlorite, with ferric hydrate, running from brown to blackish in parts; weathered specimens showing also yellow and white oxides. An assay by Hoffmann showed a trace of gold; silver, none. Southerly dip; iron and lead sulphides.

The lower ledge shows a large body of ferruginous matter, with some fine-looking quartz. Body and character cannot be determined without digging.

Pebbles of ironstone are found in the sluices of the Yellow Lion Co. at McBean's Flat. Where these pebbles are found on Antler Creek, it is said there is gold found with them. They are jaspery in appearance, approaching hematite in the quantity of iron they contain; and were probably derived from a ledge, which in depth becomes pyritous. Pebbles, ironstone.

The Limestone Ledge of Nugget Gulch, half a mile above Porter's house, strikes and dips with the country rock, and has a body of several feet in thickness, blending into limestone. *Contents:* Ankerite and ferric hydrate. An assay by Hoffmann showed that it contained neither gold nor silver. Nugget Gulch in the vicinity has been mined for 1,000 feet up from its junction with Antler Creek, and the source of nuggets had been attributed to the limestone ledge. Further up, Nugget Gulch has not been prospected to bed-rock. Vein between beds; iron carbonate.

Round-Top Mountain and Cunningham Creek.

On Round Top Mountain there is a comb of quartz or quartzite which is evidently too massive to be anything else than barren. The summit itself is mostly quartz, or quartzite, which strikes with the rest of the country rock; strike N. 80° W., dip northward $< 40°$. Vein between beds; iron oxides.

The "Big Ledge," or comb of quartzite on the eastern member of Round Top Mountain, one mile S.E. of last, contains oxides of iron in small quantity, with very little pyrites. Strike more to the S.E. than on the main summit; dip, also northerly, but steeper. Country rock, slate. This comb runs from one-quarter to three-quarters of a mile E.S.E. from our Round Top camp, striking over the summit of the eastern mountain. Slides from it, on the N. side, show oxides of iron in sufficient quantity to colour the side hill of the northern escarpment red, visible at a mile distant.

Between beds; sulphide.

Ledge on Cunningham Creek, near the head of Sharp's Ditch, two miles west of Round Top, and 100 feet above the ditch. Course, N.W. and S.E., with the rock; dip northerly less than $< 48°$. Quantity of ore considerable, but the continuity has not been proved. *Contents:* Iron pyrites, nearly pure; also decomposed products, with quartz. An assay by Hoffmann showed a very distinct trace of gold; silver, none.

Between beds; carbonate.

Ledge in Sharp's Diggings, Cunningham Creek. This is called the "Big Iron" Ledge, and is an iron stained ledge or dyke, containing pyrites. Its attitude is that of the country rock, which is slate and limestone. *Contents:* Ankerite, with a little quartz, chlorite, and some ferric hydrate. The assay by Hoffmann showed a trace of gold; silver, none.

Unknown ledges.

At the Chinamen's Diggings, on the western hill-side, half a mile below Sharp's, great numbers of quartz boulders are found scattered, indicating proximity to a ledge of good character, not yet discovered. The digging in 1886 yielded well. It is a side-gravel deposit of local origin.

Snowshoe Plateau and Snowshoe Creek.

Vein across beds; lead, iron and zinc sulphides.

The Holmes Ledge, Breaknock Ridge, head of Six-mile Creek, on the Antler trail, strikes east and west; attitude, nearly vertical. It is in a comb of slate extending down from the Mountain, the country rock striking N.W., dip N.E. $< 70°$. Cleavage lines of large masses appear to correspond with the strike of the rock. Body of ore very considerable, in the shape of nests from three to six feet in width, the continuity of which has not been determined by openings. *Contents:* Galena, and iron pyrites, with zinc blende, accompanied by white oxides; galena in considerable abundance. A sack of the ore was sent to San Francisco for a working test, which resulted very favorably, having yielded, it is said, a profit to the owner, above cost of test.

Veins between beds; free gold.

Haywood's Arastra Ledge, one-quarter mile north from upper Little Snowshoe Creek, strikes S.S.E., and dips eastward < 45 deg., like the country rock, a grey slate. Body, six to eight feet, as seen in a shallow prospect hole of the same dimensions; not further determined by exploration. *Contents:* Pyrites in quartz, with ferric hydrate, chlorite, and (reported occasionally) free gold. The quartz is a good deal honeycombed, from decomposition. A specimen assayed by Hoffmann yielded gold, 0.408 ounces; silver, 0.058 ounces to the ton. Another showed a distinct trace of gold; silver, none.

A tunnel was run in by Mr. Haywood many years ago to tap the ledge. Its direction was N. 6 E., and length, 90 feet. It did not follow the ledge; and very little can be seen from the developments, of

the character of the ledge. Prospect ditches, and openings made by Haywood proved, however, an abundance of quartz.

An arastra located on the ground was unprofitably worked by Mr. Luce. Its name was originally the Douglas ledge. Mr. Haywood reports that he found visible gold all the way down, from the day he commenced prospect work, to the bottom of his hole, which was located on the richest place at the surface. Arastra.

His tunnel was on one side of the ledge, crossed it diagonally, and then kept alongside. About 40 feet in, was obtained the mineral now seen on two dumps. Various stringers three or four inches in thickness were crossed, besides the main ledge.

A ledge on the top of the hill, 1,400 feet N.N.W from the Arastra ledge, also follows the strike of the rock. There is quartz scattered all over the top of the hill.

The Snowshoe Creek Rich Boulder Ledge, never identified, was the ledge sought in the Arastra location. The only other ledge ever found on Little Snowshoe, besides the Arastra, in proximity to the placers, is on the point 200 yards below Smith and Anderson's hydraulic diggings. In 1874, Mr. Haywood ran a tunnel to find a high rock-bed bench of the channel, and found this ledge. It contained a good deal of galena. What struck him was, that it appeard to be the same kind of rock as the rich quartz boulders for which the Little Snowshoe Creek placer diggings have been noted, containing galena and free gold. Boulder; specimens, galena, and free gold.

The Arastra ledge did not contain exactly the same kind of quartz as these boulders; galena was lacking. Other ledges and stringers near it, however, above and below the Arastra, contained galena. About 200 yards west of the Arastra, still another ledge was found, running S.W., which contained galena.

On Horseshoe Gulch, forming the extreme north-easterly source of Little Snowshoe Creek, several ledges and stringers are seen crossing the gulch diagonally, in the strike of the slates; course, N. 30° W. *Contents*, of ledge noticed, quartz and galena. Vein between beds; galena.

The Steele Ledge is on the dividing ridge between little Snowshoe, and French Snowshoe creeks; containing honey-combed quartz and brown iron oxide, with blackish parts. Several bodies of quartz a few feet wide show on the surface, without much appearance of continuity; nor containing much visible mineral. Developments, about 18 inches sunk on ledge.

The *Galena Ledge*, near by is supposed by Haywood, to be in line with the Arastra Ledge; being S. 21° E. from Arastra Ledge three quarters of a mile; on spur forming the north-west side of Yank's Peak, one fourth of a mile from summit. It is in line with the tunnel ledge on French Vein between beds; galena.

Snowshoe, which figured during the quartz excitement of 1878. Chunks of galena are found on the surface immediately below this ledge. Mr. Haywood supposes the galena in the Little Snowshoe placer mines to have been derived from it.

The "Big Ledge," on the S.W. side of Yank's Peak, claimed by Haywood and Rawley, strikes north and south, and according to Haywood, standing vertical, shows only scattered croppings to speak for itself.

Vein between beds; galena.

Galena Seams and Veinlets.—A mile below the Arastra, and about 100 yards below Haywood's present house, Haywood, in 1876, found a seam of galena an inch thick, on the east side of Little Snowshoe Creek, in plumbaginous black slate, along with a scraggy, sparry quartz. It was in the strike of the rock, running from S. E. to N. W. Near the same locality on Little Snowshoe Creek, pyrites occur in association with a felspar weathering red, in the rocks cut through by the creek.

On Harvey Creek.

Veins between beds; iron sulphide and carbonate.

The Ironstone Ledge, one-quarter mile below falls of Harvey Creek. Olive and bluish felspar with iron pyrites. Over three feet in width. Strike east and west; dip, N. $< 60°$; with the slates apparently. It is from three to eight feet wide, and is repeated in another locality near it. *Contents:* Siderite, with magnetic pyrites and a little iron pyrites; a great body of metal, being nearly solid ore. Assay by Hoffmann showed a distinct trace of gold; silver, none.

The ledge weathers red on the surface. Projecting into the creek, boulders from it strew the placer mines below.

Duck Creek.

Veins across beds; lead, iron and zinc sulphides.

Ledge 300 feet above the Forks Trail crossing. Strike of ledge S.W.; attitude, vertical. Strike of country rock in the vicinity E. and W., dip, north. Body two to four feet. *Contents:* Galena with white and yellow oxides, a small quantity of iron pyrites, zinc blende, reddish oxides, and opaline hornstone. Assay by Hoffmann showed a trace of gold; silver, 3.850 ounces to the ton.

A surface cut was made in 1878 on the north side of the creek, disclosing considerable quantities of galena. On an adjacent discoloured bluff of country rock, an excitement was raised 25 years ago, owing to placer finds supposed to have been traced to this vicinity.

Borland Ledge, two miles above trail crossing; strike, S.W.; attitude, vertical. Strike of slates in the vicinity, S.E.; dip, southerly $< 25°$. A body of four to five feet in width crops out on the N. side of the creek, into which a shallow cut has been made. *Contents:* Quartz

with iron pyrites and chlorite. Assay by Hoffmann showed a trace of gold; silver, none.

In the winter of 1878, the Chinese, supported by the merchant Ching at Quesnel Forks, took great interest in this ledge, and worked at and around it the greater part of the winter, without accomplishing much. It was believed to be rich.

North Fork of Quesnel River.

Moore's Ledge.—A ledge is reported by Mr. James Moore cropping at low water on the left bank of the North Fork 100 yards above the mouth of Spanish Creek. It crosses the river at right angles. Body, three feet.

Below Spanish Creek the bed of the North Fork was found rich; above it, poor in gold. Placer gold.

Ne Tye Ledge.—A mile below mouth of Spanish Creek Chinese hydraulic diggers near old Diller tunnel, exposed ledge in washing. Strike, N.W., dip, N.E. $< 60°$. Slates strike east and west, dip, north eight degrees. Body, one to four feet; irregular in continuation. *Contents:* Quartz with ferric hydrate, from decomposed pyrites. Assay by Hoffmann showed a trace of gold; silver, none. Vein across beds; iron sulphide.

The Diller tunnel was run into a point on the right bank, intersecting a ledge in this vicinity.

The Stephenson Ledge also on the right bank, one mile and three-quarters below the mouth of Spanish Creek, was opened by shaft and tunnel in 1878. Body and contents, unknown.

Spanish Creek.

On Spanish Creek there are seven or eight known ledges, reported by Mr. Moore. A mile above its mouth there is a ledge two feet wide, not containing any sulphurets. There is a ledge from five to seven feet in width at the meadows, near the outlet of Black Bear Creek. It contains galena in streaks about an inch wide, and strikes N.N.E. Another, a mile up Black Bear Creek, is six inches wide, and consists of decomposed quartz. Above that, one mile and a half is a ledge four feet wide containing iron pyrites. These ledges run in the same general direction. Numerous ledges.

While working placers on Black Bear Creek, Mr. Moore frequently found pieces of pure galena weighing from one ounce to ten pounds, and many quartz boulders containing galena.

South Fork of Quesnel River.

Gold in conglomerates.

Between Quesnel-Forks town, and Quesnel Lake, a nine-mile stretch of Quesnel River has been designated as the South Fork. In the placers accompanying the river here on high shelves of bed-rock, quartz boulders occur along with iron pyrites, and their rusty decomposition products, derived from the newer mesozoic rocks of that region. A soft conglomerate is picked by the miners, in order to wash it; and its metallic contents are seen to have led them occasionally far up on the hill sides, above the bed of the old river channel. Much of the gold on this stream, accordingly appears to be a secondary deposit. Veins in this area are certainly less numerous, and have attracted little attention in connection with the placer deposits.

Between the Main Quesnel and Swift Rivers.

Vein across beds, free gold.

The Dominion Ledge on western end of Cariboo Mountain ; strike N. 85° E.; dip, southward, $< 80°$. Body, eight to ten feet. It plunges down, and follows midway the steep northern escarpment of Cariboo Mountain. It is conspicuous above the surface, from six to twelve feet in width, for one third of a mile. Beyond that to westward and eastward, its identity becomes less certain, mingling with neighbouring croppings. Although broken fragments are found to the westward in the line of strike, the appearance is that of a diminution in strength in that direction. Cross stringers occur plentifully. Country rock, grey slate. Three quarters of a mile to the westward, black slate succeeds the grey. Strike of country rock, N. 40° W., dip, S.W. $< 50°$. *Contents:* A barren-looking white quartz, in some places stained light yellow. Specks of free gold are visible occasionally.

Development.

Development work has amounted only to the removal of about 100 cubic feet of rock from the surface of the ledge. Several miles to the westward, on or near the strike of the vein, Mr. Porter panned gold out of the surface dirt, at a point where the mountain slopes down into the valley of Swift River.

Hixon Creek.

Veins between and across beds.

Quesnel Company's location on Washburne Ledge. Strike N. 46° W., dip N.E. $< 70°$, with the slate country rock. Body from 6 feet to a few inches. Cross-veins of less body, striking N.E. and standing vertical, contain richer ores. *Contents:* Iron pyrites, grey copper, and their decomposition products, with free gold. Assays by various parties, from $28.00 to $274.00, averaging over $70.00 per ton, in gold and silver.

The main shaft is 200 feet deep. The Mason shaft, several hundred feet north of it at the base of the hill, is 40 feet deep; and the Koch shaft is 70 feet deep. Development.

Three more or less crooked prospecting drifts have been run northwestward into the hill, searching for a continuous ore body. Following bodies of quartz, in several instances the general course was with slates, as given above. The oldest of these was run by Buckley and Washburne, the next by G. B. Wright and Coleman, and the last by the present company, under the superintendence of Mr. George Koch. The last mentioned was the only one in 1886 open to inspection. It starts from the bottom of the Koch shaft, and is 174 feet long. The others start in at the surface level, and are about two-thirds that distance in length.

From the main shaft, drifts have been run along the strike in opposite directions, and also along the cross-veins, in opposite directions; and in other directions, at different depths, and in different places, amounting to a large aggregate of exploratory work. The lack of continuity in the ore bodies found near the surface, and the smallness of the rich cross-stringers, has been baffling. The main shaft having been deepened in 1887, a short drift to the north-east disclosed a large and promising ore body. Ore bodies.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

NOTES

TO ACCOMPANY A PRELIMINARY MAP

OF THE

DUCK AND RIDING MOUNTAINS

IN

NORTH-WESTERN MANITOBA.

BY

J. B. TYRRELL, B.A., F.G.S.

Field Geologist of the Geological and Natural History Survey of Canada.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To Alfred R. C. Selwyn, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

Sir:—I beg herewith to submit a preliminary Contour Map, with explanatory notes, of the Duck and Riding Mountains and the adjacent valley of the Assiniboine. The country depicted and briefly described lies chiefly within the province of Manitoba, but a strip of the eastern portion of the district of Assiniboia is also included.

I have the honor to be, Sir,

Your most obedient servant,

J. B. TYRRELL.

NOTES

TO

ACCOMPANY A PRELIMINARY MAP

OF THE

DUCK AND RIDING MOUNTAINS

IN

NORTH-WESTERN MANITOBA.

North-western Manitoba.

The present map embraces the area travelled over, examined and surveyed during the summer of 1887. In it are incorporated all the Dominion Lands, Indian Reserve, Timber and Railway Surveys up to the present date. It forms the south-west corner of a larger sheet embracing also the whole of Lake Winnipegosis and part of Lake Manitoba. This sheet it was hoped would have been ready for publication during the present winter, but during the early part of the summer of 1888 the writer was seized with a severe attack of fever while in the vicinity of Fairford House on the Little Saskatchewan River. Two weeks were occupied in carrying him to Winnipeg, where he lay in the hospital for seven weeks, and was unable to resume field work before the winter set in. This checked the progress of the exploration to such an extent that another season must necessarily be spent before the whole map can be ready for publication.

Its importance.

In view of the utterly unknown character of a large part of this region, of its great importance as a source of timber supply for Manitoba, and of the luxuriant fertility of the soil over considerable areas such as those drained into Lake Dauphin and the Assiniboine River, this map is now submitted for publication in advance of the larger sheet.

Surveys.

It has been compiled and drawn by Mr. D. B. Dowling, B. Ap. Sc., who also acted as my assistant in the field. In its preparation I have received every possible assistance from Capt. Deville and the gentlemen associated with him in the Dominion Lands Branch of the Department of the Interior, and also from Mr. Collingwood Schreiber and

others in the Department of Railways and Canals. Wherever surveys of townships or Indian Reserves have been made by the Dominion Lands Branch, these surveys are marked by full lines. The old locations of the Canadian Pacific Railway, both north of the Duck Mountain and south of the Riding Mountain, have furnished valuable lines through the country. For the rest, the topography is laid down from odometer and track-surveys made by ourselves, frequently checked by latitudes taken with a brass sextant of eight-inch arc reading to 10″. The contour lines are laid down from the heights given on the two railway-surveys just mentioned, as well as from numerous heights obtained from observations made with a mercurial barometer and two aneroids, compared with the readings taken thrice daily from the standard barometer at Minnedosa. The height of the standard barometer at Minnedosa is 1689 feet, a height twenty-four feet higher than that given by the railway profiles, an error of this amount having been found by Mr. Warren Upham to have been made in connecting the surveys east of the Red River with those to the west of it.

Extent of country mapped.

The map as now published embraces an area of 12,000 square miles, but of this, Lake Winnepegosis is merely sketched in from former surveys to show the discharges of the various streams, and the Porcupine Mountain, in the north-west corner of the map is as yet unexplored. This leaves an area of 8,500 square miles, or 5,440,000 acres, a tract larger than that of the State of Massachusetts, which has been more or less carefully examined. It embraces Duck and part of Riding Mountains, with the included and surrounding valleys and the more level country east of these mountains, lying between them and lakes Winnipegosis and Dauphin.

Drainage

It is drained on the north by Swan River, which flows north-eastward through Swan Lake into Lake Winnipegosis, its main tributaries being the Bear's Head, Favell, Rolling and Sinclair rivers, flowing northward from the north face of the Duck Mountain. On the west, it is drained by the Assiniboine, with its tributaries Little-Boggy and Big-Boggy creeks and Shell River. On the south, some of the small upper tributaries of Bird-tail Creek drain a limited area in the Riding Mountains. On the east, Turtle, Ochre, Vermilion, Wilson and Valley rivers pour their waters into Lake Dauphin, flowing across the fertile plain south and west of this lake. Fork, Pine and Duck rivers flow from the face of Duck Mountain, the former into Mossy River and the latter into Lake Winnipegosis.

General physical features.

In its general physical features it presents very great diversity of character. The mountains, or rather the one mountain cut in twain by the great depression of Valley River, cross the country in a north-north-westerly direction, forming a high, rugged ridge rising in different places from thirteen to nineteen hundred feet above Lake Winni-

pegosis. To the eastward these mountains descend in a steep, wooded slope to an even, almost unbroken, alluvial plain, which inclines gently to the lake shore. Westward it descends much more gradually, and, except in the vicinity of lat. 51° 30′, without any abrupt escarpment, towards the Plains.

Many small lakes.

Over a great portion of the higher lands, the surface is dotted with beautiful little lakes of clear, fresh water, those in the more open country being encircled with green wreaths of small poplar and willow, while in the more thickly wooded tracts in the higher parts of the mountains, tall spruces are growing to the edge of the water. Many of these lakes are drained by permanent brooks, but most of the smaller ones are isolated during the greater part of the time, and overflow only in rainy seasons or when the water is at its highest stages. They are all of glacial origin, lying in the depressions of the irregular surface of the till or unstratified glacial deposits.

Timber.

The whole land surface is more or less thickly timbered, the woods varying, however, from a few scattered clumps of willows in the townships in the south-west corner of the map, through groves of poplar severed by open glades in the country bordering the Assiniboine, to coniferous forest on the summit and northern and eastern flanks of the mountains. In the valley of Swan River, and in the tract of country south-west of Lake Dauphin, the forest again gives place to a partly wooded country, the open areas of which are often covered with a luxuriant growth of rose bushes and other small shrubs.

Lake Dauphin.

Lake Dauphin is a shallow body of water twenty-eight miles long and ten to twelve miles wide, with an approximate elevation above the sea of eight hundred and forty feet. Mossy River flows from its northern end into the south-west angle of Lake Winnipegosis. Its shores, where seen along its southern boundary, were either low and marshy, or bordered by beach-ridges of well-rounded limestone gravel, behind which stretched extensive meadows of rich, tall grass. In high water these meadows are doubtless flooded, but at present they are quite dry, and will be so in all ordinary seasons. Behind these meadows, a wide and apparently flat plain stretches back to the foot of the Riding Mountain. Instead of being level, however, it rises gradually and regularly, being generally well drained by the numerous small clear streams that flow through it in narrow, winding channels. These streams are skirted with rows or narrow belts of timber consisting of elm, oak, birch, and cottonwood. Between these wooded belts, the plain is dotted with groves of poplar and willow. The soil is a rich alluvial clay loam, on which abundant crops of wheat, oats, barley, maize, as well as all the ordinary garden produce grown in eastern Canada and the central and eastern United States, can be raised. On the

Rich alluvial plain.

third of August, 1887, barley was ripe and being cut, and the fields of wheat were quite tinged with yellow. On the 17th of August the settlers were reaping the dead ripe wheat, which gave promise of a very heavy yield.

Absence of summer frosts.

The summer frosts, too, which have occasionally proved prejudicial to the crops in some parts of Manitoba and the North-West Territory, appear to avoid this favoured district. This is, no doubt, in part due to the slope of the surface, the cold air sinking down the gentle incline till it reaches the lake, where it is warmed by radiation from the surface of the large body of water which has been warmed by the hot sun of the day before, and which, on account of its shallowness, gives out its heat rapidly to the overlying air. The great luxuriance of the grasses and herbage in this district has also much effect in hindering the occurrence of summer frosts. By increasing the amount of water evaporated in the day time it renders latent a large amount of heat, which again becomes sensible when this moisture is deposited in the evening in the form of dew. Growing grain would also have precisely the same effect. Its sheltered position is also very much in its favour. A wind blowing from the east across the great lakes of the Winnipeg basin will be loaded with moisture, which, if it does not fall as rain, will form into clouds or be deposited as a heavy dew, and will avert a frost either by hindering the radiation of the heat from the lower stratum of air, or by raising its temperature. If the wind is blowing from the drier plains to the west it will be partly diverted to the south-west along the Duck and Riding mountains, and what crosses the mountains, though very dry, will be so much warmed by condensation in descending thirteen to eighteen hundred feet that little danger of frost need be feared from it. In this connection, it may be remarked that it appears very probable that the planting of trees around the fields on the plains of Manitoba and the North-West Territory would have considerable influence in preventing the occurrence of summer frosts by breaking the winds and hindering the free circulation of air. The moisture that was evaporated from a field of growing or ripening grain or other crop would then, to a considerable extent, remain over the field, whereas now it is often replaced by dry air from the plains, which offers no obstruction to the rapid loss of heat from the earth by radiation. The circumstances under which frost occurs are often as follows:—During the day a stiff wind is blowing from a westerly direction, carrying off the moisture as fast as it is evaporated. In the evening the weather becomes very calm, and on account of the absence of any moisture in the atmosphere the stars shine with exceptional brilliancy. The earth is warm from the heat of the day, but radiation

Reasons.

Luxuriance of herbage.

Sheltered position.

Presence of trees.

proceeds so fast that by one or two o'clock in the morning its immediately available supply of heat is exhausted and the overlying air falls below the freezing point. The presence of a greater amount of moisture in the air will prevent this rapid dissipation of heat, and one of the means of insuring the presence of this moisture is by constructing wind-breaks in the form of rows of trees in order to retain the damp atmosphere over the fields rather than to allow it to be replaced by the drier air of the plains.

Smudges, the smoke from which on those quiet, bright nights will settle down over the land, would doubtless also have a very beneficial effect in hindering the occurrence of frosts.

Breaking of the soil.

The breaking up and tilling of the soil will also have a great effect in reducing the diurnal variations of temperature. The direct rays of the sun during the day do not raise the temperature of ploughed land as high as that of the unbroken plains, but they warm it to a greater depth, a fact which may readily be observed in walking across the drier plains on a hot day in summer. The dry sod, covered with short withered grass, will be felt to be very hot, but if ploughed land is reached, the ground will at once be found to be much cooler. By taking a spadeful of earth from the two places the lower part below the sod will be found to be very much cooler than that under the ploughed land. The effect that this will have on the night temperature of the air will be that the radiation of heat from the ploughed land will be much slower than from that which is unbroken, but which is practically bare on account of the withering of the short grass. The temperature will be lowered comparatively slowly, and while in the latter case a frost might have set in at four or five o'clock in the morning, in the former the air will be kept above freezing point till the sun rises again.

But to return to the alluvial Lake Dauphin plain, the surface is so level or evenly sloping that lakes or ponds are very scarce, but plenty of good water can easily be obtained in wells ten to fourteen feet deep. In ascending from the lake to Riding Mountain, the surface rises by low steps to the foot of the more abrupt escarpment. The steps are occasionally replaced by ridges of rounded gravel, both the steps and ridges representing old shore lines of the ancient lake which formerly occupied the whole of the basin of Lake Winnipeg and the valley of the Red River, a lake the former existence of which was first clearly pointed out by Prof. H. Y. Hind in 1859 and which was afterwards named by the late General Warren, Lake Agassiz, in honour of Louis Agassiz, the first great exponent on this continent of the force of glacial erosion and of the former distribution over the northern portion of America of a great ice-sheet in glacial times. The full comparison of these ancient shore lines with the shores of the present adjoining lakes must be left to the final report on this area.

Old shore lines of Lake Agassiz.

Most of the steps are low, seldom reaching a greater height than ten or twelve feet, but one of the higher ones, which is crossed on the Vermilion River trail, and the bottom of which may be considered the foot of the mountain, rises to the height of one hundred feet. Its face is now a steep slope wooded with poplar and small bushes, but when the waves of the ancient lake beat against it, it rose above the water as a naked cliff of white Cretaceous chalk-marl. Following the shore-lines northward to beyond the Valley River, the low coast-cliffs almost entirely disappear, and the ancient shores are represented entirely by gravel beach-ridges. This change of conditions is caused by the fact that the base of the escarpment of Duck Mountain is much higher than the foot of Riding Mountain, and higher than the highest level to which Lake Agassiz appears to have risen. From this escarpment the land slopes gently down a long easy grade to the level of Lake Winnipegosis.

Ancient coast-cliff.

Gravel beaches.

The beaches consist of more or less rounded gravel, the pebbles, which are chiefly of limestone, though a few are of granite, varying from the size of pigeons' eggs down to that of No. 6 shot, but however fine, they are still distinct pebbles, mixed with little or no quartz sand. The ridges follow in a long sweeping curve the general direction of the face of the escarpment. The highest of these ridges seen on Shanty Creek has an elevation of 1,365 feet above the sea, and as far as one could judge is about two hundred feet below the level of the base of the mountain escarpment. The pebbles in it have their angles worn off by water action, but are not at all well rounded, and between it and the next lower ridge there is very little alluvial deposit, showing that the water stood at this height for a, comparatively, very short time. Above the ridge the surface is lightly undulating and composed entirely of unstratified glacial till scattered over with irregular pebbles and boulders, it having never been buried under the waters of this great post-glacial lake.

Natural roads.

The northward extensions of these ridges form remarkably straight natural roads through the otherwise level and often swampy or marshy country. One, having an elevation of 1,084 feet at Valley River, was followed northward with buckboard and carts for twenty-three miles, to beyond Shanty Creek, while another, about seventy feet above the last, was followed from a little south of Wilson River northward for twelve miles to a branch of Valley River, where the extension of the forest across the ridge obliged us to descend to its lower neighbor. At Shanty Creek we returned to the higher beach, and continued to follow it northward for nineteen miles, at which point it was still quite well marked. Half a mile to the eastward the lower beach was also typically developed. Thus these two ridges were found to extend, the lower one at least forty, and the upper one forty-four miles.

A few miles further north, near Duck River, similar gravel ridges are found to obtain, though here, instead of being generally open and grassy, they are covered in part with a scattered growth of small Banksian pines. Looking southward from Duck River along a ridge, the height of which is given on the profile of the old location of the Canadian Pacific as 1,201 feet, a high knoll is seen to rise above and just to the westward of it. This knoll, when reached, was found to be the northern end of a gravel ridge running off to the southward, and rising sixty feet above the ridge immediately to the east of it. Its face is steep, the slope being apparently as great as that at which the gravel would stand. The point is bent around to the westward in the form of a knob or hook, the whole appearing as if it had projected out into the lake as a gravel spit or hook, as the land behind as well as in front of it is from fifty to sixty feet below its summit.

Beaches pine-covered.

End of beach.

This point was somewhat peculiar in being scattered over with a great number of large gneissoid boulders, lying on a surface of sand filled with rounded, waterworn pebbles of gneiss, limestone, ironstone, etc. As a rule, the ancient beaches are composed entirely of small rounded pebbles, in this particular differing very materially from the beaches of the lakes which now occupy the lower levels of the Winnipeg basin. On the existing lakes the shores are very thickly strewn with gneissoid boulders, which in winter have been, and are still being, frozen into the ice, and then shoved outwards by its expansion till they are placed up beyond its reach, or packed into a very regular wall. Many of the boulders on the above mentioned ancient gravel bar or spit have probably been placed there in a similar way, the bay to the westward having doubtless been frozen over during the winter, while the general absence of boulders on the long straight beaches would seem to indicate that the whole lake was never covered with ice.

Gneiss boulders

North of Duck River the higher ridges, which alone have been followed here, bend sharply round the north-east corner of the Duck Mountain into the valley of Swan River.

Abrupt change of direction.

The presence of these ridges influences in a very marked degree the character of the country they traverse. Although they furnish magnificent natural highways they also act as dams in preventing the ready drainage of the country down its easy natural slope, except in a few places where these dams are broken through by streams such as the Duck and Fork rivers. There is very commonly a marsh or marshy lake just above or west of the ridge, or a little sluggish stream may flow northward or southward beside it. The country in the latter case is somewhat better drained and generally supports a close growth of small black spruce and tamarac. The lower side of the ridge is drier and sometimes supports a growth of poplar, but

Ridges serve as natural dams.

generally is thickly covered with small black spruce. Some fine groves of large white spruce are met with close to the banks of the larger streams. Stunted oaks on the ridges in the more open parts and some beautiful groves of tall, stately elms were seen, a very noticeable one of the latter being a grove near the foot of the Duck Mountain, a few miles south of Duck River. A few pleasant prairies here and there occur, but they are not numerous, and the country may be said to be generally thickly wooded. Forest fires in recent years have, however, destroyed the greater part of the timber that could have been converted into lumber, and instead there is now a close growth of small sticks as yet comparatively valueless. As was stated above, large areas are now covered with swamp or marsh, but this wet land could be drained with very little difficulty, since the surface everywhere slopes gently towards the east, except where the incline is broken by gravel ridges from fifty to one hundred and fifty yards in breadth. Drains could be readily cut through these at intervals sufficiently close to allow the water to flow off freely to the lake.

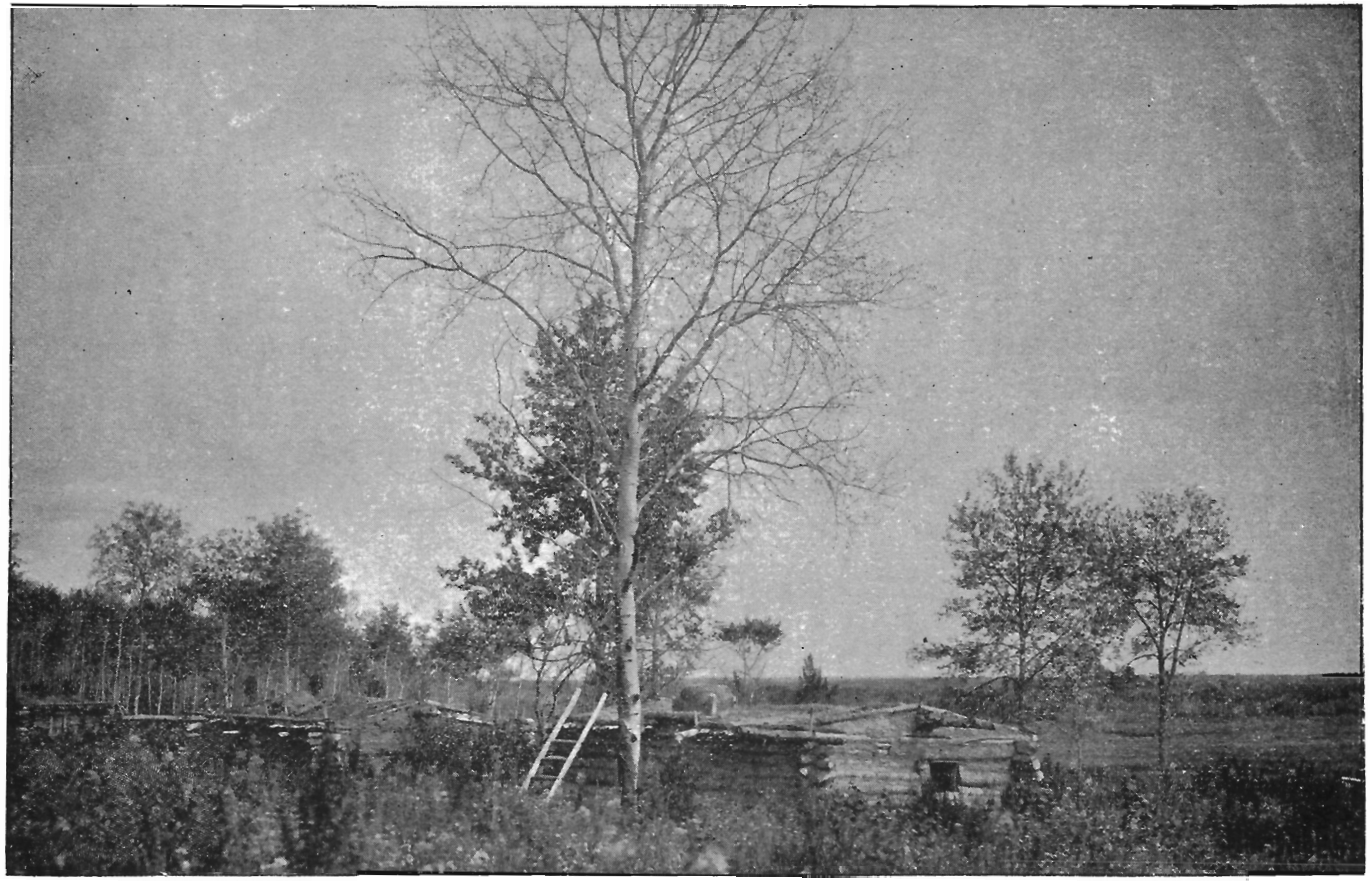
Valley river.

Of the two largest streams that flow eastward within the district, the Valley River winds in a beautiful sloping valley which doubtless represents an ancient drainage channel in pre-glacial times. Above or west of the gravel ridges that cross this valley is a wide sandy plain, representing an old delta deposit when Lake Agassiz was at its highest stages and when a stream flowed into it through the valley of Short Creek from the west side of the Duck Mountain. The Swan River valley is much wider and is cut down to a much greater extent. The lower part, below what is locally known as the "Coast Ridge," is covered with alluvial deposits of sand or sandy clay, while further west are some rough morainic tracts, among which lie extensive flood plain deposits. In both of these valleys, Indians and Metis have at different times had thriving little villages, the soil being very rich and fertile. On the latter there is now a Metis settlement about a mile or two beyond the northern limit of the present map. Two Indian reserves were formerly occupied on the banks of this river and on them the Indians raised grain and the ordinary root crops. Lately, these Indians have been removed to the vicinity of Fort Pelly for the greater convenience of communication and trade.

Swan river.

Old Indian settlement.

On Valley River there was formerly an Indian settlement in township 25, range 24, west, and now there is a thriving village at the mouth of Short Creek, at the point where the River leaves the Duck Mountain. A good cart-trail runs from Russell on the Manitoba and North-Western Railway to this village, and carts can also pass eastward from it to the Lake Dauphin settlement. Here in the summer of 1887 some good crops of the ordinary grains and roots were being raised.



J. B. TYRRELL, PHOTO., 19TH AUG., 1887.

G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

OLD INDIAN HOUSES, NEAR VALLEY RIVER.
Township 25, Range 24 West Manitoba.

West and south-west of the alluvial plain of the ancient Lake Agassiz, the Duck and Riding mountains rise to from two thousand to two thousand seven hundred feet above the sea, in most places faced by a steep escarpment, but between Vermilion and Valley rivers the slope is gradual, no appreciable escarpment being seen during the ascent. This slope is generally well drained and in places supports a strong growth of poplar and spruce, but unfortunately much of it is fire-killed and useless. Duck and Riding mountains.

The higher parts of the mountains are very rough and uneven, being composed of drift hills and ridges from one to three or four hundred feet high, among which nestle beautiful lakes of pure clear water, or sparkling brooks flow to the main watercourses, most of which have a general north or south direction. Many of the hills are thickly clothed with spruce and balsam fir (A. balsamia) mixed with birch and poplar, and in the more southern portions with maple (Acer spicatum) and more northerly with an occasional tree of mountain ash. Some of the knolls in the northern and north-eastern areas are so thickly strewn with large gneissoid boulders, that the land is almost barren, supporting but a short stunted growth of Banksian pines, and where these have been burned, as they have been over considerable areas, the ground is almost entirely uncovered by either grass or herbage of any kind. Between these rough hills stretch considerable areas of level swampy country covered with a close growth of black spruce, in most cases too small to be of any general economic importance. Rough morainic country.

The northern face of the Duck Mountain has formerly supported much excellent forest, but most of this area has now been burnt over, and is being overgrown with poplar. A fine grove of white spruce however yet remains near the head of Favell River and between Favell and Rolling rivers. Some spruce.

The thickly wooded areas of these mountains are the favourite hunting grounds of Indians who have their reserves by the lakes or along the Assiniboine. One of these latter bands, under Chief Coté, has cut a good cart trail from its reserve north of Little-Boggy Creek to Angling Lake, where it has built a number of substantial log houses. These houses are deserted during the summer, but in the autumn, when the season for hunting and trapping returns, a portion, if not the whole, of the band moves here from the village and farms on the Reserve and supports itself during the winter on the proceeds of the chase. Good hunting grounds.

West of Duck Mountain stretches away to the westward the rich alluvial plain through which the Assiniboine River flows in a direction 25° east of south. The eastern side of this plain between Lac la Course and Little-Boggy Creek is a steep slope or escarpment from two to five Assiniboine valley.

hundred feet high, but south of Little-Boggy Creek this escarpment soon disappears, and the plain rises through a gradual though generally undulating or rolling, incline to the summit of the mountains. The soil in this plain or valley bottom is exceedingly fertile, being composed of a rich alluvial dark sandy loam, which produces abundant crops of grain.

Its peculiar character.

The course of the river itself is a very peculiar one. Just above Fort Pelly it flows in an almost northerly direction, making straight for the wide valley at the bottom of which at present a small stream, Shake Creek, rises in a quagmire just north of the Fort and flows into Swan River. Instead of following this valley northward, however, the Assiniboine turns abruptly and flows a little east of South in the bottom of a shallow and indefinite valley. This valley, however, gradually becomes better defined and increases in depth lower down, and though the country on either hand becomes higher, the river maintains its direction, at length cutting a valley about four hundred feet deep. The land on either side of the valley north of the mouth of Shell River consists of alluvial deposits which appear to have been laid down in the bottom of an ancient lake which stretched westward from the western base of the Duck Mountains. Its further shore has not yet been determined.

Lake Assiniboine.

This lake, as well as Lake Agassiz, is closely associated with the former glacial conditions of the country, and a brief statement of the conditions then probably existing may be here given.

Conditions during glacial period.

During the continuance of the glacial period, a huge glacier moved in a south-south-easterly direction in the great valley east of the Duck, Riding and Pembina escarpment, while another flowed parallel to it down the valley of the Assiniboine on the western side of these mountains. At times these glaciers doubtless coalesced into one vast ice sheet, while at other times they were separated by the mountains either in part or entirely and along the tops of the mountains threw up a median, or rather what has been called by Professor Chamberlin an "interlobate" moraine consisting almost entirely of boulders and debris of the Archæan rocks to the north. This is what has given the mountains their rough, rugged and broken character, a character which is most pronounced in the more northern portions. Where the Indian trail crosses the north-eastern corner of the Duck Mountains much of the country is so completely a mass of boulders that it supports but a few small stunted Banksian pines. At length a rise of the land took place in the southern or central portion of the continent, which rise is doubtless accountable in part for the high elevation of some of the plateaux of the Western states and of the Rocky Mountains.

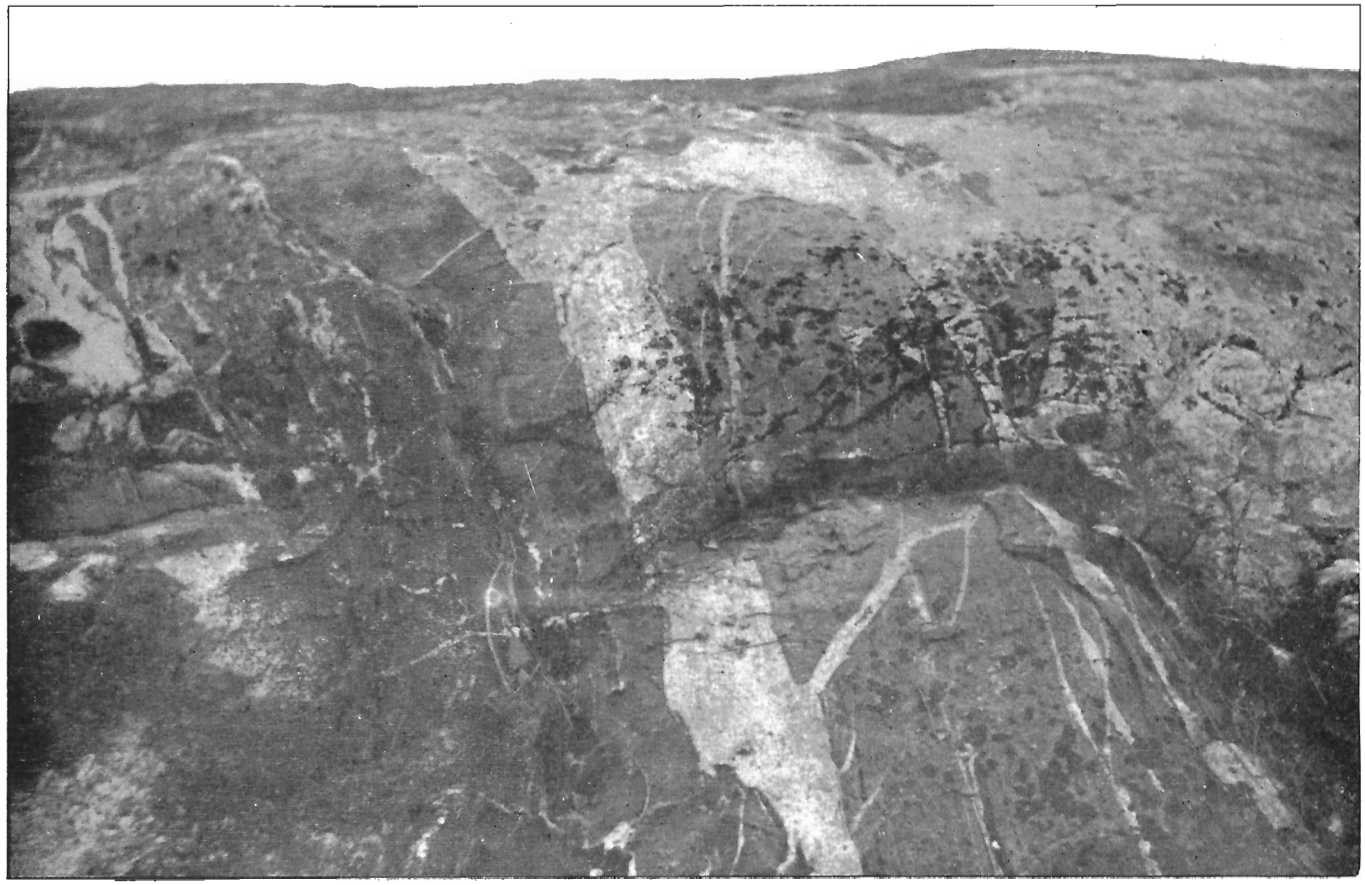
The glaciers now rapidly receded down the valleys, leaving large bodies of fresh water occupying the depressions along their fronts. It was apparently in this way that Lake Agassiz, the ancient lake of the Red River valley, and the lake which occupied the upper part of the Assiniboine valley, were originated. The ice front at last receded to a point where it again became relatively stationary, the flow of ice from the higher lands making up for the portions that were being melted off and carried away. Recession of the glacier.

Whether this ice front formed the northern or north-eastern shore of the above-named lakes it is impossible as yet to say, but the fact that the old shore lines of Lake Agassiz rise by a very gradual and even incline to the north as far as they have as yet been traced, showing a northern elevation of the land since the lake stood at its higher level, rather than a very considerable northern depression or southern elevation of the land, which must have occurred if the northern border of the lake was any of the land lying to the northward, lends great strength to this theory. However, for the complete determination of this question, further systematic investigation is necessary, but the existence of the lakes themselves admits of no doubt whatever. The relation of the two lakes to each other is somewhat difficult to make out completely, having doubtless been quite different at different times. At one time Lake Assiniboine was possibly only a bay of Lake Agassiz, being perhaps connected with it through the valley of Swan River, but if this was the case the alluvial deposits in the upper part of the Swan River have been covered by succeeding glacial deposits. At all events at one time a glacial dam appears to have stretched across the north end of this portion of the Assiniboine valley, and the superfluous waters of Lake Assiniboine flowed into Lake Agassiz through the deep valley which is now in part dry, and in part drained by Short Creek into Valley River. It was at this period that the delta plains of the Valley River were formed. When Lake Assiniboine receded towards the north a considerable stream still flowed through the valley of Shell River, fed in all probability by local glaciers on the Duck Mountain, while other streams flowed in from the south in the lower part of the same valley, and in a deep valley to the east of it now abandoned. After this time the valley of Snake Creek was formed and Lake Assiniboine was doubtless drained. The glaciers on the mountains, however, now gradually extended, closing all these valleys and the water from the ice front was obliged to find some other outlet, which it did down the valley of the Assiniboine below the mouth of Shell River, this valley having in all probability been first marked out, in part at least, by a stream flowing from the foot of Riding Mountain northward into Lake Assiniboine. These glaciers have left marks of their presence in Gradual incline of beaches. Valley of Short Creek. Recedence of glaciers.

Moraines.

morainic dams stretched across the valleys of Short Creek, Shell River and Snake Creek, &c. The flow of water was thus established towards the south, and a valley was worn out through which the Assiniboine River continues to flow up to the present time, though it is probable that now the amount of sediment carried away by the river exceeds by very little, if it exceeds at all, the amount of sediment brought down into it by small affluent streams, and consequently it has ceased to deepen its valley.

The geological structure of the country will be discussed in the final report, but it may be here stated that the floor underlying the whole country is a white or cream-colored Devonian limestone. Its surface is somewhat undulating, but on the whole it exhibits a slight slope towards the west or south-west. On this floor are heaped up successive beds of sands, marls and shales of Cretaceous age, constituting all the older rocks seen in this area west of the lakes. These form, under the glacial deposits, the entire mass of the Duck and Riding Mountains, and extend from them westward across the Assiniboine and under the Great Plains to the foot of the Rocky Mountains.



A. C. LAWSON, PHOTO., 1886. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Contact of Laurentian gneiss and schists of the Coutchiching series, on island between Gash Point and Back Point, Rainy Lake. The gneiss (light colored portion) penetrates the schists in all directions. It extends away continuously to the right, while the schists (shaded portion) extend to the left.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE GEOLOGY

OF THE

RAINY LAKE REGION.

BY

ANDREW C. LAWSON, M.A., PH.D.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To A. R. C. SELWYN, C.M.G., LL.D., F.R.S.

Director of the Geological and Natural History Survey of Canada.

SIR,—I herewith submit to you my report upon the physical and geological features, and economic resources of portions of the Rainy Lake and the Lake of the Woods regions, including the country through which the Rainy River flows; also a geological map of the same, in two sheets, on a scale of $\frac{1}{4}$ of an inch to the mile; each sheet embracing an area of 72×48 miles. The topographical surveys necessary for the construction of the map, upon which to represent the geology, occupied a much larger portion of the time devoted to field work than did the geological examination. With the exception of Rainy River, all the topography on the Canadian side, in the Rainy Lake sheet, is from our own surveys, checked by a few exploratory lines that had previously been run through the country.

Our warmest thanks are due to Mr. and Mrs. Pither of the Indian Agency at Coutchiching, for their most generous hospitality to myself and party during the seasons we have been at work in the country around Rainy Lake.

I have the honor to be,

Sir,

Your obedient servant,

OTTAWA, March 4, 1888. ANDREW C. LAWSON.

NOTE.—Bearings have reference to the true meridian, and read from 0° (N.) around to 360°.

REPORT

ON THE GEOLOGY OF THE

RAINY LAKE REGION.

INTRODUCTION.

Progress of survey.

The present report, with the accompanying geological maps, is an instalment of the results which are accruing from the systematic prosecution of a topographical survey and geological investigation of country north-west of Lake Superior. The northern portion of the Lake of the Woods was first surveyed and the results published in the Annual Report, Volume I, 1885. In continuation of this work, Rainy Lake and the region adjacent to it were, in 1885, next subjected to survey, as promising the most satisfactory results on account of their accessibility, and the abundance of rock exposures. Of the two sheets now ready for publication, the one embracing the Rainy Lake Region, or the "Rainy Lake sheet," is the more interesting and important. The other or "Rainy River Sheet," embracing the greater part of the Rainy River and the Lake of the Woods, from about the latitude of Turtle Portage and Driftwood Point southward, is much less satisfactory, and represents much less work, from the fact that only a portion of it is within Canadian territory; and of that the greater part is covered either by the waters of the Lake of the Woods or by the post-glacial deposits through which the Rainy River flows.

Maps.

Field work in 1885.

In 1885, I was assisted by Messrs. A. E. Barlow, W. H. Smith and C. S. Morton. These gentlemen were engaged till the close of the season in the prosecution of topographical surveys of portions of Rainy Lake and of the Kishkutena canoe route, while my own work consisted of a geological reconnaissance of the whole field, as sketched briefly in my summary report for that year. A portion of the season was also devoted to the survey of those islands of the Lake of the Woods which come within the Rainy River sheet.

Field work in 1886.

In 1886, I was assisted in the field by Mr. W. H. Smith. The season's operations were begun at Wabigoon, where Mr. Smith was instructed to carry a micrometer and compass survey from a fixed point on the Ca-

Manitou route.

nadian Pacific Railway through to Rainy Lake, by way of the Manitou canoe route, to connect with the system of township surveys on Rainy River. The west side of the lakes on this route was mapped in detail as far as the middle of Manitou Lake, from which point onwards both sides were embraced in the survey, being within the limits of the Rainy Lake sheet. Several weeks were next occupied by Mr. Smith in completing the survey of the north western expanse of Rainy Lake

Rainy Lake.

from Coutchiching northward to the Devil's Cascade. In addition to the usual micrometer and compass survey, a transit line was run between the two latter points, as a basis upon which to check the variation of the compass, which does not appear to be uniform throughout the district. This done, Mr. Smith next made a survey of an important chain

Otukamamoan route.

of lakes extending from the bottom of Redgut Bay, Rainy Lake, to Lake Manitou, which it is believed has never hitherto been explored. During the last few weeks of the season, Mr. Smith was engaged in completing certain detached surveys near the mouth of Rainy River and in the south part of the Lake of the Woods, which stress of weather

Lake of the Woods.

or other adverse circumstances had interfered with the previous season; so that nearly all the topographical material requisite for the mapping of the Rainy River sheet was secured.

After having, at the beginning of the season, provided Mr. Smith with men and equipment requisite for his survey of the Manitou route, I left him at Wabigoon and proceeded to Rat Portage. Here two or three days were spent in the usual preliminary arrangements, and in inquiring into the state of the mining industry of the district, after which I proceeded to make a topographical and geological survey of

Pipestone route.

the canoe route which extends from Lake of the Woods to Rainy Lake *via* Crow Lake and Pipestone Lake. The route consists of a chain of large lakes which have never hitherto been mapped. The west side of Crow Lake had previously been traversed by the survey; so that the work was begun in the neighborhood of Turtle Portage, and carried along the south side of Crow Lake; thence through Boulder, Sand-hill and Schist Lakes into Pipestone Lake, and then through Stonedam, Loon, Jackfish and Footprint lakes to the North-west Bay of Rainy Lake. The survey was made by means of a Massey's patent log, the portages being chained, and was checked at various points on previous surveys.

Geological work.

The belt of Keewatin rocks which crosses the Kishkutena route between Lake Kishkutena and Lake Despair was studied in detail, and traced in continuous connection with the area of the same rocks examined earlier in the summer on Crow Lake and Pipestone Lake. Some three or four lakes, of which Kahtimiagamak Lake is the most important, were surveyed, and added to the topography of the route. The

geological features of the northern part of the Manitou route were mapped by the aid of the topographical sheets supplied by Mr. Smith's survey. I returned to Rainy Lake by the Little Canoe route, making a log survey of the several lakes which form it, and mapping the geological features exposed on their shores.

In the southern part of Rainy Lake, some time was spent in working out the geological features of the islands and part of the south shore, as well as of those portions of the north shore which required special investigation in the light of the previous season's work; and considerable additions were made to the topography.

Pigeon River route.

For the purpose of acquiring a knowledge of the geological features of the south-eastward continuation of the Rainy Lake formations, and at the same time of becoming familiar, in a general way, with the features of the country between Rainy Lake and Thunder Bay, the last few weeks of the season were devoted to an examination of the shores of the canoe route along the Canadian side of the Minnesota boundary, and the field work was brought to a close at Port Arthur.

Field work in 1887.

In 1887, I was again assisted by Mr. W. H. Smith. More than half of the season, till about the middle of August, was required for the completion of the surveys and examinations necessary for the construction of the Rainy Lake sheet. My own work comprised: a further examination of a few critical points on the Kishkutena and Pipestone routes, with some slight additions to the topography; a survey and examination of Yoke, Strawberry, Bluff, Sucker, Furlonge, and Kaiarskons Lake; of the lakes of the Lake Harris route, within the limits of the sheet; of the lakes of Big Canoe River route; a geological examination of portions of Rainy Lake not previously examined; a geological examination of the Otukamamoan route, with additions to the topography, and an examination of the formations of Rainy River and the south part of the Lake of the Woods, together with a portion of Sabaskong Bay.

Mr. Smith's time was taken up with an exploration of the country between Big Turtle Lake and Heron Lake, resulting in a survey of a number of lakes; a survey of the lower part of the Little Turtle River, of the lakes of the Little Kishkutena route, and of the route between Stanjikoming and the North-west Bays; and more especially of the shore and islands of the east arm of Rainy Lake.

Character of country and methods of survey.

These various surveys and examinations, occupying our time up to about the middle of August, completed all the work that was deemed necessary for these two sheets, and our field of operations was moved further east. The country is devoid of roads or trails, and accessible only by the net-work of lakes, rivers and canoe portages, which is spread over its surface. All our travel was, therefore, effected by

means of canoes, with occasional excursions on foot through the woods. The surveys were such as enabled us to work rapidly and yet to afford sufficiently accurate data for the geological elucidation of the region and its cartographical representation on the scale adopted. Measurements on shore lines were made by the micrometer telescope or the Massey log, together with a compass triangulation having the lines so measured from point to point as bases. Portages or bush traverses were measured by the tape or by pacing. All bearings were made with reference to the magnetic meridian by means of the prismatic compass, except on a check line from Coutchiching to the Devil's Cascade on Rainy Lake where the transit was used.

Previous surveys.

The following surveys and sketches which had been made prior to ours, have served as checks and aids to our work, on the Rainy Lake sheet:

The Dominion Lands Rainy River Township Survey.

The Minnesota township surveys along the south side of the International boundary.

The Canadian Pacific Ry. exploratory line from Wabigoon to Coutchiching through the Manitou canoe route by Mr. W. Kirkpatrick.

A similar exploratory line from the Canadian Pacific Ry. to Rainy Lake by the Sand Island River route.

The Canadian Pacific Ry. exploratory line from White-fish Lake to Heron Lake.

The Indian Reserve surveys.

The timber limit surveys were of little service, and in some instances were ignored in our compilation.

The sketches of Thompson's Boundary survey have been superseded by our own, except for a few miles of the south-east side of Redgut Bay where his sketch was adopted.

A transit and chain line by Mr. Saeger, from the Indian Reserve at Wabigoon down the Manitou route to about half way to Fort Frances, was kindly placed at my disposal by that gentleman, and has also been used as a check.

For the Rainy River sheet, the surveys and sketches at our disposal in addition to our own, were :—

The Dominion Lands Rainy River township surveys.

C. F. Miles' survey of Sabaskong Bay for the Department of the Interior, 1875.

Joint maps of the North American Boundary Commission, 1878.

Cartographical work.

In the cartographical work we have had the advice and assistance of Mr. Scott Barlow, chief draftsman, who has laid down the projection of the sheets, and determined, as nearly as possible, the position of the more important points. The general compilation and drafting of the

Rainy Lake sheet has been the work of Mr. W. H. Smith; while the Rainy River sheet is by Mr. A. E. Barlow.

Geologically, the Rainy River region has hitherto been almost a *terra incognita*. The literature of the field is very scanty, and has reference only to the shores of Rainy Lake itself.

Previous geological work

Literature.

Dr. J. J. Bigsby has the honor of being the first to attempt a geological description of Rainy Lake. In the Quarterly Journal of the Geological Society of London, for Jan., 1854, Vol. X, he published a paper on the "Geology of Rainy Lake, South Hudson's Bay," accompanied by a geological map of the lake on a scale of four geographical miles to the inch. In his paper on the "Erratics of Canada," in the same journal for April, 1851, Dr. Bigsby's notes, so far as they apply to Rainy Lake, are interesting, and indicate a considerable amount of attention to superficial phenomena.

Bigsby.

Owen.

In the Report of the Geological Survey of Wisconsin, Iowa, and Minnesota, by D. D. Owen, 1852, there is a paragraph on page 319 devoted to brief notes of the rocks observed on a two days voyage through the lake from Kettle Falls to Rainy River.

Bell.

In the Report of Progress of the Geological Survey of Canada for 1873, Dr. Bell in his "Notes on the Geology of the Region between Lake Superior and Red River," devotes about a page (88-89) to notes of geological observations made in passing through Rainy Lake and down Rainy River.

Hind.

In the "Report on the exploration of the country between Lake Superior and the Red River settlement," 1858, Prof. H. Y. Hind has a chapter devoted to a description of Rainy Lake and river. The most interesting of his notes from a geological standpoint are those descriptive of Rainy River. No attempt is made to add to Dr. Bigsby's description of the geology of the lake.

Hector.

Hector, in his paper "On the Geology of the Country between Lake Superior and the Pacific Ocean," Q. J. G. S., Vol. XVII, has a brief reference to the geology of Rainy Lake.

Dawson.

The literature bearing on the geology of the south part of the Lake of the Woods has already been cited in my report for 1885. The "Geology and Resources of the 49th Parallel" by Dr. G. M. Dawson gives an account of the southern portion of the lake, particularly the United States side, which my own notes on the Canadian side, where rock surfaces are more abundant, will serve to supplement.

Physical Features—their Dependence upon Geological Conditions.

Surface of country.

The surface of the country mapped on the two sheets accompanying this report presents a natural division into two portions, the respective characters of which are in striking contrast. These are :—

1. *The rocky lake country.*
2. *The alluvial plain, or river country.*

Alluvial plain.

The latter differs from the former essentially in the fact that the rocky, hummocky surface, the depressions of which would naturally form lake basins, is covered by a thick, uniformly spread blanket of post-glacial deposits. The surface of these deposits forms a comparatively flat, well wooded plain; and on the United States side, across northern Minnesota, this plain appears to merge into the prairie country. On the surface of the plain there are almost no lakes, the undrained water accumulating in wooded or treeless "muskegs." Drainage is effected by rivers of the usual sort, which cut their way through the soft horizontal strata so as to form shallow cañons.

Rocky lake country.

The rocky lake country presents the character of a plateau which, regarded on the large scale, is remarkably flat and devoid of prominent elevations, although the surface, in detail, is extremely uneven and hummocky or mammilated. It presents, for the most part, the glaciated surface of the rocks, either quite bare or covered only by forests and forest loam. There is a marked absence of alluvium or fine drift, except in occasional patches and small areas. The plateau abounds in lakes which lie in rocky basins. Rivers are few and short, being mostly mere connecting links or series of rapids between lake basins. Rivers of the cañon type can scarcely be said to occur at all, except, as in the case of the Big Turtle River, a small area of soft, flat-lying strata, through which it flows, presents the conditions which determine its character as such locally. These being the broad distinctions between the surface aspects of the two portions into which the region under consideration is divided, we may proceed to consider each portion somewhat more in detail.

The Rocky Lake Country.

Characteristic feature.

The feature of this portion of our field which is of most prominence and interest, is that of the lakes. In my report of 1885, I have drawn attention to some of the more salient characteristics of the Lake of the Woods, and shall, therefore, not now refer to it again, although portions of it fall within the field under consideration. I shall attempt, by a reference to Rainy Lake, and to the chains of lakes tributary to it, to point out briefly the close relationship which exists between geo-

logical conditions and topographical contour. A glance at the map shews that Rainy Lake is a receiving basin or reservoir for the drainage of an extensive circle of country. At its south-west corner the waters of the lake are dammed back by a low escarpment of post-glacial clays, save for the gap where this formation has been cut through, and the waters of the lake break over the jagged upturned edges of an underlying ridge of schists, forming the Coutchiching rapids, the beginning of Rainy River. To the N.N.W.,N., N.E., E. and S.E. of the lake, the surface of the country rises very gradually, forming an amphitheatre-like slope, upon the various stages of which lie lakes linked in chains, or linear series, which converge upon the receiving basins. This slope, although distinctly recognizable as such, by following the drainage of the lakes from stage to stage, has a very slight incline, and is practically, as before stated, a plateau. The average slope can at most be but a few feet in the mile, but the figures are difficult to arrive at, on account of the rough, uneven character of the surface, and the absence of systematic levels. The drop from Lake Manitou to Rainy Lake was estimated by Mr. Kirkpatrick, in his exploratory survey of the Manitou route for the Canadian Pacific Ry., to be 107 feet. This in a distance of about 12 miles, gives a mean slope along the water course of nine feet in the mile. On the Sand Island River route, the drop of the water from the N.E. corner of the region mapped on the Rainy Lake sheet to the level of Rainy Lake is estimated to be about 120 feet. The distance being about 24 miles, this gives a mean slope of about five feet in the mile.

Rainy Lake, a receiving basin for extensive circle of country.

The slope to Rainy Lake.

The absence of great contrasts of elevation, associated with the remarkable hummocky or mammilated surface, already mentioned, which characterises this plateau, are features which it has in common with the Archæan plateau in general of which it forms a part. Taking the surface of Rainy Lake as a local datum level, there are few portions of the country that rise to an elevation of 100 feet in the immediate vicinity of the lake. The only exception to this is the ridge of schists on the north side of the lake between the Bear's Passage and Open water Narrows. This ridge attains a height of about 250 or possibly 300 feet above the lake. From its crest a vast sweep of country may be seen in all directions, and when travelling on the lake, it forms a prominent land mark. Further to the northward, the surface of the plateau slope has a general maximum elevation of 200 feet above the lake. Two or three notable exceptions may be mentioned, although they do not seriously affect the general statement. One of these is the group of conical or dome-like hills of granite or granitoid gneiss which rise to an elevation of about 300 feet above Lake Harris at its west end. This would be about 450 feet above

Hummocky surface.

Elevations.

Rainy Lake. These hills stand very prominently above the general level of the country and can be seen from Manitou Lake many miles to the north-east. Kishkutena ridge, which forms the divide between the waters running into Sabaskong Bay, and those running into Rainy Lake, is probably 500 feet above the assumed datum level. The land lying to the south of Crow Lake rises in an east-and-west trending ridge, which is in somewhat prominent contrast to the surrounding country. With a few exceptions like these, the surface is remarkably uniform in general elevation, within the limits mentioned; and it is only the endless diversity of detail, the ever-changing harmony of water, rock, and forest, in all the various atmospheric keys, that conceals the monotonous flatness of the region. Such being the general maximum elevation of the region, it becomes a matter of interest to ascertain the minimum elevation or maximum depression. All the depressions or basins of the plateau which have a continuous rim, nowhere as low as the bottom of the basin, are filled with water, and form lakes, each of which, under ordinary conditions, is in a constant state of overflow into the next lower basin. In very dry seasons, the overflow and evaporation exceed the amount of precipitation gathered from the country tributary to any particular basin, and the water of the lake is temporarily stagnant. This is particularly the case with lakes at the head of a chain. These head-water lakes are sometimes, as in the case of Kishkutena Lake, the largest of the chain to which they belong, and may, under the conditions mentioned, be seen with the level of their surface several inches lower than the rim of the containing basin at the outlet. To form an approximate estimate of the depth of the depressions in which these lakes lie, a series of soundings has been made, which, although by no means complete, affords sufficient data upon which to base an estimate of the general depth of the basins. A list of these soundings is given below. The figures indicate that the depth of these depressions, below the contour line afforded by the lake shores, approximates as nearly as can be judged to the general elevation of the country above that line. Thus, if land and water surfaces were in equal proportions, the level of the water would be the mean elevation of the rocky surface of the region; or rather the mean slope of the chains of lakes would be the mean slope and elevation of the plateau. But as the land surface very much exceeds the water, the mean elevation of the plateau must be somewhat higher than the shore line contour.

Highest point of Rainy Lake region.

Depressions.

Soundings.

Relationship of depressions to elevations.

Deepest lake.

The greatest depth of water anywhere observed was that of Pickerel Lake on the Manitou route, where the sounding showed a depth of 165 feet. The next deepest sounding was on Manitou Lake, where I found 158 feet of water as the maximum of a series of soundings in the lower

part of the lake. It is of interest to note that these maximum depths of water are in a line of depression which appears to be connected in origin with the fault observable at Cedar Narrows on Pickerel Lake. The lowest depression of the region is that of the south arm of Rainy Lake south of Little Rocky Narrows or opposite the mouth of Seine Bay, where the water is 110 feet deep. This is the maximum depth found anywhere on Rainy Lake, and taken in connection with the low level of the surface of the lake, compared with that of the other lakes draining into it, it gives for the bottom of the lake at this place the minimum elevation of the region. The maximum elevation of the region was found to be the summit of Kishkutena Ridge, which was placed at about 500 feet above the surface of Rainy Lake. The difference between the maximum and minimum elevation, or the range of altitude of the various parts of the plateau is thus 600 feet. Reference has not been made to the sea level, because the altitude of our local datum level is not known with sufficient accuracy to be of service.

Greatest depth in line of fault.

Maximum depth of Rainy Lake.

The following is a list of the various determinations that have been made for the elevation of Rainy Lake above the sea:—

		Feet.
1.	Colonel Lefroy, barometrical, as quoted by H. Y. Hind.....	1,160
2.	S. J. Dawson, by way of Pigeon River route..... ...	1,045
3.	" " Seine River "	1,029
4.	" " Dawson route.....	1,035
5.	Major Long (Lake Superior 595 feet.).....	1,100
6.	W. B. Kirkpatrick, by way of Manitou route.....	1,094

Elevation of Rainy Lake above sea.

I am inclined to regard the first of these determinations as being nearest the truth. Of S. J. Dawson's determination Nos. 2 and 3, are taken from his official report. They are based upon actual measurements of falls and estimations of rapids and currents on the two canoe routes mentioned, from Lake Superior to Rainy Lake. No. 4 is given by Hind in his report on the Red River exploring expedition, and credited to Mr. Dawson, with the statement that the level of Lake Superior is taken at 600 feet above the ocean. All three determinations are under-estimated. Since they were made the levels along the line of the C. P. R. afford an important check upon them. These levels place the surface of the Lake of the Woods at its lower end at 1,062 feet above the sea. The Rainy River affords abundant testimony of a very marked difference of elevation between Lake of the Woods and Rainy Lake. If we assign to the Coutchiching Rapids a descent of 5 feet; to the falls of Fort Frances, 22 feet; to the Manitou Rapids, 5 feet; to the Longue Sault Rapid, 10 feet; and to the general current of the river, which is remarkably strong and swift, a descent of 1 foot in the mile or 75 feet, all of which estimates are moderate, we would

Discussion of data for level of Rainy Lake.

have, as the difference of level between Lake of the Woods and Rainy Lake, 117 feet, to which may be added 3 feet for the difference in the level of the upper and the lower end of the Lake of the Woods, making a total difference of 120 feet. This added to the level of the Lake of the Woods, as determined by the C. P. R. engineers, would give us, as the elevation of Rainy Lake, 1,182 feet. Assuming its correctness, the highest land within the region mapped, the crest of Kishkutena ridge, is about 1,700 feet above the sea level; and the lowest hollow, Rainy Lake south of Little Rocky Narrows, about 1,072 feet above the same level.

List of Soundings in Rainy Lake and in some of the Lakes Tributary to It.

	Feet.
Manitou Sound, 1½ miles S. E. of Devil's Cascade	39
" " opposite mouth of Little Canoe R.	54
Ash Bay, North arm	80
" West of Boreas Island	32
Channel between Boreas Island and Gube Point	31
Off S. E. shore of Argyle Island	29
Off S. E. shore of Boom Island	25
Alexandria Bay, north channel	31
Off south side, Cherry Island	30
One mile N. of Hanging stone Point	23
Half mile N. of N. W. end of Woodchuck Island	27
West of N. W. end of Woodchuck Island	24
North West Bay, Camp Narrows	30
" " opposite Brown Inlet	35
Off S. E. end of Woodchuck Island	27
Off West side of Rebecca Island	36
Off S. W. end of " "	33
Half mile N. N. E. of Standing-stone Point	32
Channel south of Chamberlin Point	60
North-east Bay, 4½ miles west of Frog Portage	60
" 3½ " "	55
Channel S. E. of Rebecca Island	27
" East end, Cheery "	43
" West " "	42
Off Tug Point	50
1½ miles W. S. W. of Blaze Point	57
2½ " " "	63
2 " S.W. "	72
1 mile N. W. of Reef Point	60
One mile W. of Reef Point	45
Between Homestretch and Risky Islands	37
¾ mile S. of Homestretch Island	38
Opposite entrance to Stanjikoming Bay	49
" Hay Marsh Bay	40

	FEET.
Sand Bay	23
One mile S. S. E. of Little Rocky Narrows	70
Two miles S. " "	110
" S.E. " "	105
Channel between Dry Weed Island and south shore	33
Opposite mouth of Seine Bay	105
2 miles E. of Hallelujah Point	80
2 " E. of Brulé Narrows	22
4 " E. " "	60
5½ " E. " "	74
S. of Vague Point	82
S of Breezy Island	59
Off N. side of Oak Point Island	59
One mile S. W. of Pine Narrows, Redgut Bay	45
Opp. mouth of Crow Rock Inlet, "	45
" " Porter Inlet, "	22
Parry Strait, "	6
Mainville Lake, north end	27
" " middle	18
Obikoba Lake, south end	16
" " north "	14
Captain Cuttle Lake, south part	31
Sam Weller Lake	16
Twist Lake	36
Dog Fly Lake, middle	68
" "	92
South end of Grant Lake	90
Middle " "	42
North end " "	126
Sairey Gamp Lake	27
Lake Harris	99
Missus Lake	75
Lake, west of Missus Lake	66
Kaiarskons Lake	118
Furlonge Lake	30
Crack Shot Lake	27
Sakwite Lake	63
South end of Kahopskikomak Lake	48
Middle " "	34
Kahwawiagamak Lake	45
Memekwesi Lake	67
Down-grade Lake	43
Smooth-rock Lake Narrows	76
" " S. end	30
Windigons Lake	87

	FEET.
Pickerel Lake	165
Manitou Lake, opposite Snare Bay	60
" " N. E. of mouth of Hidden River	96
" " N. E. " Peep Bay	158
" " N. E. of Paddle Portage	129
" " 1¼ miles N. E. of Paddle Portage	117
" " 2 " " "	87
" " 2¾ " " "	110
Clear-water Lake, S. end near Burnt Narrows	50
" " middle	56
" " north end	28
First Quill Lake	47
Narrow Lake, S. W. end	75
" " middle	122
" " N. E. end	40
Height of Land Lake, S. end	63
" " N. end	44
Kishkutena Lake, near narrows	52
Kahtimiagamak Lake	50
Pipestone Lake, S. end	105
Three Island Lake	50
Bat Lake	40
Cold Lake	42
Strong Lake	47
Vane Lake, N. end	60
" S. end	50

Average.

The average of the soundings in Rainy Lake, 51 in number, is 47·4 feet, which is probably not far from the average depth of the lake, as the depth of the water does not depend so much, in these rocky basins, upon the distance from shore, as it does in lakes lying in soft or shelving strata. The average of the soundings, 54 in number, in the lakes higher up on the plateau, is 63·6 feet, which represents not an average depth of these lakes, but rather their average maximum depth.

Dependence of contour upon geological conditions.

The intimate dependence of topographical contour upon geological conditions which was observed upon the Lake of the Woods is equally well exemplified upon Rainy Lake, and on the other lakes of the region. The shapes and disposition of the lakes and the trend of the ridges and depressions are always a function of the character and disposition of the rocks; and show that the agencies of erosion have acted along lines and with varying intensities, which were determined by the nature of the rock itself long before those agencies had access to it. This fact comes out much more strongly, of course, in those portions of the region which are occupied by the schists of the Keewatin and Coutchiching series, or in the more gneissic portions of the Laurentian, than

in the more granitoid portions of the latter. Still the principle is well illustrated even here by the irregular shape of the lakes, and the more irregularly hummocky character of the surface. Since in the more granitoid country there are few or no structural lines to give direction to decay and erosion, and these, therefore, act with equal ease in any direction.

Leaving the lakes which lie in the more granitoid of the Laurentian gneisses, and passing to the consideration of those lying in more evenly laminated or schistose rocks, it will only be necessary to draw attention to a few of the many instances which illustrate the principle in order to emphasize its force. Beginning with Rainy Lake itself, we find that it consists of two main arms, an east arm and a north arm, diverging at right angles from its outlet at the south-west corner. The east arm comprises three distinct basins or troughs, viz.:— Illustrations of this dependence.

1. From the outlet at Coutchiching to the bottom of Swell Bay, a trough 20 miles long and very narrow, compared with its length. That portion of it which is east of Open-water Narrows has an average width of one mile and its axis or mean course is 70°. The portion west of Open-water Narrows has a bearing from the narrows to Coutchiching of 75°, and its average width is something over two miles. A glance at the geologically colored map will show that these bearings are very closely those of the mean strike of the rocks at these two portions of the trough. First trough.

2. From Grassy Narrows to the bottom of Seine Bay, a trough 21 miles long. The axis measured along the longest line of open water has a bearing of 76°. The trough has a width, at its middle part, of about four miles and tapers towards Grassy Narrows almost to a point while to the eastward it passes into Seine Bay, a stretch of water seven miles long with parallel shores one mile apart. Second trough.

These two troughs are separated by a long, narrow, tapering ridge of rocks, which, westward of Little Rocky Narrows, is continued in a belt of narrow, elongated islands, separated by very short transverse channels. This dividing ridge has a trend coincident with that of the water-filled troughs on either side of it, and strictly coincident with the mean strike of the schists of which it is composed. Separating ridge between troughs.

The parallelism of the shore lines which form the rim of this second trough or basin to the strike of the schists is everywhere observable even in great detail. The divergence of the shores which makes the middle of the basin wider than the ends, is due to a similar divergence of the strike, the rocks on the north side having a strike of about 75°, while on the south shore, from Black Bay to Brulé Narrows, the strike is east and west. Dry-weed Island and the islands near the mouth of Seine Bay and Brulé Narrows are all long and narrow, and have their longest axes parallel to the strike of the rocks.

Seine River, a continuation of second trough.

The Seine River and its lake expansions forms a trough whose mean axis is strictly parallel to that of the trough just described. The trough extends from Bleak Bay, with a bearing of 75°, 22 miles to the limit of the region mapped. The minor deviations from the mean line or axis always follow curves in the strike of the rocks.

Third trough.

3. The last of these troughs or basins which, together, make up the east arm of Rainy Lake, is that which lies between Brulé Narrows and Kettle Falls. It is separated from the second trough by points of land which approach each other at Brulé Narrows. Its greatest length is 19 miles along the line extending on a bearing of 97° from the bottom of Saginaw Bay to the bottom of Stokes Bay. This line of greatest length is not, however, the true axis of maximum erosion, and to bring out the parallelism of the maximum erosion and of the trend of the shore lines to the strike of the rocks, it will be necessary to regard this trough as made up of two sub-troughs. The axis or longest diameter of the first of these extends 85° from the bottom of Saginaw Bay, 13 miles to the bottom of Cormorant Bay. This line coincides very closely with the mean strike of the rocks. The second sub-trough extends from Big Island to the bottom of Stokes Bay, a distance of 12 miles. Its axis and the mean strike of the rocks, from which there is but little deviation, are both east and west.

Composed of two sub-troughs

North arm of Rainy Lake, its cross-shaped basin.

The north arm of Rainy Lake has a trough which takes the form of a cross. The portion of the trough corresponding to the larger bar of the cross, often 5 to 6 miles wide, has for its mean course a due north-and-south line extending from the south shore of the lake past Squall Point to the vicinity of the Devil's Cascade, a distance of 24 miles. The portion corresponding to the transverse or narrower bar is somewhat curvilinear, concave to the north, and extends from the west end of the North-west Bay to the east end of Redgut Bay, by way of Frog Portage, a distance of 38 miles. The whole of this cross-like basin lies in Laurentian gneiss, which is, for the most part, distinctly foliated or laminated; and both the N. and S. and the E. and W. trending troughs, which together form the basin, conform strictly to the strike of the planes of foliation of the gneiss. The irregularities and apparent exceptions to the rule are due, for the most part, to masses of granite which cut the gneiss in places. From the Devil's Cascade at the extreme north end of the lake down to the entrance to the North-west Bay on the west side, and to the entrance of the North-east Bay on the east side, this coincidence of shore line with the strike of the rocks is perhaps best exemplified. From the Devil' s Cascade southward, the trend of the rocks diverges, curving around on the one side so as to strike up the North-west Bay, and thence through Foot-print Lake, Jack-fish Lake and Loon Lake, the strike of the rocks making a complete circle, and

Coincidence of shore line with strike.

closing again on itself at the Devil's Cascade. This circular disposition of the foliation is closely followed by the shores of Manitou Sound, Ash Bay, Alexandria Bay, the Islands of Manitou Sound, the shores of the North-west Bay and the lakes above named. On the other side, the curve of the strike is first to the south-east into the North-east Bay, and then east through Macdonald's Inlet, Black Sturgeon Lake, Crow Rock Inlet and Redgut Bay. Where the rocks cross the lake with an east and west trend, the long axes of the islands all lie in the line of strike. From Standing-stone Point southward, the rocks curve around from east and west to north and south, and the shore and off-lying islands have the same trend. On the east side of the lake, between the North-east Bay and Gash Point, the shores of the bays and the more prominent points are coincident with the strike.

Circular disposition of strike of gneisses.

Among the more striking instances of the minor lake basins showing parallelism of contour to the strike of the schists in which they lie, may be mentioned the following: Narrow Lake, north of the N. E. end of Sabaskong Bay; the south part of Crow Lake; the whole of the waters of the canoe route from the south-east end of Crow Lake to the North west Bay of Rainy Lake by way of Boulder, Schist, Pipestone, Link, First Quill, Clearwater, Minomin, and Despair lakes. This chain of lakes forms a Z-shaped trough lying almost entirely in the Keewatin schists. The two sharp bends in the water course, at the N. E. end of Pipestone Lake and at the south end of Clearwater Lake, correspond closely to two sharp bends in the strike of the rocks. The lakes are all narrow in proportion to their length. Manitou Lake, Grant Lake, Missus Lake, Strawberry Lake, and other smaller lakes in this portion of the Keewatin belt, are remarkable for the fidelity with which they adhere to the strike of the rocks and for their long, narrow shapes. The exceptional case of Pickerel Lake, with its irregular shape and long axis, transverse to the strike, finds its explanation, doubtless in the two granite bosses which interrupt the strata, and in the fault which dislocates them at Cedar Narrows. Dog-fly and Vista Lakes conform in their general contour to the strike of the rocks, but are somewhat irregular in shape as are most basins eroded out of agglomerates. Kahopskikamak and Sakwité lakes on the Otukamamoan route, Little Turtle Lake, Tésup, Big Sawbill, Otter and Mainville lakes, are notable instances of basins in Laurentian biotite gneiss which are long and narrow, and have their shores determined by the position of the planes of foliation. These various instances here cited are only the more prominent ones which come out in the mapping, but on the scale on which the map is published there is a host of details lost, in which the topographical contour is in the closest dependence upon the character and structure of the

Instances of minor lake basins coinciding in shape with strike of rocks.

Exceptional case due to fault and irruptive granite.

rocks. This dependence impresses one very forcibly in the field, but cannot here be more than alluded to, except where, as above sketched, it affects the main topographical features of the region.

The Alluvial Plain or River Country.

Extent of alluvial plain.

Its slope.

The wooded plain which extends from the south-west corner of Rainy Lake to the Lake of the Woods is on a slight but distinctly lower level than that of the "rocky lake country." Its slope is apparently the continuation of that of the rocky plateau just described. The highest part of the plain, so far as I was able to observe, is where the scarped face of the bedded clays which underlie it overlook Rainy Lake near Coutchiching, with an elevation of 10 or 12 feet above the surface of the lake. Down the Rainy River to the Lake of the Woods, the plain has practically the same slope as the river, and on the Lake of the Woods between Hungry Hall and 49th parallel, the edge of the plain has an elevation of from 10 to 20 feet above the surface of the lake, and according to Mr. Bolger* extends back with "extreme levelness" over townships one and two, south ranges XXIII and XXIV. Between these two points of maximum and minimum elevation of the surface of the plain, the slope is apparently gradual and uniform, the average incline in a W. N. W. direction, being probably two feet in the mile. Occasionally, as to the north-west of the Indian Reserve at the Longue Sault on Rainy River, the country is rolling or undulating, an appearance which is probably due to the ridged character of the concealed rocky surface, at a place where the covering of post-glacial deposits is thinner than usual. Occasionally too, a knob of rock projects through these deposits, which has been either exposed by local denudation of the clays, as at different rapids of the river, or which appears to have been a small islet in the vast lake in which these deposits were laid down. Such island-like knobs of rock have usually a more or less distinct formation of shore gravel about their base, as, for instance, the knob which projects above the plain on the northern limit of the Longue Sault Indian Reserve, or the portion of trap dyke observed at the back of Mr. Lutterel's farm. The uniform flatness of the plain affords no depressions which serve as lake basins, and none are known beyond a few mere ponds. Drainage is effected by the numerous creeks and rivers which flow into the Rainy River. These all cut channels down through the clayey strata, and afford excellent sections of a thickness varying from 10 to 30 feet. The most important tributary, on the Canadian side, is Pine River, a narrow stream, sluggish at low water, whose principal branches flow in the bottom

Rock exposures

Drainage.

* Report, Commissioner of Crown Lands, Ontario, 1886, p. 48.

of the low valleys in the undulating surface above referred to. Several much larger streams feed Rainy River from the American side. The undrained water rests on the surface of the plain in the form of muskegs and swamps. Mr. Bolger estimates that "perhaps 30% of the area is swamp, most of which can be drained and made tillable land." Rainy River has, at the mean height of the water, a depth which, from a number of soundings in mid-stream, appears to vary from 15 to 21 feet. At the Longue Sault and Manitou Rapids it is, of course, shallower, but not so shallow as to obstruct navigation except at very low water, when the boulders in the channel of the Longue Sault obstruct the passage of the small screw-steamers which ply between Rat Portage and Fort Frances. The serious obstacle to navigation is the falls of Fort Frances. The completion of the locks at Fort Frances, all the heavy and expensive work of which is done, would extend navigation very much, and stimulate the development of this portion of the country. The general features of the river have been well described by Bigsby*, Hind†, Long‡, and S. J. Dawson§.

Extent of swamp.

Depth of Rainy River.

Lock at Fort Frances.

ARCHÆAN GEOLOGY.

GENERAL STATEMENT.

The Archæan rocks of the Rainy Lake region, like those of the Lake of the Woods, are clearly separable primarily into two main divisions, viz.: An upper, chiefly schistose, bedded, and metamorphic: and a lower, of the granitic or syenitic type of mineralogical composition, but mostly gneissic in structure. In the upper division there can be recognized at least two distinct groups. One of these is identical with the Keewatin series of the Lake of the Woods,¶ and has been traced stratigraphically in direct continuity with it. The other is prominently developed in the southern part of the region, and occurs between the base of the Keewatin series and the Laurentian. Being unable to correlate this second series with any with which I am acquainted, I have named it, in a preliminary notice** of the geology of the region, the Coutchiching series.†† In the lower division distinctions of stratigraphical sequence and relationships, if any such ever existed, have been obliterated. For this assemblage of rocks or lower division of

Upper and Lower Archæan

Distinctive characters.

Keewatin series.

Coutchiching series.

* Geol. Journal, Vol. VII, 1851, and Vol. X, 1854.

† Report of the Red River Exploring Expedition, 1858.

‡ Sources of Peter's River, Keating, 1825.

§ Appendix to XVII Vol. of Journals of Legislative Assembly, 1859.

¶ Annual Report, Geological and Natural History Survey, 1885, Part CC.

** Am. Jour. Sci., Vol. XXXIII, June 1887.

†† This series presents interesting lithological resemblances to the Montalban series, but has not the geological position which has been assigned to the latter.

the Archæan, the term Laurentian is retained. The Laurentian rocks in this particular field can be classified only on a petrographical basis. The different kinds of rocks which are comprised within the assemblage so named are susceptible of a geographical separation into zones or areas, but, as above stated, are not geologically separable into strata or bedded formations, though often stratiform.

Schematic representation.

The leading divisions of the Archæan for this region may, from what has been stated, be arranged in the following scheme, according to the order of which the geological features of the region will be considered in detail:—

Archæan. { Upper division. *a*. Keewatin.—(Huronian ?) *b*. Coutchiching. Lower division.—Laurentian.

A more comprehensive statement of the results arrived at, together with a discussion of their theoretical bearing, will be given in the summary, after the facts, upon which these and other generalizations are based, have been set forth.

Keewatin Series.

Limits of the Area of the Keewatin Rocks—Conditions of Contact with Lower Rocks.

Keewatin series on Lake of the Woods.

At the S. E. corner of the Lake of the Woods map, 1885, the Keewatin rocks are represented as in contact with the Laurentian gneiss on the shore of Sabaskong Bay, at a point a little to the east of the portage road which leads from that bay to Arrow Lake, through the Indian Reserve 35 C. From this point eastward, the line of contact curves to the north, around the extreme N. E. inlet of Sabaskong Bay, the trend of the shore being approximately parallel to the curvature of the line of contact. The shores of this inlet are all very coarse granitoid gneiss or granite. The contact line lies in the ridge of land which divides the waters of Sabaskong on the south from those of Arrow Lake and Crow Lake, on the north and north-east, and runs much closer to the former than to the lakes named. The last exposure on the Lake of the Woods at which the Keewatin rocks and the Laurentian gneisses are seen in contact is at the northern extremity of the S. E. arm of Sabaskong Bay, close to the south end of Crow portage. In coming over Crow portage, from Crow Lake to Sabaskong, the rocks passed over are black-green, hornblende schists. They are first seen about one-third of the way from Crow Lake, with a strike of 130° and dip at high angles to the north-east. Four chains farther south they have a strike of 140° with

Rocks on Crow Portage.

the same dip. Beyond this to the end of the portage they are seen at intervals with a uniform S.E. strike; dip N. E. At the end of the portage, on the shores of the bay, on the west side, the schists come in contact with a medium-grained, flesh-tinted, or reddish to grey, biotite gneiss, which exhibits, for the most part, a very distinct and even foliation of the constituent minerals, quartz, felspar and biotite. This foliation is approximately parallel to the schistosity of the hornblende schists; the contact is, however, a brecciated one, the gneiss being apparently injected into the schists, which seem to have been more or less shattered in a brittle condition, so as to admit of the passage of the gneiss in its former soft and plastic state within the fissures of the schist, which are sometimes parallel and sometimes transverse to its cleavage planes. The strike of the rocks at the contact is 130°, dip N. E. < 60° to 70°.

Contact of Keewatin and Laurentian.

The next place where this line of contact was crossed by our surveys is on Kah-timi-agamak Creek. The interval between the last described point of contact, at the south end of Crow portage and this creek is about nine miles. But although the line of contact has not been actually traced out for this interval we know that it must occupy approximately the position given to it on the map, from our knowledge of the distribution of the Laurentian rocks to the south, on the shores of Sabaskong Bay, Kah-kabik-kitchiwan Lake, Crooked-pine Lake, Big-pine Lake and Wigwam Lake, and of the Keewatin rocks to the north on the shores of Crow Lake and Kah-timi-agamak. The contact of the gneiss and hornblende schist occurs on the creek about half way between Wigwam and Kah-timi-agamak lakes. The actual contact is not well exposed, but the rocks on either side can easily be traced along the creek and shew that a very granitoid, reddish, biotite gneiss comes in contact with a dark, green, hornblende schist, which gives way, a little further up the creek, to green agglomerate schists.

Contact on Kah-timi-agamak Creek.

To the south-eastward of Kah-timi-agamak Creek the line of contact appears to continue in the same general direction for about four miles, when it begins to curve around to the south, so that on the north side of Night-hawk Lake, where the contact is next seen, the strike is about north and south. Following it across Night-hawk Lake and thence for nearly a mile and a-half to Kishkutena Lake, we find that the line of contact curves rapidly to the S. W., and from the last named lake onward it has a course which makes an angle of 70° degrees with that which it formerly held between the south end of Crow Portage and a point to the north of Night-hawk Lake. The west side of Night-hawk Lake is occupied by a rather coarse, reddish, granitoid, biotite gneiss or granite, composed of quartz, in large grains, and orthoclase in about equal proportions with a subordinate proportion of biotite. This rock

Contact at Night-hawk Lake.

Kishkutena Ridge.

is not only observed to occupy this shore of the lake, but is seen to make up the bare burnt hills which extend for some miles to the westward. The east side of the lake is occupied by the Keewatin rocks which form a comparatively high ridge with an abrupt face to the north-west. This ridge runs from this point south-westward for several miles and extends to the south of the 49th parallel, forming the divide between the waters flowing into the Lake of the Woods and those flowing into Rainy Lake. The rocks of the Keewatin series which compose this ridge, particularly on its north-west side, differ from the ordinary hornblende schists which are usually found in contact with the Laurentian gneisses, in being very much more compact and often quite devoid of schistose structure. The rock appears, to the naked eye, to be, like the schists, composed mostly of hornblende, but has, in addition, numerous large porphyritic crystals of white felspar, studded all through it, so that on the large scale, on the face of a cliff for instance, the rock presents a distinctly and curiously mottled aspect although in hand specimens it is often difficult to get more than one or two porphyritic crystals. This rock is very probably an altered porphyrite, and grades into more schistose varieties with the disappearance of the felspar. The same rock has been noted at the contact of the Keewatin series with the Laurentian on the north side of White fish Bay, Lake of the Woods.* The contact of this altered porphyrite with the granitoid gneiss runs along the base of the cliff which forms the north-west side of the ridge above mentioned, and as the rocks are well bared, may be traced easily from the south end of Night-hawk Lake to the N. E. end of Kishkutena Lake.

The rocks composing the ridge.

The granitoid gneiss is here mixed, only to a very limited extent, with the Keewatin rocks, a fact doubtless due to their unusual compactness and toughness at this locality. At the north-east end of Kishkutena Lake, one-quarter of a mile from Kishkutena portage, the actual contact is not exposed, and between the nearest exposures of the granitoid gneiss and the porphyrite, there is a small exposure of a greenish, grey quartz porphyry made up of an aphanitic ground-mass in which are imbedded crystals of felspar. Whether this porphyry is only a local porphyritic facies of the granitoid gneiss, or whether it is a later intrusion, or even an older formation incorporated with the porphyrite, there is no evidence to determine. For two miles farther to the S. W., the line of contact runs under the waters of the lake, the rocks on one side of the narrow arm being the altered porphyrite of the Kishkutena ridge, and those on the other the Laurentian granitoid gneiss. This gneiss is here often quite devoid of foliation and is then more properly a granite, though both the foliated and non-foliated

Quartz-porphry at contact.

Continuation of the line of contact.

* v. Annual Report, 1885, pp. 38-39 cc.

varieties are part of the same geological mass. After leaving the south side of Kishkutena Lake, the line of contact of the Laurentian and Keewatin rocks continues for five miles in the same S. W. course, and is next intercepted on Little Kishkutena portage one mile south of the 49th parallel. The conditions of contact are here quite analagous to those noted between Night-hawk Lake and Kishkutena Lake. The same ridge of Keewatin rocks composed of hornblende schists and altered traps, schistose or massive, has been traced for six miles farther to the S. W. through the lakes of the Little Kishkutena route to the west end of Off Lake. Here the schists have a strike of 50° and dip to the S. E. at $< 70°$. Throughout this distance the actual contact of the Keewatin rocks on the N. W. side of the ridge with the Laurentian gneisses has not been observed, but there is little doubt but that it follows the same line as to the N. E. of Little Kishkutena, the strike of the rocks and the trend of the country remaining constant. To the west and south-west of Off Lake the country becomes low and flat, with little or no exposure of rock, so that the course of the contact of the Keewatin rocks with the gneisses cannot be accurately determined. The rocky surface of the country passes under the post-glacial deposits of Rainy River valley, and for 16 miles, in the direction of the strike where last observed at Off Lake, we have no evidence as to the distribution of the rocks. The black, green, hornblende schists of the Keewatin are next seen in considerable volume on Rainy River. They crop out along the river from a point about one-quarter of a mile above the Longue Sault Rapids to near the foot of the same, where they appear to be in contact to the south with a rather coarse-grained, reddish, granitoid gneiss, which is exposed on two small islands at the foot of the rapids opposite the chief's house. The strike of the schists along the rapids is with the direction of the river or E. and W., and the dip is northward at angles which are, at places, as low as 45°. In passing northward from the river through the woods on the Indian Reserve, the schists are occasionally observed projecting through the soil, and on the northern limits of the reserve between four and five miles from the river, across the strike of the schists, they are exposed over several acres on the crest of some *roches moutonnées*, and have a strike of 80° with a southerly dip at an angle of 65°.

Contact on Little Kishkutena Portage.

Keewatin rocks on Rainy River.

On a small creek that empties into Rainy River about three miles and a half below the Longue Sault, I am informed by Mr. Cameron, who resides on the river near the place, that there is a small exposure of similar schists, and that on a logging road, which runs four miles back from Rainy River, there are three other exposures of similar rocks.

The next place where I have seen these rocks myself is where they are crossed by Pine River some seven miles west of the exposure

Keewatin rocks on Pine River.

described on the north side of the Longue Sault Reserve. At the first rapids on Pine River, about four miles up from Rainy River, a fine-grained, green, compact, hornblendic rock is exposed with a schistose structure only slightly developed in it. For a mile and a-half farther up Pine River, to the second rapids, there are several exposures of the same rock. From this point, up stream, as far as it is possible to travel, there are no further rock exposures.

Thus combining all the evidence at our disposal regarding the distribution of these Keewatin rocks on the north side of Rainy River, below the Longue Sault, we find that they have an extensive development; and although they are for the most part concealed by post-glacial formations, it appears to be tolerably certain that they have a breadth across their strike of at least eight miles. The main branch of Pine River flows in a W.S.W. direction in a shallow valley which has for its southern boundary a fairly well marked ridge. This ridge, though covered with soil and well rounded, is, I take it, the continuation of the Kishkutena ridge, which makes itself apparent in spite of its mantle of post-glacial formations. It was found at Night-hawk Lake, Kishkutena Lake, and at Little Kishkutena portage, that the line of contact of the Laurentian gneiss and the Keewatin rocks lies in the valley or depression which skirts the Kishkutena ridge on its north-west side, and it seems probable that the conditions which were observed there continue to prevail to the south-west, so that the valley of the main branch of Pine River corresponds with that in which lies Night-hawk, Kishkutena and Little Kishkutena Lakes, and the line of contact of the Laurentian and Keewatin coincides approximately with the course of Pine River from Sec. 36, tp. 3 S., R. XXVI, to Sec. 18, tp. 3 S., R. XXV.

Kishkutena ridge indicates probable line of contact.

West of Pine River, the next exposure of the Keewatin rocks on Rainy River is at the mouth of Rapid River on the American side. The rocks here are not, however, hornblende schists or altered traps, but fine-grained, grey, compact, clastic rocks, such as occur in the upper portion of the Keewatin series. They are distinctly bedded and in places slightly schistose and micaceous, and dip N. W., $< 60°$, the strike corresponding with the course of Rainy River immediately above Rapid River. The only other formations observed on Rainy River, from Rapid River down to the Lake of the Woods, are of post-glacial origin.

Other exposures on Rainy River.

At the mouth of Rainy River and on the south-east shore of the Lake of the Woods, between Hungry Hall and Little Grassy River, we again meet with the Keewatin rocks, although only in isolated exposures, and then much mixed with the Laurentian gneisses. This portion of the lake is unique in running transverse to the strike of

Keewatin and Laurentian rocks on S.E. coast of Lake of the Woods.

the rocks, a circumstance due, probably, to the fact that the shore is made up of rocky points, with sands and other post-glacial matter filling up the intervening hollows. Were the loose deposits removed, we would have, as is the general rule in this region, long, narrow bays or channels occupying their place, and lying between the ridges which terminate on the lake shore in the rocky points above mentioned. On these points and at the mouth of the river, the rocks are found to have a very regular strike of W.N.W. to N.W. and it would seem that to the westward of Pine River they gradually curve around from an E. and W. strike to one having a bearing of W. N. W. and then N.W. This inference is borne out and supported by the fact, that the bed of Rainy River curves around precisely in the way indicated, and the close dependence of the physical features of the country upon the geological structure gives such a fact great significance, where direct evidence as to the structure is wanting. Wherever rock exposures have been noted on Rainy River, the strike has been invariably coincident with the course of the river at the particular place where the rocks crop out, and there is good reason for believing that where they are not so exposed, the course of the river indicates the strike of the underlying rocks.*

Evidence of strike drawn from topography.

At the mouth of Rainy River, on a small island near Michel Morrisseau's house, and on the lighthouse plot, there are exposed rather massive, black, green, crystalline, hornblende schists, which are composed sometimes of hornblende only, and sometimes of hornblende and felspar. These schists strike N.W. Following the shore northward there is no other rock exposure for six miles, when a low point juts out of the sand which is mostly made up of black, green, hornblende schist, striking 100° to 110°, but with considerable biotite gneiss. The latter is often associated with the schist so as to produce a very evenly banded appearance, but here and there the gneiss cuts the schist transversely, as if the gneiss had been injected along the planes of cleavage of the schist and thus produced the banded appearance presented. Half a mile farther along the shore, a similar point is composed entirely of black-green, hornblende schist, strike 110°, dip vertical. On Burton's Island, the rock is a grey, biotite gneiss, strike 100°, and similar rock occupies the small bare islet just to the north-east of it. On the neck of land which runs out from the main shore, about half a-mile to the N.E. of Burton's Island, the rock is a mixture of hornblende schist and biotite gneiss, often presenting a remarkably even ribanded aspect, but still affording sufficient evidence of the intrusive character

Observations on S.E. coast of Lake of the Woods.

Burton's Island

* Dr. Bell observes in his report for 1873-74, on much less evidence than is at my disposal, that "there is reason to believe that under these superficial deposits a broad band of Huronian (Keewatin) rocks crosses the lower section of the river."

of the gneiss. The strike is here 120°, dip vertical or north at very high angles. Half a mile farther north, the same mixture of hornblende schist and gneiss is observable, strike 115°. On a small shoal about half-way between Burton's Island and the south end of Bigsby Island, which is strewn with huge angular boulders of gneiss, the rock

Windy Point.

is hornblende schist, strike 155°. On the extremity of Windy Point and on Buzzard Island, as well as the extremity of the point of land which forms Indian Reserve 35 E. the same mixture of hornblende schist and gneiss occurs, the prevailing strike being 145° to 150°, and the dip either vertical or to the north, at angles not less than 75°. On

Little Grassy River.

the shore south of the mouth of the Little Grassy River the rock is biotite gneiss. North of the Indian Reserve 35 E, the only rocks exposed are gneisses.

Thus the trough of Keewatin rocks, one of the confines of which we have traced, with varying degrees of certainty, from the N.E. corner of Sabaskong Bay, and indeed from the extremity of Rabbit Point,* in a sort of a horse-shoe curve, around by the south of

Diffuse character of Keewatin trough on S.E. coast of Lake of the Woods.

Kah-timi-agamak Lake, along the north-west side of the Kishkutena ridge and the south side of the Pine River valley, out to the Lake of the Woods again, appears, as it emerges upon the lake, to be very shallow and diffuse. All that remains apparently of the voluminous series of schists are the bottoms of in-pinched folds, much mixed with the gneiss, in which, in its once soft and plastic state, they appear to have been immersed. To define the limits of the belt in its scattered, diffuse and brecciated condition is not possible, and it only remains to be noted that it is extremely probable that the belt, which has been traced, as above indicated, for five-sixths of a complete circuit, once closed upon itself, before excessive denudation removed the other sixth whose place is now occupied by the waters of the Lake of the Woods between Rabbit Point and Windy Point.

Limits of Keewatin rocks to the eastward.

Having thus traced out, as closely as field conditions will allow, one of the limiting edges of the Keewatin belt along its line of contact with a great central, more or less circular or elliptical mass of Laurentian gneisses, we may cross the belt at any point and proceed to examine the limits of its distribution to the eastward. We may begin the tracing out of the more easterly edges of the area of the Keewatin rocks in the neighbourhood of Clear-water Lake on the Kishkutena route. Here the belt is narrowest, being not more than three miles wide in a direction transverse to the strike, which is about N.E. and S.W. In crossing the belt, from the granitoid gneiss on the one side to the same rock on the other, we pass over the upturned edges of

Clear-water Lake section.

strata which lie in a sharply folded trough. The rocks on Clear-water

* v. Annual Report, 1885, p. 77, cc.

Lake which occupy the middle of the trough, or the upper portion of the Keewatin series, are very largely volcanic rocks of an acid character, being mostly felsites more or less slaty and schistose, glossy sericitic schists, and felsitic agglomerates (altered quartz-porphyries and their tuffs) with, however, some more basic rocks such as serpentine and agglomerates, or conglomerates (?), in which the matrix is a green, rather massive schist and the inclusions blotch-like masses of felsite. The sides of the trough or basal portions of the series are made up of altered traps and black hornblende schists. On the east side of the trough, portions of the basal formations of the series have been removed by the disturbance associated with the irruption of the great mass of granitoid gneiss with which the belt is in contact, so that the granitoid gneiss comes against the higher formations of the series, or the middle portions of the trough. This mass of Laurentian gneiss on the east side of the Keewatin belt on Clear-water Lake will be found to be the counterpart of the large circular or elliptical mass of Laurentian gneiss described as encompassed by the Keewatin belt from Rabbit Point around by Sabaskong, Kishkutena, and Rainy River to Windy Point on the Lake of the Woods again. In general shape, dimensions and character of rocks composing it, as well as in the nature of their relations to the belt of rocks encompassing them, the two masses or areas are perfectly analagous. I shall, therefore, proceed as before to trace out in such detail as is possible the contact of the edge of the Keewatin belt with this central mass of gneiss, so that there may be no misunderstanding as to the data upon which the mapping is based, nor any confusion between what is observed fact and what conjectural. The most northerly exposure of this contact on the east side of the Clear-water is at the bottom of Sunny Cove three miles and a-half from the north end of the lake. The Keewatin series is represented at the contact by a grey felsite schist with quartz grains (altered quartz-porphyry) which, towards the contact, merges into a fine grained grey gneiss by reason of the development of biotite in plates which lie in the schist planes. The Laurentian gneiss is coarse grained, reddish to gray in color, very quartzose and only very feebly and indistinctly foliated, and in places not at all. The west and south shores of Sunny Cove are occupied by this granitoid gneiss, and also the shore of the lake for nearly half a mile south of the cove to a point directly opposite Hazy Point. South of this the shore is occupied for about one mile by the Keewatin rocks. At the contact opposite Hazy Point an agglomerate made up of a rather massive green schist matrix with blotches like felsitic inclusions comes in contact with the gneiss. This agglomerate, together with a much larger proportion of felsite schists with quartz grains (quartz-porphyries), occupies this mile of

Central schist-encircled area of Laurentian

Contact of Laurentian and Keewatin on Clearwater Lake.

Character of rocks.

shore to the entrance of Gloomy Cove, where the altered quartz porphyries come in contact with the granitoid gneiss, which is here very distinctly foliated in contrast to its more granitoid aspect at Sunny Cove. As before, when the altered quartz-porphyries approach the Laurentian gneiss the alteration becomes more and more pronounced, and they pass into fine grained, gray gneisses by the development of biotite, so that there can be no doubt but that this passage, from a quartz-porphyry to a fine grained gray gneiss, is the result of contact metamorphism, or, more generally, to a metamorphism of disturbance analogous to that which Lehmann states has produced the granulites of Saxony. From the north side of the entrance to Gloomy Cove the shore of the lake and one or two of the off-lying islands are occupied by the Laurentian gneiss, to a point on shore a mile and a-half southward, measured in a straight line. At this point, which is at the mouth of a small stream, half a mile south of Burnt Narrows, the Laurentian gneiss is again observed in contact with the gneissic modification of the altered quartz-porphyries of the Keewatin. On the west side of the lake, less than half a mile from the contact, the Keewatin rocks have been much less affected by the metamorphosing influences of the Laurentian gneiss, and consist of what are ordinarily termed felsite schists (quartz-porphyries), and felsitic agglomerate schists. All along the east side of Clear-water Lake the dip of the schists is to the east or under the Laurentian gneiss at angles varying from 70° to 80°. From the neighbourhood of Burnt Narrows on Clear-water Lake, the trend of the line of contact between Laurentian and Keewatin bends around to the south-east very sharply, in accord with a similar sharp bend in the strata of the eastern portion of the Keewatin belt, and is next seen at a point about five miles and a half distant on the shore of Lake Despair. Here a band of black-green, hornblende schists, the regular basal formation of the Keewatin, comes in between the Laurentian gneiss and the fine grained gray gneisses of the central portions of the Keewatin trough, which are presumably the alteration products of quartz-porphyries. This band of hornblende schists is well exposed on Lake Despair for a distance along the strike of two miles and a-half, and across its entire breadth. Associated with these schists at the bottom of South Bay is a considerable mass of serpentine which will be referred to again. The schists appear to constitute the true basal member of the Keewatin series. The Laurentian rocks with which they are in contact to the north-east are for the most part coarse-grained, reddish to gray, hornblende syenite gneisses, with a sparing amount of quartz and biotite, the latter often appearing to be merely an alteration product of the hornblende. The gneissic foliation is quite distinct. The dip of the schists is uniformly to the north-

Alteration of quartz-porphyry schists to gneisses near the contact of the Laurentian gneiss.

Dip of the Keewatin rocks under the Laurentian gneiss.

Bend in the trend of the rocks.

Hornblende schists on Lake Despair.

Serpentine in middle of the band.

east, or under the Laurentian gneisses, at angles varying from 60° or 65° to 70° or 75°, and the planes of foliation of the Laurentian gneiss are approximately in the same position. In its north-westward prolongation, this band of hornblende schists appears to thin out and disappear at the present surface, since they do not occur, as has been noted, at the contact of the Laurentian with the Keewatin observable near Burnt Narrows on Clear-water Lake. This thinning out is probably not due so much to an original lenticular deposition as to removal by absorption or displacement, incident to the irruption in a state of fusion of so large a mass of granitoid gneiss. With regard to the question of removal by absorption, it is interesting to note that the Laurentian granitoid gneiss on Clearwater Lake, where it comes in contact with the acid altered quartz-porphyries, is a quartzose, biotite granite gneiss, whereas, on the other hand, where it comes in contact with the more basic, hornblende schists on Lake Despair it is a hornblende syenite with, for the most part, only a small proportion of quartz. The occasional occurrence, in certain portions of the gneiss on Lake Despair of a large proportion of quartz, such as would constitute it a granite gneiss, seems indicative of an imperfect mixture.

Thinning out of schists, and its probable explanation.

On the shores of South Bay of Lake Despair, this band of hornblende schists has a breadth across the strike of at least half a mile. In its southward prolongation from this point the band appears to curve around to the south-west, and to strike in the direction of Rainy River, in the neighbourhood of the Longue Sault, where the schists are next seen in considerable volume as already noted. In the interval between the South Bay of Lake Despair and Rainy River, however, the country is mostly covered by post-glacial deposits, and the continuity of the rocks cannot be traced.

Continuation of hornblende-schists of Lake Despair.

North-eastward from the middle of the east side of Clear-water Lake the actual contact of the Keewatin and Laurentian has not been traced out for several miles. The distribution of the rocks on either side of it has, however, been established so well that the line can be mapped with approximate precision. The west side of the north end of Clear-water Lake and all the shores of First Quill Lake, Narrow Lake, Link Lake, and Pipe-stone Lake, are occupied by Keewatin rocks which are mostly altered traps and hornblende schists. A long ridge of these schists runs down the S. E. side of Pipestone Lake with a strike of N.-E. and S.W. This ridge is crossed at two places by depressions through which waters from the south flow into Pipestone Lake, and at each of these places the contact can be accurately located. The first of these is at Stone-dam rapids where Stone-dam Lake empties into a bay of Pipestone Lake. A short distance above the rapids the schists give place to a rather coarse-grained hornblende-syenite gneiss. This gneiss

Line of contact to the N.E. of Clearwater Lake.

Contact on Stonedam Lake.

is observable, with variations in composition, such as addition of a little quartz occasionally, or the presence of more biotite than usual, in continuous exposure for over twelve miles on Stone-dam Lake, Loon Lake and Jack-fish Lake to its extreme S.W. end. The line of contact between the Keewatin rocks and the Laurentian must lie between this line of exposure and the exposures of the Keewatin rocks on Clearwater, Pipe-stone and intervening lakes. The line of contact is assumed, as is generally the case where clearly observable, to be parallel to the strike of the Keewatin schists. A line drawn, therefore, from the point of contact on Clearwater Lake to that at Stone-dam rapids, parallel to the strike of the schists on Pipe-stone Lake, must be approximately the line of contact which we are endeavouring to trace out.

Contact on Creek flowing into Pipestone Lake.

The second place at which the ridge of the Keewatin schists on the south-east side of Pipestone Lake is crossed, is a little over a mile eastward of Stone-dam rapids where a small creek flows in from the south, and the point of contact is in the projection of the line just sketched, the strike of the rocks being 85°.

Line of contact skirting north shore of Kaiarskons Lake.

About four miles to the eastward, Kaiarskons Lake affords easy access to the rocks, and the line of contact of the Keewatin hornblende schists and the Laurentian gneiss is found to skirt the northern edge of the lake and to be observable at a number of points, some of which are good exposures. The first of these is at the N.W. corner of Kaiarskons Lake where a small creek flows in from the north. The Keewatin series is represented as usual by a black, glistening hornblende schist. The schists are peculiar in having imbedded in them large crystals or nodules of white altered felspar, which cause them to resemble closely the basal formation of the same series where in contact with the Laurentian gneiss on the north side of White-fish Bay, Lake of the Woods. The Laurentian gneiss is a coarse-grained hornblende-syenite of gray color. The gneiss traverses the hornblende schists in different directions, but most commonly in the direction of the planes of fission. Angular fragments of the schist are also contained in the gneiss. The general strike of both schist and gneiss is about E. and W. The Keewatin rocks extend away to the north, and the Laurentian gneisses have an extensive areal exposure to the southward.

Gneiss traversing hornblende-schists and including angular fragments of the same.

Conditions of contact farther east on Kaiarskons Lake.

Two miles farther east, in the same line, the contact is again observable on both sides of the narrows of the north arm of the lake. The hornblende schists of the Keewatin, which occupy the country to the north, are seen in direct contact with the coarse syenite gneiss of Kaiarskons Lake on the east side of the narrows. The strike of the schists is about 105°, and the dip south, or under the gneiss, at $< 80°$

The schist is traversed by small irregular dykes of the hornblende syenite gneiss which emanate from the main mass. On the west side of the narrows there appears to have been a partial fusion of the schists with the gneiss, and portions of the former are included in the latter.

About half a mile farther to the east, in the same line, at the east end of the north arm of Kaiarskons Lake, the contact can be very closely located, but not actually observed. The same statement is true of the contact half a mile still further east on the opposite shore. In both these cases the two different rocks are traceable on either side to within a very short distance of the contact, so that its location may be said to be definitely determined.

Interception of line of contact on Manitou canoe route.

Eastward of the point on Kaiarskons Lake where the contact was first noted, the line of contact curves around somewhat to the southward along the north side of the lake. After leaving the lake the line continues apparently in this same curve till it is next intercepted on the Manitou route near Cedar Narrows on Pickerel Lake. Where the line crosses the Narrows, there is very clear evidence of a fault, whereby the rocks on either side have suffered a differential dislocation in a horizontal direction of about 2000 feet, the northward thrust being on the east side, and the southward thrust on the west side of the fault line which runs N.N.E. and S.S.W. On the west side of the lake the contact between the Laurentian hornblende-syenite gneiss and the black-green hornblende schists of the Keewatin can be located within a few yards. On the east side the actual contact is visible just at the narrows. Here the hornblende schists appear to have undergone partial fusion with the syenite, and for a few yards there is a sort of transition between the two distinct types of rocks; and within the hornblende schists, distinctly recognisable as such, there may occasionally be detected large crystals of red felspar, which is quite foreign to these rocks, as if the felspathic magmas had penetrated within the schist and crystallized there in the same large crystals in which they are wont to appear in the coarse gneiss. In the belt of gneiss between this point and Rainy Lake, fragments of the black hornblende schist included in the gneiss are not infrequently met with. The strike of the schists at the contact is about 95°, and the dip at the north at $< 72°$ to 76°.

Fault at Cedar Narrows.

Apparent fusion of schists and gneiss at contact.

Inclusions of hornblende schist in gneiss.

East of Cedar Narrows the line of contact bends slightly to the northward in harmony with the northward trend, which the country to the east of the narrows has received. It is next intersected at a point three miles and a-quarter distant on the shores of the north end of Bat Lake on the Little Canoe River route. Here the Laurentian gneiss, instead of being a hornblende syenite, is a very coarse mica-syenite

Contact on Bat Lake.

with only a subordinate amount of quartz. The line crosses the lake half a mile from the portage at its extreme north end, and can be located very closely, though not with absolute precision on either side of the lake. On the east side of the bay which leads up to the portage the hornblende schists of the Keewatin have a strike of 145°, and dip N.E. at $< 35°$. The country to the north, which is well exposed, is occupied by the Keewatin rocks, while that to the south is Laurentian. It is this known distribution of rocks on either side of the contact line, as well as the knowledge of the precise localities at which it is intersected and observed at irregular intervals, that enables us to trace out, with great certainty, the locus of the contact of the Laurentian and Keewatin across country. The next point of intersection is on the Big Canoe River route near the lower end of Pickwick Lake. Between this point and the last noted on Bat Lake, the line of contact has apparently a N.W. and S.E. course. Just where it crosses Pickwick Lake its course is about due N. and S. and the hornblende schists, whose strike is coincident with this, dip to the E. or away from the Laurentian at angles varying from 65° to 90°. The Laurentian gneiss is a coarse hornblende syenite. The distance from the contact on Bat Lake to that on Pickwick Lake is seven miles and a-half. But the country to the north and east is accessible and known to be occupied by Keewatin rocks, while that to the south is all Laurentian gneiss, where it has been examined along the canoe routes. On Pickwick Lake the actual contact is concealed by a narrow, marshy bay on the south side of the lake, and by the forest coming down to the water's edge on the south side. The rocks on either side of the line have, however, been traced close up to the contact.

Contact on Pickwick Lake.

Although the course of the line of contact, where it crosses Pickwick Lake, is locally N. and S., the general course, after leaving that lake, appears to be as before, N.W. and S.E., for, at six miles farther on in this direction the contact is again observed at the N.E. end of Big Saw-bill Lake. Here, however, the black-green hornblende schists of the Keewatin are not, as heretofore, in contact with a coarse syenite gneiss, but with a quartzose, biotite gneiss of much finer texture and occasionally very evenly laminated. The strike of the hornblende schists and gneiss at the west end of the portage leading to Otukamamoan Lake is about 170°; a little farther south the line bends around to a north and south curve, skirting the west side of Big Saw-bill Lake.

Contact on Big Saw-bill Lake.

South-eastward of Otukamamoan Lake, the Keewatin trough, one of whose edges we have been tracing, suddenly shallows out; and, although on the west side of the lake, it occupies a breadth of nearly eight miles, it breaks up on the east side of the lake and to the south-eastward of it, into three narrow tongues, so that the broad belt

Shallowing out of Keewatin trough on Otukamamoan Lake.

appears to end abruptly in a sort of trident fork. The two more northerly of these tongues appear to taper out altogether some few miles east of the lake. The most southerly appears to be more continuous. Its south-western edge is the continuation of that which has been noted as in contact with the Laurentian gneiss on Big Saw-bill Lake. This tongue of the Keewatin belt has a breadth, measured from the south end of Big Saw-bill Lake to the south end of Otukamamoan Lake, of between four and five miles. South-eastward from this it tapers very rapidly and crosses Redgut Bay of Rainy Lake at Cliff Narrows in the form of an attenuated syncline a few hundred yards in width. This synclinal trough is but a pinched-in remnant of the basal portion of the Keewatin series. The rocks composing it are much shattered, and the underlying gneiss sends apophyses into it in various directions. Fragments of the hornblende schist also are found imbedded in the gneiss to the north and south of this attenuated phase of the belt, quite profusely. The strike of the rocks at Cliff Narrows is about east and west on the average, though it varies much locally. The dip of the schists is distinctly that of a syncline, being to the north on the south side of the band, and south on the north side at high angles. Traced still south-eastward this attenuated band of the Keewatin rocks appears to expand again and merge into the broad belt of these rocks which occupies the country between Little Turtle Lake and Seine River. In the neighbourhood of Little Turtle Lake, this belt appears to bifurcate; one branch, the smaller, striking off to the N-E. accross the narrows of the lake, and across Heron River and Big Turtle River. Where it crosses the narrows of the lake, it is much mixed with the Laurentian gneiss, which penetrates it in all directions, and which holds, in the neighborhood of the contact, great numbers of fragments of the schist which are generally quite angular.

Continuation of belt across Redgut Bay

Fragments of schist imbedded in gneiss.

Keewatin belt on Little Turtle Lake.

The northern edge of the other branch, the Seine River belt of the Keewatin rocks, skirts the the south shore of Little Turtle Lake, that entire shore with the exception of two miles of syenitic gneiss about the middle of the lake, being occupied by green schists. At the east end of the lake and on the north side of the lake between the Big and Little Turtle rivers, there is a band of mica-schists and fine-grained, evenly laminated gneisses between these green schists of the Keewatin and the granitoid Laurentian gneiss. These beds have a thickness of perhaps 2000 feet, and are analogous, both in petrographical characters and in geological position, to the rocks of the Coutchiching series, so voluminously developed on the south side of Rainy Lake, which they seem here to represent. Both the Coutchiching and Keewatin rocks have, at the east end of Little Turtle Lake, a common east-and-west strike, and a dip to the northward under the Laurentian

Seine River belt of Keewatin rocks

Coutchiching series.

Dip of schists under Laurentian gneiss.

gneiss of from 45° to 80°. The schists which skirt the north shore of the lake between the Big and Little Turtle rivers are much traversed by a salmon tinted rock, which has the characters of a felsite or quartz-porphyry. This rock cuts the schists in different directions, but mostly along the planes of fission. In places this quartz-porphyry assumes a distinctly crystalline aspect and shows a gneissic arrangement of the minerals. These characters become more pronounced as the Laurentian gneiss is approached, and it finally appears to merge into the latter rock, the gradation being quite analogous to that often observable at the periphery of a granite boss where the apophyses from the main mass, having cooled more rapidly, appear as fine textured porphyries.

Resuming again the inquiry as to the position of the edge of the Keewatin belt as it bends around at the west end of Little Turtle Lake and strikes to the W.S.W., we find that the actual contact of the basal beds with lower rocks is not easily observable for about ten miles till it appears on the north shore of Swell Bay on Rainy Lake. The mapping of the line of contact, for this interval, depends on indirect evidence. This consists of the known distribution of the Laurentian gneiss and Coutchiching schists on the shores of Redgut Bay and on Little Otter-tail Lake on the one side, and on the other, the known distribution of the Keewatin rocks on Bad Vermilion Lake, Seine River, Seine Bay and Swell Bay.

Evidence for mapping line of contact where it is not actually traced.

Keewatin trough on Rainy Lake flanked by the schists of the Coutchiching series.

The Keewatin trough, from its northern edge on Swell Bay, one mile east of the Bear's Passage, to its southern edge on the first bay of the Seine River and north of Halleluiah Point, has a breadth of about five miles. This trough is flanked on either side by the rocks of the Coutchiching series, which dip under it, forming the floor upon which the Keewatin rocks rest, and lying between the latter and the still deeper Laurentian gneisses. At the contact of the two series on Swell Bay, one mile east of the Bear's Passage the mica-schists of the Coutchiching and the green hornblende and chloritic schists of the Keewatin have a common dip of from 60° to 75° E. 15° S., and there is no evidence of an unconformity between the two series, only a marked contrast in their petrographical characters, which is persistent throughout the series. The same contact, it may be mentioned, is also observable three-quarters of a mile to the N.N.E. at the bottom of an inlet of Redgut Bay, where the direction of the common dip is 10° more to the south.

Contact of Coutchiching and Keewatin on Swell Bay.

On the south edge of the trough the contact of the basal portion of the Keewatin series, with the upper beds of the Coutchiching, is approximately observable, as already mentioned, at two places, viz.: on the shores of the first bay of the Seine River and again to the north of Halleluiah Point. At both places, the immediate contact is concealed,

but the exposed rocks on either side are only about 100 yards apart. On Seine River the lower series is represented by mica-shists and the upper by soft-green hornblendic and chloritic schists, overlaid by a thick bedded formation of scarcely schistose altered trap. The schists of the two series have a common strike of about 75° to 85°. Farther up stream the contact between the two series can be traced at a number of points, and it appears to adhere very closely to the direction of the river. The Coutchiching schists occupy the south side of the river east of Kettle Point, and the south side of the east end of Grassy Lake, while the Keewatin rocks are on the north side. The contact is crossed on the Rat River portage and farther east it runs through the middle of Wild Potatoe Lake, the Keewatin schists occupying the north shore, and the Coutchiching the south. The same is true of Partridge Crop Lake. In all of these cases the structural planes of the Keewatin rocks are parallel to those of the Coutchiching, and so far as this is indicative of conformity, the two series are conformable. But as will be pointed out in another place there are other weighty facts which indicate an unconformable relationship. The dip of the Coutchiching rocks near the contact is to the north, under the Keewatin or quite vertical. This vertical attitude is, however, only assumed in close proximity to the Keewatin trough, for, a short distance to the south, the Coutchiching rocks dip northward at low angles, and only plunge down vertically on approaching the Keewatin trough, the superincumbence of which is undoubtedly the cause of the higher angle of dip. At the contact between Halleluiah Point and Seine Bay, there are apparently no green schists of the Keewatin series between its massive altered traps and the mica-schists of the Coutchiching.

Contact of Coutchiching and Keewatin on Seine River.

Vertical attitude of Coutchiching rocks as they plunge under the Keewatin.

From the vicinity of the mouth of Seine River and Swell Bay the trough of Keewatin rocks can be traced very distinctly, in a W.S.W. direction across Rainy Lake, for a distance of about eighteen miles in a gradually tapering belt, flanked on either side by the schists of the Coutchiching series. All the islands of the lake have rocky shores and, as a glance at the map will shew, a study of these shores should afford us very much more abundant data for the mapping of the different formations than can ordinarily be obtained inland.

Course of Keewatin trough through Rainy Lake.

Along the northern edge of the trough, from the north side of Swell Bay, the contact of the green hornblendic and chloritic schists of the Keewatin and their associated bedded traps, with the mica-schists of the Coutchiching, has been traced as mapped. It runs across the southern portion of Dude Island, through the middle of Morton, Armot, Sand Point, Angling and Red Pine islands. Red Sucker, Jackfish and Stop islands and Medouganak Point, are occupied by the Coutchiching schists, while Grassy Island and the south and west shores of

Northern edge of trough flanked by schists of Coutchiching.

Rat-root Bay are occupied by the Keewatin schists. Thus the line of division between the two series on the northern side of the Keewatin trough can be mapped with great precision, although considerable portions of it are concealed by the waters of the lake.

Dip of rocks at contact.

Along this line, the dip of the rocks of the two series is the same, and is always at high angles, generally varying between 70° and 90° although occasionally 60°. The dip is very frequently reversed so that the Keewatin rocks dip under the Coutchiching. Thus on Armot Island the dip, although at very high angles, is normal, or south, and the mica-schists of the older series pass under the green schists and traps of the newer. Along the north shore of the eastern part of Sand Point Island the prevailing dip is reversed, or north, so that the newer rocks pass under the older. The dip is also reversed in the vicinity of Medouganak Point where the Keewatin schists pass under the Coutchiching at $< 60°$. For the most part the contact of the two series is one of apparent conformity, and there is even a sort of transition from the one to the other observable in many places where fissile green-hornblendic and chloritic schists are interbedded with more siliceous and micaceous ones. On the north-east end of Red Pine Island, however, a portion of the altered traps of the Keewatin which is associated with the green-schists may be seen breaking through the Coutchiching schists which abut directly upon it.

Basal conglomerate.

On the shores of Rat-root Bay, the basal beds of the Keewatin are pebble conglomerates, of which the paste is a green schist and the pebbles mostly water-worn, rounded or oval pieces of vitreous or saccharoidal quartz. Some of the pebbles are felspathic, and when so, are occasionally foliated. On the south shore of the bay, boulders of granite are observed to form part of this conglomerate, one boulder being at least eighteen inches in diameter and of a roughly rounded shape.

Variation in character of basal hornblende schists of Keewatin.

It is extremely significant that nowhere along this line of contact of the Keewatin with the Coutchiching, do we find at the base of the former series those black, or black-green, eminently crystalline, glistening hornblende schists which are so prevalent at the base of that series wherever it is in immediate contact with the Laurentian gneiss. The intervention of the Coutchiching series between the Laurentian gneiss and the basal beds of the Keewatin enables us to see those beds in their least altered aspects. The eminently crystalline, black glistening aspect of these basal beds, when in contact with the Laurentian gneiss, appears to be a function of their proximity to the gneiss. This view is in harmony with many other facts which point to genetic identity of the Laurentian gneiss and irruptive granite. The rocks of both the Coutchiching and the Keewatin series appear generally to be much more altered or metamorphosed, as the contact with the

Laurentian gneiss is approached than they are in the middle of the troughs, or upper portions of the series. This gradation of alteration is analogous to the gradation in a contact zone of slates around a granite boss; and the inference, supported by many other contact phenomena, and by the almost identical character of the rocks, is that the alteration of the rocks of the Coutchiching and Keewatin series bears the same relation to the gneiss that the alteration of slates of a contact zone bears to a granite boss.

"Contact" and "regional" metamorphism.

There is, indeed, a difference in the scale on which the operation in the two cases has been, so to speak, conducted. The molten gneiss being under and around these troughs of Upper Archæan rocks, and the action long continued by reason of confinement under a superincumbent crust, the resulting metamorphism has been more intense and more general, or *regional*, than in the case of a mere local intrusion of granite through higher portions of the crust. But while the metamorphism has been regional, it has been more intense at the actual contact of the basal portion of the firm crust with underlying magmas than in higher portions of the series of formations, and in this gradation of results we have distinct analogy with "local" or "contact" metamorphism, so called. The conception of the igneous origin of the Lower Archæan or Laurentian and the metamorphic character of the Upper Archæan, thus explains very satisfactorily why the basal beds of the Keewatin, where it rests on the Coutchiching, should not be similar to those same beds when resting on the Laurentian, and why, in the latter case, those beds should appear much more altered than in the former.

Southern edge of Keewatin trough flanked by schists of Coutchiching series.

The southern edge of this Keewatin trough which stretches, as sketched, from the Seine River across Rainy Lake to Rat-root Bay, cannot be traced out so satisfactorily as the northern edge, for the reason that it is mostly concealed by the waters of the lake. At the mouth of Black Bay, however, the line of division between the two series, Keewatin and Coutchiching, can be located with comparative precision; and, as the rocks on Grind-stone, Dry-weed, and numerous other smaller islands between the last of these and Halleluiah Point, are well exposed, the distribution of the rocks of the two series is not a matter of doubt. The south shore of the lake from the west side of the entrance to Black Bay to the bottom of Rat-root Bay is a continuous exposure of Keewatin rocks, and affords a section across the trough diagonal to the strike. In this section it is seen to be flanked on either side by the mica-schists of the Coutchiching series.

Continuation of Keewatin trough on S. side of Rainy River conjectural.

Any attempt to follow up this belt of the Keewatin rocks from Rat-root Bay, W.S.W. in the direction of the strike is baulked by the thick blanket of post-glacial formations which conceals the greater part of

the old rocks, and by the absence of any means of access to the country whereby occasional exposures of them might be noted.

Outcrops of Keewatin rocks on Rainy River.

About twenty-five miles distant, however, in the line of the strike, Keewatin rocks belonging probably to this same belt are observable in two or three small exposures on Rainy River. The first of these I have not seen myself, but I am reliably informed that the Indians quarry pipestone from a small patch of green rock that projects through the soil on the river road just at the bend of the river in tp. 6, S., R. XXVIII. Such pipestone is only found in the Keewatin rocks in this region. Farther down the river, in the next township of the same range, I have observed two exposures of hornblende schists, one on either side of the river, and at some distance from its banks. In both instances the reason of this projection of the rocks above the level of the fresh water deposits which cover the country is the protrusion of a trap dyke. That on the American side affords access to a considerable body of hornblende schists which have a vertical attitude and a strike coincident with the direction of the river at this place. The one on the Canadian side reveals only a few small patches of hornblende schist adhering to the side of the dyke, but still quite sufficient to indicate the character of the country rock through which the dyke has cut.

Laurentian and Coutchiching rocks on Rainy River.

These exposures, limited as they are, give us a very satisfactory clue to the structure of the country if they are considered in connection with other facts. The strike of the belt would appear to curve around to the N.N.W., as is further suggested by the sharp bend of the river. In so bending, the belt curves around an area of Laurentian hornblende syenite gneiss which is exposed on Mr. Singleton's farm, tp. 5 S., R. XXVIII, Sec. 8 and 9. From this syenite gneiss it appears to be separated by a band of fine-grey bedded gneiss which is thus analogous petrographically and in geological position to the Coutchiching series of Rainy Lake, though here apparently the series is very much diminished in volume. The exposure at which this fine-grained grey gneiss is seen, on an island about four miles above the Manitou Rapids, indicates that the rocks, again in harmony with the bend of the river curve around to the west, this time probably around an area of granitoid gneiss on the south side of the river, of which there is an exposure at the foot of the Longue Sault Rapids. If the belt of the Keewatin rocks, which we have been tracing, thus curves around here, as all the evidence at our disposal indicates, it must merge into the expansive belt already noted on the Longue Sault Rapids, in the country to the north of it, and on Pine River.

Probable disposition of the rocks beneath the post-glacial formations.

Thus in following up this belt of Keewatin rocks, and tracing out its inner edge, or line of contact with underlying rocks, we find that it forms a complete circuit. From Lake Despair around to

Rat-root Bay by far the greater part of this circuit has been traced in detail. For the portion that is concealed by the post-glacial deposits of the Rainy River country, such outcrops as can be found, together with the other evidence cited above, all point to its unbroken continuity, by way of the Keewatin area north of the Longue Sault, with the greater portion which has actually been traced out. This circuit embraces a great central area which is made up almost entirely of Laurentian gneiss, between which and the Keewatin rocks of the south part of Rainy Lake, there intervenes, however, a comparatively small area of rocks of the Coutchiching series.

The Keewatin rocks traced in an almost complete circuit embracing a central area of Laurentian.

It now begins to be apparent that a very general areal disposition of the Laurentian gneiss, with reference to the rocks of the upper Archæan, is that of central, circular or oval areas, begirt with a continuous belt of those rocks in the shape of a sharply folded trough.

General relative disposition of Laurentian and upper Archæan rocks.

In the report of 1885, on the Lake of the Woods, one of these areas of gneiss, that comprising the Grande Presqu'ile and White-fish Bay, was described, and the inner edge of the encircling belt of Keewatin rocks defined. In the earlier pages of this report it is shewn that the Laurentian gneiss of Sabaskong Bay and the country to the southward constitutes another of these central areas, also encircled by the Keewatin rocks. And now it has just been indicated that the Laurentian country to the north of Rainy Lake is another, the confines of which as limited by the inner edge of the encircling Keewatin trough have been traced out in detail. There will be frequent occasion to refer to these areas and the most convenient way to do so is by name. The first of these may be called the Obabicon area, from the lake of that name in its central part; the second, the Sabaskong area; and the third, the Stanjikoming area.

Different Laurentian areas named.

The belts of Keewatin rocks which encircle these different areas are all anastomosing or confluent. They form a continuous retiform area, the meshes being occupied by the Laurentian gneiss. At their nodes, or points of confluence, these belts have their greatest width. Elsewhere they are generally narrower, and at times extremely attenuated.

Confluence of encircling belts of Keewatin series.

These three prominent central areas of Laurentian gneiss are not the only ones. If we cross the belt which encircles the Stanjikoming area at its narrowest points, we come upon other schist-encircled areas of gneiss besides the Sabaskong area which lies to the west of it. Some of these cannot be mapped with any degree of precision, on account of the covered character of the country; others extend beyond the limits of the region examined, and can only be partially mapped on the sheets now published. Some of these, however, of subordinate importance, are within the limits of the region mapped. Thus on

Other central or nuclear areas of Laurentian.

Minomin Lake and Lake Despair on the Kishkutena route, there is exposed an area of biotite gneiss of varying texture which is certainly partially and probably wholly surrounded by Keewatin rocks. This area is of comparatively small extent and occupies a position intermediate between the Sabaskong and Stanjikoming areas. It may be referred to as the Minomin area. As has already been noted, evidence was observed of another of these Laurentian areas on the south side of Rainy River in the vicinity of the Longue Sault Rapids, but the country is so covered that it would be hopeless to attempt to determine its extent.

Minomin area.

A course of five miles in a northerly direction from the southern edge of the Keewatin belt, on the north side of Kaiarskons Lake, takes us across the entire width of the belt at this point, at right angles to the strike of the rocks; and we come upon another area of Laurentian rocks. Only the southern portion of this last area comes within the limits of the Rainy Lake sheet. Its contact with the Keewatin rocks has, however, been accurately determined on Harris, Missus and Bluff lakes. The rocks of this Lake Harris area are granites and syenites, in which a gneissic structure is in places almost entirely wanting. The mass is regarded provisionally as the equivalent of the Laurentian gneisses of the Stanjikoming area to the south of the belt. The Keewatin rocks in contact with it are not those of the base of the series, but those of its upper portion, usually observed to occupy the middle of the trough. They are chiefly felsites and felsitic schists, most of which appear to have been quartz-porphyries or their tuffs. The irruptive character of the granite as observed at its contact with those felsites, and felsitic schists is inferred from the dykes or apophyses which ramify from the main mass into the surrounding rocks. When the contact of the granite and schists is observed on the north-west side of Lake Harris about its middle, the schists are much cut by such dykes. From this point, south-westward, the whole of the north-west side of Lake Harris is occupied by granite, while the south and south-east shores are occupied by felsites and felsitic schists, followed to the south-east, across the strike, by felsitic agglomerates. The greater part of the shores in the north-east portion of Missus Lake are granite, while in the south-western portion, the felsitic schists occupy one shore and the agglomerates the other, as mapped. The north shores of the two small lakes to the south-west of Missus Lake are occupied by felsitic schists more or less glossy and sericitic.

Lake Harris area.

Irruptive character of Laurentian.

On Bluff Lake the line of contact between the Laurentian and these same felsites and felsitic schists, crosses the lake about one-third of its length from its outlet, the two rocks being very much mixed along the contact.

Contact on Bluff Lake.

Tuttle Lake area of Laurentian.

If we follow eastward that portion of the Keewatin belt, whose narrowest section is north of Kaiarskons Lake, we find that it rapidly expands and eventually bifurcates into two arms which embrace still another, and apparently very extensive, area of Laurentian gneiss. One of these arms trends to the south-east and bifurcates again in the vicinity of Little Turtle Lake, as has already been described. The other strikes north-east and has been traced, along the shores of the Manitou canoe route, as far as Wabigoon, probably, however, with several lateral ramifications in the interval. The contact of the eastern edge of the Keewatin belt with this Laurentian area which occupies the north-east corner of the Rainy Lake sheet, from the lakes of the Otukamamoan route across to the Big Turtle River, has been fairly well traced within the region mapped. This line crosses Windigons Lake near the north end of the two arms into which it is divided. It next crosses Smooth-rock Lake near its south end. The Keewatin rocks are in both instances black hornblende schists, and the Laurentian coarse granitoid gneiss, which varies in composition from that of a hornblende-syenite or a hornblende-granite to ordinary biotite-granite. From the south end of Smooth-rock Lake, the line of contact has not been closely traced but is known to lie to the west of Kahops-kikamak Lake and Sakwi-té Lake, the shores of both of which are occupied by Laurentian gneiss. The line of contact of the two rocks is next observable on the west side of Otukamamoan Lake, where there is the clearest possible evidence of the rapid thinning out or shallowing of the Keewatin trough and its breaking up into tapering terminal tongues. The disposition of the rocks as mapped on the shores of Otukamamoan Lake has been accurately determined.

Contact of Keewatin belt with this area.

Isolated trough of Keewatin rocks cradled in schists of Coutchiching.

An isolated synclinal trough of the Keewatin schists, cradled, so to speak, in the Coutchiching schists, which are in turn flanked by the Laurentian gneiss, stretches from Gash Point to Redgut Bay, near Grassy Portage. The patch calls for no special description, its relations being the same as the Keewatin elsewhere in the region.

Stratigraphical Relations and Structure of the Rocks of the Keewatin Series—Sections.

Stratigraphical composition of Keewatin series

Having sketched briefly the limits of the distribution of the rocks of the Keewatin series and pointed out their disposition relatively to the underlying rocks, we may now consider the stratigraphical composition of the series. It was found that it is usually disposed in a sharply folded trough sinking down into the gneiss which flanks it on either side. I have selected for discussion a number of lines of section where the whole series so far as represented is exposed. The first of

these sections is that afforded by the shores of Clear-water Lake and the lakes of the Little Kishkutena route. It is represented on the map by the diagramatic section A–B.

Section A-B across Clear-water Lake.

The ridge of altered traps and green schists, which has been traced from Kishkutena Lake south-west to Little Kishkutena Lake, and thence to Off Lake, has a breadth across the strike of a mile and a half on the line of section. On the north-westward edge of the ridge at the contact with the Laurentian gneiss, is the massive porphyritic altered trap described as Sec. 1892, p. 72. Occasionally it is schistose, but for the most part on Little Kishkutena Portage, Box and Burnt lakes, it is difficult to detect either bedding or schistosity. Such schist planes, as are observable, seem to dip to the north-west or under the gneiss at high angles. On Panorama Lake, these massive traps give way to much more schistose greenstones and green hornblende schists. These strike with the long axis of the lake or N.N.E. and the dip of the schists, always at very high angles, is sometimes in one direction and sometimes in another. On the line of section, these green schists and schistose greenstones are seen on the west side of Clear-water Lake to be followed by a comparatively narrow band, somewhat less than one-eighth of a mile across the strike, of felsitic schists with quartz grains (quartz-porphyries). This band, like many others of the same or similar rocks, is non-persistent or lenticular. To the north, both this band and the next succeeding band of agglomerate schists taper off rapidly, and do not appear at all in a parallel section across Narrow Lake from Kishkutena Lake to First-quill Lake, only more or less schistose altered traps and hornblende schists being found in the section, the present surface being doubtless below the line at which may be found, the inpinched remnants of the upper portion of the series. To the southward this band of felsitic schists also thins out rapidly, for on the west side of Cedar Lake the green schists of Panorama Lake are in contact with the next succeeding band of agglomerate schists. These agglomerate schists constitute a wide band, tapering to the north east and expanding to the south-west, which occupies the west side of the wide portion of Clear-water Lake, with the exception of Hazy Point. All the shores of Cedar Lake and of the two small lakes to the south-west of it are occupied by these same agglomerates. The agglomerate is throughout highly felspathic, although in places it is also very largely hornblendic or chloritic. The paste is usually very similar in aspect to the included fragments and often grades into glossy sericitic, felsitic schists, being undoubtedly the ash or tuff of an acid volcanic ejection, the massive phase of which is the quartz-porphyry. The included fragments are usually lenticular where the rock is very schistose as a result of pressure deformation, but often they are quite

Details of section—character of different strata and their distribution.

Agglomerates.

angular, sometimes rounded or boulder-like, but not apparently in this case smooth or water-worn, like the pebbles of true conglomerates found elsewhere in the series. On the line of section, this band of agglomerates has a width three-eighths of a mile. To the north-east it thins out and disappears in less than three miles and a half. To the south or south-westward it expands so that at a distance of three miles, on a section across the south end of Cedar Lake and the south end of the wide portion of Clear-water Lake, where the rocks are well exposed, it has a width of a mile and a half. Two miles still farther to the southward on the shores of Off Lake, the coarse agglomerate character of the rock has wholly disappeared and we have nothing but the paste, the felsitic ash or tuff, minus the included fragments of large size. This pyroclastic, felsitic rock is schistose in varying degree and where coarser-grained, a very distinct gneissic arrangement of the minerals has been induced by pressure, and accompanied by the development of secondary mica. The fragmental origin of the rock is, however, apparent, particularly in microscopic sections.

All these agglomerate schists on the west side of Clear-water Lake, have a strike 30° to 45°, and the dip is either vertical or to the S.E. at angles not less than 75°.

Felsitic schists.

On Hazy Point they are followed to the east by a considerable breadth of felsite and felsitic schists, which evidently thin out to the north, and on the line of section have a breadth of probably less than one-eighth of a mile.

Hornblende schists.

Serpentine.

These schists do not appear at the north end of the wide portion of Clear-water Lake. The agglomerates are here followed by a band of green hornblendic schists which have a strike 25° to 30°, and a vertical dip. Only a small out-crop of these green schists is exposed. They are followed immediately to the east by a band of massive serpentine, which occupies the west side of the lake for a distance of a mile southward from the 49th parallel of latitude. Though not by any means a continuous band this massive serpentine appears to occur with some degree of constancy in the middle portion of the Keewatin trough. On South Bay of Lake Despair a mass of serpentine is found in quite an analogous position to that occupied by the serpentine of Clear-water Lake. They are, probably, the altered remains of olivine rocks which were formed antecedent to the folding of the Keewatin rocks, though irruptive through them. The Clear-water Lake serpentine is flanked on the east by another band of green hornblendic schists and altered traps observable on Pot Island. This appears to thin out to the south and is not visible on the islands or shores of the south part of the lake. It is followed to the east by a coarse, blotchy agglomerate schist, of which the paste is a green hornblendic

Blotchy agglomerate schist.

schist, and the included fragments, masses of a yellowish-white or grey felsitic rock. The lines of demarkation between inclusion and paste in these agglomerates is vague, it being difficult to say where one begins and the other ends. This agglomerate occupies the shore for about a mile north of the entrance to Sunny Cove. Still to the east of this we come upon another band of felsite and felsitic schists about a quarter of a mile in breadth. These schists occupy the north side of Sunny Cove and the south side of the bay, a mile and a-half to the north of it. They also occupy about a mile of the shore between Sunny Cove and Gloomy Cove, and are observed again on both shores of the lower part of Clear-water Lake, south of the Narrows. To the east they are in contact with the Laurentian gneisses of the Stanjikoming area; and we have thus completed the section across the belt. The full complement of bands of rocks necessary to fill out the structure of the ideal trough is lacking along the line of section. The basal member of the series is not present on the east side. To the north-east of Clear-water Lake it is present in considerable volume, and also to the south-east, where the belt curves across to Lake Despair. The absence of the basal hornblende schists and altered traps is not to be ascribed to their primitive non-existence, but more probably to their removal by the disturbances which brought the granitoid gneiss in contact with the Keewatin rocks in their present folded state. One of the means of removal in the process of such disturbance, would be absorption by fusion, but to what extent the agency has been at play, would be difficult to say. There are not wanting evidences that it has played a very important part.

Felsite schists.

Incompleteness of section.

From what has been said of the section across Clear-water Lake, it is apparent that on account of the very marked lenticular character of some of the formations, particularly the agglomerates and felsitic schists, that no two parallel sections would exactly correspond. The agglomerates and felsites, though separable petrographically, so wedge themselves one within the other, that they must be regarded here as forming together a single geological formation; an intimate genetical relationship being indicated by their petrographical characters.

Lenticular character of formations.

If thus regarded, the actual surface section, which I have described as nearly as it can be ascertained, will bear the simple interpretation shewn in the colored diagramatic section A-B, viz., that of a trough composed of a twice-folded series of two members, a lower or basal one made up of altered traps and green hornblendic schists, and an upper made up of felsitic schists (quartz-porphyries and their tuffs) and agglomerates.

Interpretation of section.

The second line of section selected, C-D, is one drawn northward from a point north of Kishkutena Lake across Kahtimiagamak Lake and the south-east end of Crow Lake. The section does not take in

Section C-D. across Kahtimiagamak Lake to Crow Lake.

more than probably half of the breadth of the Keewatin belt. In its main features it is very analogous to the Clearwater Lake section. It is interesting chiefly as shewing the great width across the strike of the component bands of the belt. Thus the mapping of the band, which comprises the basal member of the Keewatin series, as inferred from the exposures on Kahtimiagmak Creek and Lake, Night-hawk Lake, the south shore of Crow Lake and the west side of Pipestone Lake gives it a breadth of very little less than five miles, the schists being all in a vertical or nearly vertical attitude. The bedding, wherever it can be detected, as it frequently can, is also in vertical attitude. If we take into consideration, however, the enormous jamming together which the rocks have undergone, we can easily imagine as a result the complete parallelism of all the structural planes, affording a false appearance of a continuous section at right angles to the planes of deposition. Hence, it does not seem safe to infer much from the five-mile section of altered traps and green schists as to the original normal thickness of this member of the Keewatin series. It is evident, however, that such thickness must have been enormous. On Kahtimiagamak Lake, moreover, massive or only slightly schistose altered traps in which bedding can be detected only with much uncertainty, preponderate very much over the more distinctly bedded schists; and it is questionable whether these rocks, which shew little or no schistosity, and which occur in great masses, ever have been up-tilted so as to afford a section across their edges. Associated with the green hornblendic schists on Kahtimiagamak, are a few attenuated lenses of agglomerate schist and of greenish-grey felsitic schist with clear quartz grains. These beds are too small to permit of mapping on the scale adopted, but their intercalation with the various beds of green schists, and the bedding of the latter themselves, show that the rocks are in a vertical attitude. But the pressure which would effect the up-tilting of these beds might be inadequate when brought to bear upon a great mass or thick lens of tough crystalline diabase; and the more thinly bedded rocks might be simply crushed into vertical attitude against such mass. Considerations such as these render it unsafe to advance any figures for the thickness of these green schists and traps, based on the measurement of such a section.

Attitude of rocks.

Enormous thickness of basal portion of Keewatin series

True thickness cannot be safely inferred.

This band is followed to the north on the shores of Crow Lake by a wide band of bedded felsites, and felspathic grau-wackes with other clastic rocks, among which there appear some quartzites. The rocks composing this band are continuously exposed on the south shore of Crow Lake in a line oblique to the strike from Patch Island to a point within a mile and a half of the extreme east end of the lake. The rocks along this line of exposure have a general strike of 90° to 110°,

Beds of felsites, grau-wackes, quartzites.

and a prevailing dip to the northward at angles nowhere less than 75°. From the evenly bedded and quite uncrumpled condition in which the rocks are here observed, I am persuaded that there is no duplication in the section, and that the width of the band, corrected for the dip, gives the actual thickness of the formation. The width of the band, as near as can be estimated on the line of section, is about two miles, and a small deduction from this to correct the angle of dip gives us as the thickness of this member of the series 10,200, or say, 10,000 feet. To the westward, in the vicinity of Patch Island, this band appears to thin out very rapidly, and to give way to the agglomerates which occupy Chase Point and the adjacent islands. To the eastward on the shores of Schist Lake and the northwest end of Pipestone Lake, the felsites and grey-wackes which constitute the band on Crow Lake are thickly intercalated with formations of soft, very fissile, greenish grey, more or less glossy schists, which as they do not appear at all on Crow Lake must be presumed to thin out rapidly in that direction as lenses. Some of these very fissile schists are quite nacreous and are apparently only more schistose phases of altered quartz-porphyries and their tuffs, while others are associated with their local beds of pebble conglomerate, and are in places charged with dolomite which, however, appears to be a segregation and not a bedded deposit. Eastward from Schist Lake these finely fissile, grey, glossy schists are very persistent, the distinct clastic varieties prevailing. They will be noted in succeeding sections.

Thickness of band.

Other intercalated rocks in same band.

On the line of section C–D the band of felsites, felspathic grey-wackes and quartzites is followed to the north by a broad band of coarse, well characterized felspathic agglomerates. The greater part of the basin of the south arm of Crow Lake appears to have been excavated in this band of agglomerates. The extreme west end of the lake affords a splendid section across the whole width of the band. Its width here, transverse to the strike, is two miles and a half in continuous exposure. Westward along the basin of the lake the same rocks are well exposed on Shanty Point, Chase Point and Line Point as well as on the numerous islands between the north and south shores of this arm of the lake. In its eastward prolongation this band appears to thin out and give way very largely to the felsites and grey-wackes which prevail on the shores of Yoke and Buff lakes. These agglomerates as seen on Crow Lake are mostly of a light greenish yellow or grey color. They are usually schistose, with the inclusions of lenticular shape all lying with their greater planes parallel. Not infrequently, however, no schistose structure has been developed in the rock and the inclusions are not at all lenticular, but sharply angular. Instances of the latter variety are prominent on the Boulder Portage where the paste is a non-schistose,

Agglomerates of Crow Lake.

greenish-grey fragmental rock (pyroclastic) of rather fine grain, and the inclusions are sharply angular blocks of a light greenish yellow or dirty white felsite.

Thickness of agglomerates.

What relationship exists between the present breadth of the band, viz: two miles and a half in a direction transverse to the strike of rocks in a nearly vertical attitude, and the original normal thickness of the formation is uncertain. But to me it seems difficult to avoid the conclusion that this measurement, enormous as it is, represents approximately the actual thickness of the formation.

Gabbro.

This band of agglomerates is followed to the north on the line of section by a mass, the extent of which is yet only partially known of a coarse gabbro which crops out at intervals behind the agglomerates on the north shore of this arm of the lake for a distance of about four miles. This gabbro appears to have been irruptive through the agglomerates, but probably antecedent to the time of the folding. It is much decomposed, and in places quite altered to serpentine. Two small patches of serpentine which occur farther west, one on Slim Point and one on Line Point, are very probably genetically associated with this gabbro.

The two following sections traverse that portion of the Keewatin belt which is pinched in between the Stanjikoming area of Laurentian gneiss and the Lake Harris area of the same rocks. The complete trough does not appear to be represented, since the rocks of Lake Harris break through the Keewatin in such a way as to bring the gneiss or granite, for it is often devoid of foliation, in contact, not with the base of the Keewatin series, but with its upper portion.

Section E-F. From Kaiarskons Lake to Bluff Lake.

The line of section E–F from the narrows of Kaiarskons Lake to Bluff Lake shows a sequence very analogous in its general features to those revealed by the sections A–B and C–D. At the base of the Keewatin series at the narrows of Kaiarskons Lake, black hornblende schists in nearly vertical attitude, in contact to the south with a broad area of hornblende-syenite gneiss, which at the immediate contact is mixed with the schist. The observed strike of the schists at this point as already noted is a little south of E, and the dip is to the south or under the gneiss at an angle of 80°. Farther north on the shores of Furlonge Lake the schists are green rather than black, and altered traps more or less schistose are prevalent. From the exposure at the north end of Kaiarskons Lake, and on the shores of Furlonge Lake, Pipestone Lake, Sucker Lake and Manitou Lake, all of which are very satisfactory, it is inferred that this band of hornblende schists and other green schists, with their associated altered traps, has a breadth on the line of section of about two miles and a quarter. It is possible that the felsite schists which are represented on Pickerel Lake to the eastward by a broad band, and on Pipestone Lake to the west-

Thickness of hornblende schists.

ward by a very narrow band, may be continuous through the lower end of Furlonge Lake. If so, it must be very meagerly represented, and as I did not observe such rocks, I have mapped the band as discontinuous.

Serpentine—analogous in position to other bosses of serpentine.

A small boss of serpentine occurs in the green schists at the southwest end of Sucker Lake; it is associated with a mottled greyish-white saussurite gabbro. The actual contact of this serpentine and gabbro with the surrounding schists is concealed, but there is little doubt of its irruptive character. With relation to the other rocks of the belt, it occupies a position analogous to the other bosses or patches of serpentine, (and gabbro) already noted on Lake Despair, Clear-water Lake and Crow Lake. These bosses of altered basic, massive rocks have a coarse granular texture when not altered to serpentine, or when so felspathic as to alter to saussurite. They seem to have been irruptive through portions of the Keewatin series prior to their folding, and not improbably represent the cores of vents from which were extravasated the more basic portions of the Keewatin series.

Felsite schists.

Following the green schists and altered traps on Sucker Lake is a narrow band of glossy or nacreous sericitic felsite schists with clear quartz grains (altered quartz-porphyries). This band is doubtless continuous with the more extensive development of the same rocks south of the mouth of Strawberry Creek on Pipestone Lake, and with the band that crops out on the west side of Pickerel Lake just to the south of the granite boss, which there interrupts the strata. The exposure on Sucker Lake is a small one, and from the known occurrence of other rocks on either side of it, the band must be a narrow one where it crosses the lake.

Soft grey fissile schists.

Following this is a band, a mile and a half in breadth, of soft, grey, fissile schists with which are intercalated at least two small subordinate bands of green-chloritic and hornblendic schists. This band is a rather persistent one, the rocks composing it being continuous with the similar rocks already alluded to on Schist Lake and the north part of Pipestone Lake. They are traceable also eastward on Pickerel and Manitou Lakes and on the west side of the latter lake, through to Grant Lake as far as the limits of the region mapped. The rocks composing it are probably mostly altered sediments, silts and clays derived from the erosion of volcanic rocks. The occasional occurrence of beds of pebble conglomerate proves their clastic origin, and other portions of them merge into schists, which are little more than slightly micaceous fissile clay-slates. On Strawberry Lake, these schists are, as near as possible, in a vertical attitude and strike E. and W,

Agglomerate schists.

They are followed, on the north side of Strawberry Lake, by a band of agglomerate schists. At the west end of the lake this band has a

width of half a mile, but apparently thins out before reaching the Yoke Lake portage from Pipestone Lake. To the eastward it is very probably continuous with the band of the same agglomerates so extensively developed on the south side of Harris and Missus Lakes.

At the mouth of the Bluff Lake Creek, and for a mile and a-half to the northward, the only rocks observable on the creek and on the shores of Bluff Lake are rather massive, whitish or yellowish-grey felsite, sometimes pinkish to greenish tinted. This felsite is a distinct agglomerate for a short space on the creek, and seems to constitute a band which is probably continuous with the more voluminous formation of the same agglomerates on the north-east arm of Yoke Lake. At the south end of Bluff Lake, as the contact with the Laurentian rocks is approached, these felsites become more schistose, and by the development of mica along the planes of schistosity assume a gneissic aspect. The Laurentian rocks near the contact are very basic and may, perhaps, be classed with the gabbros. The schists are cut by this gabbro in all directions. Away from the contact along the almost continuous exposures of the shore to the northward, the Laurentian rocks are observed to merge gradually from the basic or gabbro variety into the acid or granite. The gabbro passes first into a hornblende-syenite gneiss of coarse granitoid aspect with, besides the orthoclase, a good deal of triclinic felspar. The quartz appears gradually a little at first, and then more and more, till at the extreme north end of Bluff Lake the rock has the characters of a very quartzose-hornblende granite, very distinctly gneissic in some places, in others much less so, and properly a granite.

Character of Laurentian near contact.

The next section G-H is along a very satisfactory line of exposure extending from the south end of Pickerel Lake along the west side of that lake, across the lower end of Manitou Lake to Missus Lake. The first interesting feature observable on the line of section is the fault of 2000 feet at Cedar Narrows which has already been alluded to (*ante* p. 33).

Section G-H. From Pickerel Lake to Missus Lake.

At the contact with the Laurentian syenite gneiss, the base of the Keewatin is, as usual, represented by a band of black hornblende schists, with a strike nearly E. and W., and a dip to the north of 72° to 76°. The band has a width on the west side of the narrows of a-quarter of a mile transverse to the strike. The fault, with its northward trend on the east side, makes these schists abut squarely upon the Laurentian syenite gneiss which occupies the east side of the narrows. These hornblende schists are followed by a band, one mile in width, of felsite schists (altered quartz-porphyries). The effect of the Cedar Narrows dislocation is still distinctly perceptible since the lower portion of these felsitic schists on the west side of the lake abut directly upon the continuation of the basal hornblende schist band on

Fault.

the east side. This dislocation probably owes its origin to the same disturbance which resulted in the protrusion of the two granite masses on Pickerel Lake, and the larger one to the south of Bat Lake. The dislocation in its north-eastward continuation is probably represented in the present topography by the basin of Manitou Lake which is a long, narrow, deep trough.

Felsites or altered quartz-porphyries.

The band of felsites (altered quartz-porphyries) which occupy both sides of Pickerel Lake to the north of the narrows seems to have the form of a lens whose thickest part is on the line of section. Though having the width of a mile on Pickerel Lake, the rocks comprising it do not appear on Furlonge Lake, three miles to the west, nor on Three Island Lake about one mile to the east. On the west side of the lake the schists have a very uniform strike of 90° to 100°, and a northerly dip of from 75° to 80°. On the east side of the lake the strike is less constant, varying from 80° to 115° with the same northerly dip.

Hornblende schists.

The next rocks met with going north along the line of section are green hornblende schists. These form a narrow band about one-eighth of a mile across, observable on the west side of the lake. The schists strike E. and W. and dip N. $<$ 70°.

Second band of felsites.

These are followed by another band, half a mile wide, of felsite schists precisely similar to those of the first band described. This band also is apparently very lenticular. It does not appear on the shores of the lakes to the east of Pickerel Lake, and if it is continuous to the westward, as I suppose, as far as Sucker Lake, it has, at the latter place, a very limited breadth. This band is interrupted on both sides of Pickerel Lake by two distinct bosses of granite. That on the west side is shewn on the line of section G-H. Its exposed extent on the shore of the lake is about one mile. The boss of similar granite on the east side of the lake has its area better defined. Its greatest diameter is about one mile and a-quarter.

Granite bosses of Pickerel Lake.

Clastic rocks.

To the north of these granite bosses on Pickerel Lake is a broad band of clastic rocks, which occupy the shores of the north end of Pickerel Lake, and the lower end of Manitou Lake. This band has a known width of over a mile, and, according to estimates based on the disposition of the rocks on Strawberry Lake, Grant Lake and Missus Lake, its full breadth is placed at about two miles. At the north end of Pickerel Lake, the rocks are fine-grained grau-wackes or grits of dark color. Farther north, towards the rapids between Manitou Lake and Pickerel Lake, these become finer grained and pass into schists at the rapids, which are scarcely distinguishable from bluish clay-slates, though they are somewhat micaceous and distinctly schistose. The schists have a strike varying from 80° to 115°. The dip is either vertical or to the northward at high angles as far as the south shore of

Manitou Lake. On the north side of Manitou Lake, at the lower end, the dip is southward at angles varying from 70° to 90°, and the rocks here are less of the character of clay slates or grey-wackes and more of the character of greenish-grey ash beds with some thin beds of felsite schists, nacreous and glossy, and an abundance of soft, glossy, grey, fissile schists. The latter are, as has been shewn, abundantly represented to the westward on Strawberry Lake and Sucker Lake on the line of section E-F, and the same band appears to be persistent up through Grant Lake.

Agglomerate schists.

The next band of rocks which the line of section intersects is that of the felsitic agglomerate schists so voluminous on Lake Harris. At the north-east end of the latter lake, and at the middle part these agglomerates have a width transverse to the strike, of over a mile. They are well exposed on the south side of Missus Lake and appear, apparently much diminished in volume, at the east end of Strawberry Lake.

Felsitic schist.

Between these agglomerates and the Lake Harris Laurentian area is a band of felsitic schist which, on Manitou Lake, has a breadth of not more than a quarter of a mile. The section, as a whole, is remarkable for the comparatively small proportion of hornblende schists and altered traps which it reveals. In its general features, however, it is quite in harmony with the other sections already detailed.

Section I-J. from Smooth-rock Lake to Lake Harris.

The next section, that on the line I-J, crosses the Keewatin trough where it forms a wide belt, striking along the course of Manitou Lake, just before it bifurcates into two portions embracing the Stanjikoming area of Laurentian gneiss. That portion of the section which lies on the N.W. side of Manitou Lake is much better known than that on S.E. side.

Hornblende schists.

The eastern edge of the belt which strikes up Manitou Lake is intercepted at the points mapped on Windigons Lake and on Smooth-rock Lake. At the south end of the latter lake, the hornblende schists have a breadth westward across the strike from their contact with the Laurentian gneiss of over one mile, the rocks being, as usual, in a nearly vertical attitude. Here a mass of granite devoid of foliation projects through the schists. It presents a contrast to the Laurentian gneiss of the northern portion of Smooth-rock Lake in composition as well as in structure, it being a quartzose biotite-granite while the gneiss inclines more to the habitus of a syenite. The mapped area of this granite mass is inferred from its outcrop on Smooth-rock Lake. From the south end of Smooth-rock Lake across to Manitou Lake the rocks have not been actually traced on the line I-J, but their distribution is inferred from the exposures on the shore lines of the neighboring lakes. It is presumed that the hornblende schist surrounds the granite mass above mentioned on the west side as well as on the east.

Granite of Smooth-rock Lake.

Agglomerate schists.

The most interesting feature of the section on the S.E. side of Manitou Lake is the triangular area of agglomerate schists which occupies the middle portion of the trough just at the bifurcation of the belt. These agglomerates are prevailingly of a light yellowish-grey color, being mostly felsitic in composition. They are well exposed on Dog-fly and Vista lakes and on the canoe route between them. The area tapers off in three directions corresponding to the three branches of the Keewatin belt. The north-west corner of the area tapers off to a band which is traceable through to the south-end of Snare Lake to Mirror Bay of Pickerel Lake. The south-east corner tapers rapidly south of Vista Lake, and although exposed on the shores of Twist Lake the trough which it forms is pinched out between the latter and the north shore of Pickwick Lake where the Keewatin rocks are all hornblende schists. To the north-eastward it seems to thin out more gradually, traces of the agglomerates being observed at the north end of Windigons Lake, though not apparently in any well defined band.

Hornblende schists and altered traps of Manitou Lake.

West of the band which is formed by the north-eastward extension of these agglomerates is a band of hornblende schists and altered traps. Though there is little or none of the hard, black, glistening hornblende schist which characterises the Keewatin rocks at the base of the series when in contact with the Laurentian gneiss, this band, so well exposed on Manitou Lake, is very probably a repetition due to folding of the same rocks as those at the east end of the section, which are in contact with the Laurentian gneiss. The more schistose varieties of the rocks of this band are often quite soft and chloritic and there are not wanting local patches of small extent of fissile soft-grey schists. Many of the schists were observed to be charged with carbonate of lime or dolomite, and masses of the latter several yards in extent were observed which are probably segregations. A good deal of this dolomite occurs in the schists on the north-west side of Manitou Lake below Peep Bay, but none of it takes the form of distinct beds. The altered traps are nearly all somewhat schistose. The rocks are all in a nearly vertical attitude.

Felsite schists and agglomerates.

This band is followed to the north-west, on the west side of Manitou Lake, by a broad band which consists for the most part of alternations of grey felsites or glossy felsitic schists and felsitic agglomerates. Associated with these is a subordinate band of fissile, soft, glossy, grey schists and another of green hornblendic schists. The sequence from Paddle portage on the west side of Manitou Lake, to the north-west side of Lake Harris where the Keewatin rocks are in contact with the Lake Harris Laurentian area, is easily made out from the excellent exposures on Grant, Sairy Gamp, and Harris Lakes to be as follows, in a direction more nearly transverse to the strike than the

line of section I-J :—Agglomerate schists, ½ mile; soft, glossy, grey, fissile schists, ¼ mile; agglomerate schists, ⅛ mile; felsitic schists, ½ mile; green hornblende and chloritic schists, ¼ mile or less; agglomerate schists, 1¼ mile; felsitic schists, ¾ mile; Laurentian gneiss (or granite), indefinite extent. The measurements are, of course, approximate, but the sequence in about these proportions is undoubted; and, as the rocks are in a vertical attitude, or dipping at angles rarely less than 80°, the section appears to represent approximately the actual thickness of this part of the series, and indeed it is probably less than the original thickness by the deformation due to pressure. The rocks of the Lake Harris portion of the Keewatin trough are stratigraphically doubtless a repetition of the agglomerates of Dog-fly and Vista Lakes, since the felsites are so intimately associated with the agglomerates, and resemble them so much in composition, that they may be regarded for stratigraphical purposes as making up one geological formation. The structure of the trough is apparently that of a double fold, such as is suggested by the colored diagramatic section I-J., the basal portion of the series at the N. W. end of the section being wanting. The section thus interpreted gives a thickness for the series of probably five miles.

Further sequence of strata on section line I-J.

Thickness of Keewatin series

The line of section K-L crosses the Seine River belt of the Keewatin rocks at a peculiarily interesting locality. We meet here, for the first time, the rocks of the Coutchiching series between the Laurentian gneisses and the Keewatin rocks, forming the floor of the trough upon which the latter rest. From the south side of the Seine River, the whole of the country to the southward as far as Namakan Lake is occupied by the Coutchiching rocks. On the north side of the south-east part of Rainy Lake, these rocks dip at low angles to the northward under the Keewatin. As the Keewatin trough is approached, however, the underlying Coutchiching beds assume gradually a more vertical attitude, and close to the contact, plunge almost vertically under the basal beds of the geologically higher series. Those basal beds are on Grassy Lake, fissile, soft, green chloritic and hornblendic schists, the detrital origin of which is established by the fact that on the north side of the lake they constitute the paste of a pebble and boulder conglomerate. The structural planes of the rocks of both the Keewatin and Coutchiching series are parallel at the neighborhood of the contact and present an appearance of conformity. This appearance is, however, only what may be expected in formations that have been so squeezed together, and affords but little evidence as to the question of original conformity or unconformity. The very marked contrast in the lithological characters of the two series is indicative of an abrupt change in the conditions of formation; and the presence

Section K-L.

Coutchiching series.

Pebble conglomerate at base of Keewatin.

Indications of unconformity.

of a basal conglomerate in the upper series, in which the pebbles have very probably been derived from the underlying formation, is also indicative of a geological break, with a period of erosion which is one of the characters of an ordinary geological unconformity. There is an absence at the contact of those very black glistening hornblende schists which so commonly characterise the base of the Keewatin where it is in contact with the Laurentian gneiss. The conglomerate is a much more voluminous formation on the north side of Shoal Lake, a little to the east of the line of section, than on Grassy Lake. A similar conglomerate occurs in an analogous position on the opposite side of the same trough on the shores of Rat-root Bay, Rainy Lake.

Rocks on Bad Vermilion Lake and Little Turtle Lake.

Nearly all the bedded rocks across the belt on the line of section, so far as can be ascertained by the exposures on Bad Vermilion Lake, Little Turtle Lake and the portage between them, are more or less fissile, soft, green, chloritic and hornblendic schists, quite similar to the schists which form the paste of the pebble conglomerate on Grassy and Shoal lakes. Farther westward, altered traps are abundantly intercalated with these fissile schists on the shores of Seine Bay and Swell Bay. On the shores of Little Turtle Lake, at the narrows, where these schists are much mixed with Laurentian gneiss, they appear to have been altered to black, glistening, hard hornblende schists.

Boss of irruptive rocks.

The chief interest attached to the section is not, however, in the bedded formations of the series, but in the irruptive rocks which occupy a boss-like area in the middle of the belt, and cause it to bulge out on either side. In the middle of the belt on the S. W. side of Bad Vermilion Lake, there is exposed a distinct boss of very quartzose medium grained granite. This boss is roughly circular or heart-shaped, its greatest diameter being about three miles and a-quarter.

Very quartzose granite encircled by very basic gabbro.

It is surrounded on all sides by an encircling area or collar of very coarse-grained saussurite gabbro, in which the felspathic constitutent (anorthite) predominates greatly over the pyroxenic constituent (hypersthene?). This encircling area of gabbro is of varying width, and on the south-east side of Bad Vermilion Lake, or to the east of the granite boss, it forms a very considerable triangular area tapering to the eastward. The evidence establishing the relative distribution of the granite and gabbro is very clear, the continuous rock exposures on the shores of Bad Vermilion Lake and the scarcely less satisfactory out-crops on the river of the same name, and on its small lake-like expansions, permit the definition of the granite mass encompassed by gabbro with a more than usual degree of precision. A second much smaller area of granite occurs to the south of this collar of gabbro, between it and the green schists of Seine River. The mutual relations of these two rocks, the one of the extreme acid type and the

other of the extreme basic, and both of an eminently granular, massive, non-foliated structure, are most interesting and suggestive. They do not form an integral part of the Keewatin series, but in their present distribution seem to represent the truncation of an immense boss which protruded through the basal portion of the series. The simplest explanation that suggests itself, and that which is most in harmony with all the facts known in this field, is that this area of massive rocks represents the roots of an immense volcano, of the age of the Keewatin rocks, and that it indicates the vent through which have been extravasated a portion of the volcanic rocks which so largely enter into the composition of the Keewatin series. In this view two very distinct kinds of rock must have come from the same vent, the basic first and the acid last. The gabbro would represent the plutonic facies of the much less coarsely-grained altered traps (diabase and gabbro) which are so abundant in the lower portion of the Keewatin series. The granite would similarly represent the plutonic facies of the felsites, felsitic schists, and felsitic agglomerates (altered quartz-porphyries and their tuffs) which are so characteristic, in this region, of the upper portion of the same series. The extravasation of basic and acid rocks in this sequence is strikingly in harmony with the conceptions of the development of the Archaean crust to which all the other facts of the region point.

An Archæan volcano.

Sequence of extravasation.

Petrography of the Keewatin Series.

Altered Diabase Trap.

The most important of the rocks of the Keewatin, and those which give character to the greater part of the series, are in this region, as on the Lake of the Woods, the bedded traps or greenstones. These rocks are in all cases very much altered from the original condition in which they existed after solidification from their molten state. The influences which have been at work in bringing about this alteration are of two kinds, viz.: (1) those of paramorphic and metasomatic metamorphism, whereby the constituent minerals have their molecular particles re-arranged physically, or their atoms re-arranged chemically, so as to arrive at a state of maximum stability for present normal conditions; and (2) those of dynamic metamorphism, whereby the structure of the rock has been altered by an actual rending and sundering of its parts, associated with the development of new minerals which in part serve as a cement between the broken pieces. The first set of these metamorphic influences is found to have affected all these old traps. The second set, the result of pressure, is found to

Two processes of alteration.

have affected only part of them. Where the pressure metamorphism has been at work, we have, therefore, a combination of both sets of influences. The rending effects of pressure appear to afford the most favorable conditions for metasomatic changes, so that under such a combination of metamorphic agencies, the alteration from the original type is often so extreme that it is not possible to recognise it in the present form of the rock, and it can only be inferred by analogy. When the rock has undergone changes of a purely paramorphic or metasomatic character, scarcely, if at all, affected by pressure, it is usually not difficult, with a knowledge of fresher or younger rocks, and of the changes which their constituent minerals undergo, to arrive at a clear conception of its original form. Thus, among the altered traps of the Keewatin series it is possible to detect two closely allied types of rocks from which the present greenstones must have been derived. These are diabase and gabbro. In their fresh forms these two types are, as is well known, distinguished chiefly by their structural differences, together with an incidental foliated condition of the pyroxene of the gabbro which is not observable in the diabase. These differences are, in the nomenclature of Rosenbusch,* briefly, that in the gabbro both plagioclose and pyroxene are of synchronous generation, and consequently of allotriomorphic form, and the structure granular as in granites; while in the diabase, the plagioclase is of earlier generation than the pyroxene, and is of idiomorphic form, while the pyroxene is allotriomorphic, or at least hypidiomorphic; and the structure of the rock tends to the porphyritic. Now, when the rock has been subjected to simple paramorphic or metasomatic changes, even to an extreme degree, these structural differences are not obliterated, although the felspars may be entirely changed to saussurite, or replaced by calcite and quartz. In the one case, the characteristic idiomorphic form of the felspar still remains, and in the other the allotriomorphic. Again, although the pyroxene may be entirely re-placed by its paramorph hornblende, or even by chlorite, the relations in form of the secondary mineral to the plagioclase, depend upon the original conditions of crystallization, and are scarcely less distinct than in the case of the fresh minerals. So far as observation has gone on the bedded traps of the Keewatin series it seems to be a general rule that the foliated pyroxene of the rock of the gabbro type has been more resistant to paramorphic incroachment than has the augite of the diabase. A large number of slides have been examined, and in nearly every case where the ophitic or diabase structure was evident, there was no trace of augite remaining; while in the hornblende of rocks of granular structure, cores of diallage were not infrequently observed.

Diabase and gabbro. Distinction between.

To what extent distinctions are retained or obliterated by paramorphic or metasomatic alteration.

* Mikro. Phys. der Massig. Gestein. Stuttgart, 1886.

If we pass now to those rocks in which, in addition to paramorphic and metasomatic changes, there are evidences of crushing and stretching, where, besides the breaking and sundering of the crystals, those changes have proceeded much more actively than in less disturbed rocks, the difficulty of assigning a rock to a particular original massive type, or of asserting, with confidence, that it ever was a massive rock crystallized from a magma, becomes greater and increases proportionately to the violence of the crushing action. When the comminution of the rock has proceeded so far that the original structure is quite obliterated, the only grounds for asserting that the rock is an altered trap is that of analogy established by the study of gradations from rocks whose structure is intact. In extreme cases, however, the aspect of the rock under the microscope is undistinguishable from that of undoubted clastic rocks, such as the paste of certain pebble conglomerates and volcanic agglomerates. This paste would appear, in most cases, to have been originally made up of volcanic débris of the same material as that constituting the original diabase or gabbro rocks with which they are associated. This compacted débris or clastic rock, having been subjected to the same conditions of paramorphic, metasomatic and dynamic metamorphism as the massive rock, naturally presents much the same aspect as the massive rock whose structure has been crushed out of recognition.

Effect of dyamic metamorphism.

Difficulty of distinguishing between originally massive and originally clastic rocks when both have been much crushed.

From these considerations it will be apparent that when we have reached the limit of alteration, which still leaves us grounds for ascribing to a rock a once massive condition, we come upon a class of rocks between these and certain undoubtedly clastic rocks, of which it is impossible, at present, to determine the original condition. The altered traps which are altered only by paramorphic and metasomatic agencies, without the intervention of pressure sufficiently great to produce crushing effects, do not appear in the Keewatin series to be perceptibly schistose, but on the contrary, to have an eminently massive aspect. With the first evidence of crushing, however, as revealed by the microscope, in the sundering of minerals, etc., there is an accompanying development of a schistose structure, observable microscopically, which becomes more and more pronounced in proportion as the yielding of the rock to pressure has been great.

The green rocks of palpably clastic origin, other than agglomerates, appear to be the most fissile and schistose rocks of the series. Hence we have a gradation in schistosity from massive, practically uncrushed traps, through more and more crushed and stretched traps to the fissile condition of the chloritic schists of clastic origin; those of medium degree of schistosity, generally speaking, being those of which it is impossible to say that they were originally massive or clastic.

Degrees of schistosity.

The detailed results of the study under the microscope of the altered traps of the Keewatin series are given in more or less categorical form. The statement of observations, together with the localities, will serve as a record to which reference may be made conveniently in a more comprehensive treatment of the geology of the region. Those schistose rocks which resemble traps, but whose original characters as such, cannot, on account of their extreme alteration, be certainly determined, are considered by themselves.

Rocks on section from Bear's Passage to Seine River.

On the shores of Swell and Seine bays, the rocks of the Keewatin series lie in a sharply folded synclinal trough flanked on either side by the schists of the Coutchiching. A section from the Bear's Passage to the mouth of the Seine River shews this Keewatin trough to be made up very largely of altered traps, massive and schistose, and various kinds of green hornblende and chloritic schists.

A number of the traps crossed in such a section, as observed on the shores of Swell and Seine bays, have been examined, and the results are given first as representative of these rocks in an almost complete section across the Keewatin trough.

Gabbro one mile east of Bear's Passage.

Section No. 1604.—About one mile east of Bear's Passage, Swell Bay. Mottled green and white, massive, crystalline rock.

Under the microscope it presents the characters of a uralitic saussuritic gabbro, the structure being granular rather than ophitic. The felspar is almost entirely altered to zoisite and the pyroxenic constituent to a pale green hornblende, both fibrous and compact, the latter being frequently twinned according to the common law ($\infty P \bar{\infty}$). Leucoxene in irregular brownish-grey grains is the only other prominent mineral present.

Section No. 1606.—Half a mile north of last locality, Swell Bay. Greenish-grey massive rock of rather fine texture. It has a much smaller proportion of felspar than the last, and is made up chiefly of hornblende, in ragged, sheet-like or fibrous masses, with epidote in stout columnar, colorless crystals and in aggregates of grains. A little chlorite, leucoxene, magnetite and secondary quartz are also present.

Secondary enlargement of hornblende crystals.

The compact hornblende of this section occasionally appears in sharply defined crystals, with a fringe of fibrous hornblende of apparently the same optical orientation as the nuclear crystal, the appearance being much the same as that figured by Becke.* The sharp line between the compact hornblende and the fibrous margin of the same orientation sometimes observed recalls the secondary enlargment of hornblende as described by Van Hise.† The original augite of the rock appears to

* Eruptivgest. aus der Gneissformation des Niederösterreichischen, Waldviertels. Min. und Petrog. Mitt. von G. Tschermak, 1883, p. 159, fig. 6.

† Am. Jour. Sci. Sept., 1885.

have been changed within its own limits to compact hornblende which has become enlarged by a fibrous margin subsequently. The only indication of the original augite now remaining is the pale color of the central portions of the hornblende. The fibrous green hornblende is occasionally seen to be developed along the cleavage of the compact lighter colored mineral. The aspect of these enlarged hornblendes is shewn in Fig. 1 drawn with camera lucida from section of an altered diabase (734) from south side of Grassy Island, which is here not further described.

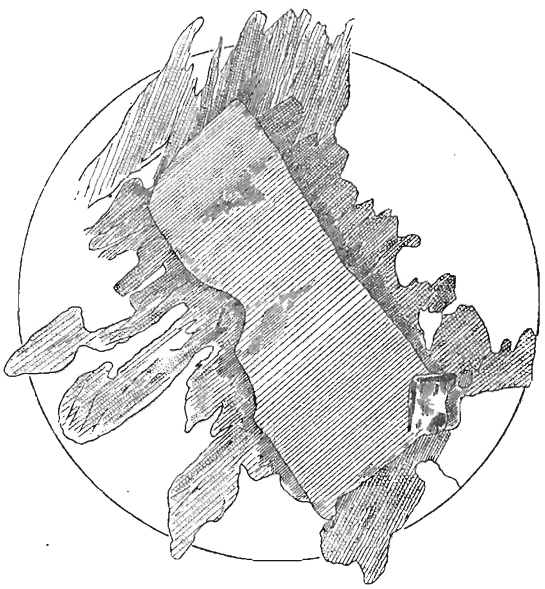


Fig. 1. — Crystal of compact hornblende with light colored central portion, secondarily enlarged by fringe of columnar or fibrous, deep colored hornblende of the same, or approximately the same, optical orientation as the central crystal. From altered diabase of south side of Grassy Island. × 18.

Section No. 1607.—One mile and three-quarters east of the Bear's Passage, Swell Bay. It is more chloritic than 1606, and contains much more magnetite. Epidote, zoisite and leucoxene are common throughout the section.

Section No. 1610.—Two miles and a-half east of the Bear's Passage. Two and a-half miles E. of Bear's Passage.
Light, mottled green, granular, uralitic, saussurite gabbro. The plagioclase is cloudy with decomposition products and is partly altered to saussurite. The twinning traces are not altogether obliterated, and twins of both the albite and baveno types are observable. A large part

of the hornblende is fibrous, though mostly compact, there being no pyroxenic mineral left unchanged. Pleochroic chlorite, in pale-green colors, colorless epidote, leucoxene with cleavage traces of the titanic iron still remaining, and magnetite are present, besides garnet in rounded colorless isotropic grains full of inclusions.

N. E. corner of Swell Bay.

Section No. 1614.—North-east corner of Swell Bay. Moderately coarse greenish-grey crystalline rock. Under the lens or low power of the microscope it exhibits a "flaser," or squeezed and pulled arrangement of the component minerals. The plagioclase is in long, lath-shaped crystals and is usually cloudy with decomposition products. The twinning structure is obliterated in some cases, but quite distinct in others. The hornblende is partially replaced by chlorite and calcite. Besides these, quartz and epidote are present in considerable quantities. Both quartz and calcite occur in mosaics of small interlocking grains, the mosaic areas having a parallel arrangement. The chlorite often appears as a base in which are imbedded grains of calcite and epidote. Leucoxene, with opaque nuclei of titanic iron is abundant. Associated with leucoxene, and apparently of the same secondary origin, are small double-wedge shaped crystals of titanite.

S. E. corner of Swell Bay.

Section No. 1618.—South-east corner of Swell Bay. Light greenish-grey, rather finely crystalline rock. Under the microscope it presents the characters of a uralitic diabase. The felspar is represented only by saussurite, of which zoisite is the most abundant constituent. The hornblende appears in section in ragged plates. Pleochroic chlorite, calcite in occasional large grains, quartz and leucoxene, with sometimes an opaque nucleus, are the less prominent minerals.

S. shore Swell Bay.

Section No. 1621.—South shore Swell Bay, near east end. Rudely schistose, green uralitic diabase. The plagioclase is in fresh crystals lath-shaped and twinned. The augite is still left in a fresh condition, and is seen in hypidiomorphic and allotriomorphic grains, occasionally shewing polysomatic structure. The felspar contains inclusions of acicular actinolite, besides a number of stout little bodies of high refractive index. The secondary minerals are: hornblende and chlorite as alteration products of the augite, which is often entirely replaced by them; quartz in mosaics, with an occasional grain of calcite; calcite in large single grains and in separate mosaics like the quartz; and leucoxene in large grains. Shreds of fibrous hornblende or actinolite derived from the augite are observed to have been developed within the substance of the fresh plagioclase, and along its line of contact with the augite.

Section No. 1622.—Half a mile west of last. Fine-grained green rock, made up of fresh plagioclase, in which both the albite and baveno twinning laws are observed, fibrous hornblende, epidote in large yellow

crystals, quartz in mosaics, large grains of leucoxene with cleavage traces, and a little calcite and iron oxide. The leucoxene is frequently faulted or crumpled by pressure, and chlorite has been developed along the cleavage lines. The felspar is also occasionally bent and broken, and the cracks filled with a cement of secondary hornblende and chlorite.

Section No. 1625.—South side of Swell Bay. A massive green schist. Under the microscope it has the structure of a porphyritic diabase, much altered. In a fine-grained ground mass of felspar, epidote and chlorite are imbedded large lath-shaped crystals of felspar which often

S. shore Swell Bay.

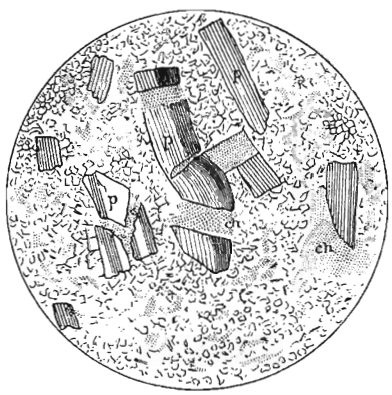


Fig. 2.—Section of altered diabase from Swell Bay, Rainy Lake, shewing bent, broken and sundered crystals of plagioclase (p), the cracks being filled with chlorite (ch). × 44.

shew pressure or rending effects very markedly, the crystals being torn apart and the cracks filled with chlorite (Fig. 2). Quartz occurs in mosaics with which are associated octahedra of secondary magnetite, some of which are surrounded by rims of hornblende. Calcite is present sometimes as a pseudomorph after the porphyritic felspar, but oftener in irregularly scattered grains. Leucoxene is abundant, often with chlorite deposited along the cleavage cracks of the original titanic iron, giving rise to a beautiful series of bars of alternating grey and bright green in ordinary light, or grey and black in polarized light between crossed nicols.

Section No. 57.—Four miles east of Little Rocky Narrows, north shore, Seine Bay. A uralitic diabase, composed of an aggregate of lath-shaped crystals of plagioclase and green uralitic hornblende, the latter greatly predominating. The felspar is largely decomposed and is replaced in part by epidote. Numerous isolated grains of clear quartz are scattered through the section.

Seine Bay.

Section No. 59.—Six miles and a half east of Little Rocky Narrows, north shore of Seine Bay. A porphyritic uralitic diabase in which the ground mass is an aggregate of fresh lath-shaped plagioclase and hornblende. In this are imbedded large crystals of plagioclase, which are partially replaced by epidote and zoisite. Needles of apatite occur in the felspar. Numerous anastomosing veins of epidote traverse the section, throughout which are also scattered in sparing quantities calcite and chlorite.

Rock at mouth of Seine River.

Section No. 2101.—Seine River near the mouth. A medium textured massive green rock. Original character scarcely determinable but presents the aspect of a much altered porphyritic trap. It is made up of a rather non-descript aggregate of plagioclase, chlorite, epidote, quartz in lenses with granular margins, leucoxene with opaque nuclei and calcite. In this base are imbedded large cloudy crystals of felspar.

Porphyritic diabase at base of Keewatin series, Bleak Bay.

Section No. 60.—Base of Keewatin series, Bleak Bay, north side. A massive green rock of fine-grained texture with occasional porphyritic crystals of plagioclase. Under the microscope it presents the aspect of an altered diabase. The plagioclase is in large, rather stout, crystals, sometimes in idiomorphic development, but more frequently hypidiomorphic. The augite occurs in hypidiomorphic crystals almost entirely altered to hornblende and chlorite. Secondary hornblende chlorite and epidote have been developed very extensively along cleavages and cracks of the fresh plagioclase. The accessory minerals are apatite and magnetite, both well crystallized and the latter observed, in some cases, enclosing the former.

The belt of the Keewatin rocks, which may be seen in section between the Bear's Passage and the Seine River, continues westward across Rainy Lake. A few more characteristic specimens of the altered traps from this portion of the belt have been examined.

Berry Island.

Section No. 1537.—North side of Berry Island, Rainy Lake. A medium textured, green, altered diabase with roughly schistose structure, made up of cloudy, lath-shaped plagioclase and irregular but generally elongated crystals of hornblende of a rather pale-green color, quartz, with inclusions of small colorless microlites and epidote are plentiful, the latter most frequently occurring in the hornblende.

Section No. 1538.—North side of Berry Island, half a mile east of last locality. A fine-textured massive green uralitic diabase. The diabase structure is well preserved. Plagioclase in cloudy, slender, well defined, lath-shaped crystals is imbedded in broad plates of hornblende which is partly altered to chlorite. Considerable calcite, secondary quartz, in mosaics, and some leucoxene are present.

Section No. 1539.—Eastern extremity of Berry Island. Finely mottled green and white uralitic diabase, in which the characteristic

diabase structure is less perfectly preserved than in the last. The rock is made up of cloudy plagioclase in rather stout lath-shaped crystals; hornblende, in allotriomorphic development; leucoxene, with cleavage traces of original titanic iron; and a considerable amount of quartz.

Section No. 1549.—South side of Berry Island. A medium-grained dark-green altered trap which in structure partakes partly of the character of a diabase and partly that of a gabbro. The felspar appears in lath-shaped crystals, and in broad irregular tabular masses largely replaced by calcite, quartz, epidote and kaolin. The hornblende also occurs in elongated prisms and in broad masses of irregular shape, giving the section, on the whole, a granular aspect.

Section No. 709.—South side of Rat-root Bay, Rainy Lake. A greenish-grey crystalline rock of medium texture with a rude ill-defined schistose structure. Under the microscope, the structure is seen to have been much affected by pressure and stretching. The hornblende mostly presents a very ragged aspect and is torn asunder with secondary hornblende developed in the cracks. In this torn and parted condition it seems to have been very liable to alter to biotite which accompanies it in considerable quantities. The plagioclase is occasionally seen in long lath-shaped crystals, but for the most part, the diabase

Rock on south shore Rat-root Bay.

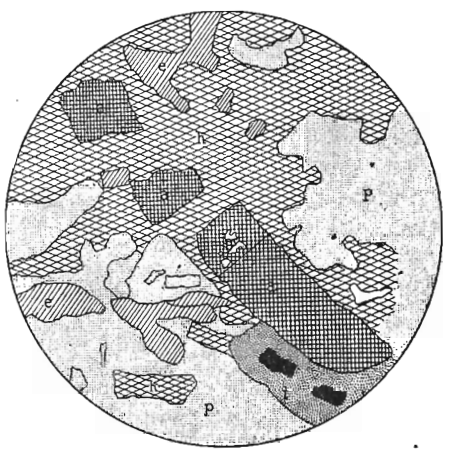


Fig. 3.—Section of altered diabase from Rat-root Bay, Rainy Lake, shewing stretching effects as evidenced by sundered crystal of apatite. × 120.

a, a, a. Apatite—same individual.
h. Secondary hornblende—various individuals.
p. Plagioclase.
l. Leucoxene.
e. Epidote.

Effects of pressure.

structure of the rock has been obliterated by the crushing and stretching to which it has been subjected. The felspar is seen to have been broken, and the smaller fragments, together with decomposition products, such as calcite, epidote, quartz and albite, form a base in which

Fig. 4.—Stretched and sundered crystal of hornblende, with shreds of secondarily developed hornblende, some leucoxene and grains of titanic iron, in altered diabase from Rat-root Bay, Rainy Lake. × 44.

the larger felspars and the more resistant hornblendes appear to be imbedded. Apatite occurs as an original constituent, and shews very well the sundering process which the rock has undergone. Magnetite is present as an associate of the hornblende, and quartz in mosaics and titanic iron with leucoxene are abundant.

Another folded trough of the Keewatin rocks, flanked also on either side by the schists of the Coutchiching series, is well exposed in section on the shores of Rocky Islet Bay. The results of the examination of the altered traps of this belt is now given.

North of Back Point.

Section No. 1493.—Island three-eights of a mile north of Back Point. A coarse-grained, mottled, dark-green and yellowish-white, schistose altered trap. Under the microscope it is made up of large individuals of plagioclase in hypidiomorphic development, beautifully striated, and compact green hornblende, interstitial and enveloping the felspar.

Section No. 1494. Half a mile north of Back Point. Dark-green, fine-grained, altered diabase made up in thin sections of plagioclase in unusually long lath-shaped crystals, and hornblende in broad plates. The plagioclase is often broken; and fragments of plagioclase, original or secondary, quartz, epidote and calcite, make up a fine-grained secondary base.

Rock on island of Rocky Islet Bay.

Section No. 1499. Small island on west side of Rocky Islet Bay. A coarse-grained rock of granitic aspect, composed of lilac-colored felspar, yellow in patches from the presence of epidote, and a green pyroxenic mineral, largely changed to micaceous chlorite. Under the microscope the plagioclase appears in broad plates, sometimes quite fresh, but usually decomposed and altered to epidote and kaolin. The pyroxene is rhombic and slightly pleochroic. When it has escaped alteration to

chlorite, it must be regarded as bronzite or enstatite. Magnetite is present in sparing quantity.

West side of Rocky Islet Bay.

Section No. 1500. West side of Rocky Islet Bay. A medium-grained, mottled, greenish-grey rock with foliated structure. Under the microscope it has the character of an altered gabbro, being made up of a granular aggregate of non-pleochroic foliated pyroxene, with an extinction of over 30° (diallage) and plagioclase. The fresh diallage is not abundant, and it is always partially altered to hornblende and chlorite, while there is an abundance of hornblende which, although it shews no cores of diallage, is doubtless paramorphic after that mineral. The felspar is very largely altered to zoisite, which appears in large patches with rounded areas of unchanged felspar included in it. Epidote is also an alteration product of the felspar, but it is very much less abundant than the zoisite.

Bedded trap north end of Rocky Islet Bay

The following three specimens were taken from the same mass of bedded trap at the north end of Rocky Islet Bay. No. 1503A is from the middle of the bed, 1503C from its contact with adjoining schists, and 1503B from a point intermediate between these.

Middle of bed.

Section No. 1503A. A mottled green and white diorite-like rock of medium texture and granular structure. In this section it appears as an altered gabbro made up of a granular aggregate of diallage, with paramorphic hornblende and plagioclase, with a considerable amount of epidote. The diallage is in large plates of grey color, showing very distinctly the usual parting parallel to $\infty P\bar{\infty}$ upon which the extinction angle is 25° and upward. It is altered to green compact hornblende on its borders, and irregularly shaped plates occur, made up entirely of the hornblende which, however, is light-green to almost colorless in the centre, and deep green towards the periphery. In both diallage and hornblende, minute inclusions occur, arranged parallel to the parting of the one and the cleavage of the other. The plagioclase is cloudy with kaolin, epidote and zoisite. A little biotite, is also observable in the section.

Intermediate part of bed.

Section No. 1503B. Finer grained and darker colored than A. Under the microscope it resembles A, but there is no diallage left, that mineral having been entirely changed to hornblende, which is frequently dusty, with grains of magnetite, usually heaped together in the centre of the crystal, but occasionally in distinct octohedra. Some of the plagioclase is almost opaque with decomposition products, among which epidote is prominent; while other crystals are clear and glassy, and abound in inclusions of straight colorless microlites.

Edge of bed.

Section No. 1503C. A little finer grained than B, but more distinctly crystalline and glistening and of a darker color. The rock is a granular aggregate of hornblende and plagioclase, together with small quan-

tities of quartz, epidote and magnetite. The hornblende, in some basal sections, is seen to have the outline of a perfect prism.

West side Rice Bay.

Section 1519B. Rice Bay Narrows, west side. Medium textured, mottled white and black altered gabbro, composed of a granular aggregate of plagioclase, hornblende and biotite, with some non-striated felspar. The plagioclase is for the most part fresh, being only occasionally cloudy with decomposition products. The hornblende is not so abundant as the plagioclase, and the biotite which accompanies it is apparently secondarily derived from it. In the case of some of the hornblende crystals, undoubted pyroxene can be detected, with brilliant polarization colors and high extinction angle. A few crystals of apatite occur in the hornblende.

Rock at north end of Bear's Passage, Redgut Bay.

Section No. 1561. Island at the north end of the Bear's Passage, Rainy Lake. A medium textured mottled black and white altered trap composed of a granular aggregate of plagioclase hornblende and titanic iron with rims of leucoxene. The felspar is rather decomposed, giving rise to quartz and epidote. It occasionally occurs in lath-shaped crystals, but for the most part, both the felspar and hornblende are allotriomorphic and the structure granular, inclining to the gabbro rather than to the diabase type. This trap rock holds included in it angular fragments of an older rock of finer texture and greener color. A section No. 1561A of one of these inclusions shews it to be made up of a felt work of hornblende, with considerable quartz, and a little plagioclase chlorite, epidote and leucoxene with opaque nuclei. The rock affords little indication of its original structure or mineral composition.

West side of Redgut Bay.

Section 1601A. West side of Redgut Bay, north of the Bear's Passage. A medium textured, black-green, massive, crystalline rock, made up of a granular aggregate of compact green hornblende in large irregular plates, with a little very cloudy interstitial felspar, some water-clear quartz, and fresh non-striated felspar. A little epidote is associated with the cloudy felspar.

Section No. 1601B. Same locality as last, and apparently only a different facies of the same rock, being greyer in color, and more quartzose and epidotic. The hornblende is largely altered to epidote, and the quartz occurs in mosaics of large grains. Grey leucoxene with opaque nuclei is the only other mineral.

Squall Point, Rainy Lake.

Section No. 763. Squall Point, Rainy Lake. A coarse textured uralitic diabase included in gneiss. Under the microscope, the hornblende is in large compact masses, with very frequently a pale green, almost colorless central portion, indicating the earlier form of the mineral as augite, and indeed in some cases traces of the augite itself appear still to remain. Epidote and magnetite are associated with the

hornblende. Plagioclase is in rather stout lath-shaped crystals, somewhat cloudy, but with twinning structure well defined; apatite and quartz are present in sparing quantities.

The following six specimens were taken from the Keewatin belt, as exposed on the shores of Manitou Lake:

Manitou Lake, opposite Snare Bay.

Section No. 1139. West side of Manitou Lake, opposite Snare Bay. A mottled green and white, altered gabbro of medium texture. Seen under the microscope, to be made up of a granular aggregate of diallage and felspar, the latter being almost completely changed to a dense, cloudy, grey mass which, between crossed nicols appears as zoisite. The diallage is partially altered to hornblende. The only other mineral to be noted is leucoxene. Pressure effects are observable only to a very slight extent.

E. side Manitou Lake.

Section No. 1088.—Manitou Lake, east side, about a mile and one-half north-east of Snare Portage. A much altered diabase. The augite is represented now only by chlorite, having first probably passed through the uralitic stage. The plagioclase is nearly all replaced by calcite and chlorite, its long lath-shaped form being, in most cases, all that is left to determine the character of the original mineral. There is a good deal of quartz present, some of which holds needles of apatite as inclusions. Leucoxene occurs in large patches, with black opaque grains scattered through it, and shows pressure effects in being torn asunder. A little pyrite in cubes is also present.

Peep Bay, Manitou Lake.

Section No. 1105.—West side of Peep Bay, Manitou Lake. A rudely schistose green rock, apparently a very much crushed and altered diabase. It is made up of fragments of plagioclase and quartz, imbedded in a base which is largely made up of chlorite and calcite, the former of which shews a tendency to a parallel linear arrangement which determines the schistosity. Both chlorite and calcite fill the interstices between the dislocated felspars, and many of the latter are wholly or partially replaced by secondary quartz, calcite and chlorite. Although the original structure of the rock is obliterated, it appears altogether probable, from the frequent idiomorphic lath-shaped character of the plagioclase or its pseudomorph, that the rock was originally a diabase.

Section No. 1106. West side of Peep Bay, Manitou Lake, half a mile north of last. A light greenish-grey, somewhat mottled, finely crystalline altered diabase. Under the microscope the rock shews abundant evidence of crushing and stretching. The stout, lath-shaped crystals of plagioclase, which are quite fresh, are frequently broken and parted, the cracks being filled in with chlorite, calcite, epidote and quartz. Titanic iron, with associated leucoxene, is abundant, and is, like the felspar, frequently sundered. Irregular masses of chlorite appear to be

all that is left to represent the augite. The lath-shaped folspars are surrounded by the chlorite as they are by augite in fresh diabase. In between these masses of chlorite, crystals of felspar and grains of titanic iron, there is a base made up of a mixture of grains of chlorite, epidote, quartz, calcite and magnetite.

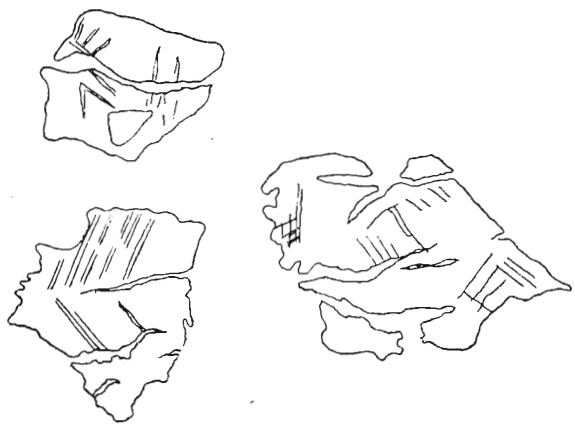


Fig. 5.—Stretched leucoxene in altered diabase from Peep Bay, Manitou Lake. × 44.

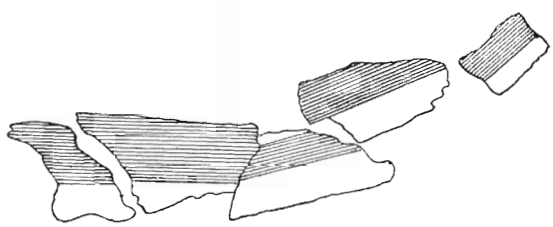


Fig. 6.—Shattered crystal of plagioclase in altered diabase from Peep Bay, Manitou Lake. × 44.

E. side Manitou Lake, opposite Peep Bay.

Section No. 1123.—Manitou Lake, east side, opposite Peep Bay. Greenish-grey, roughly schistose altered trap with an unctuous feel on cleavage surfaces. Under the microscope it presents the appearance of a very much crushed rock. The most prominent constituent is a comparatively fresh plagioclase, which is nearly always broken and appears, in some instances, to have been pulverized to a granular mass which probably, in a partially recrystallized form, mingles with chlorite and calcite, to form a secondary ground mass analogous to the "*Mörtel structur*" of Törnebohm. The augite is represented only by chlorite.

Apatite and titanic iron with leucoxene are present, but not abundant. The structure of the rock is almost obliterated, but it is probably only a cataclastic diabase. A section (1126) of a similar rock from near the same locality as last, which differs from it chiefly in the presence of biotite, is illustrated in Fig. 7, where the tearing apart of the felspars is well shewn.

Fig. 7.—Section of much altered rock from east side of Manitou Lake, shewing sundering of felspar crystals. × 44.

f. Felspar, mostly torn into several pieces.
ch. Chlorite.
b. Biotite.
l. Leucoxene.
gr. Ground-mass, crushed felspar, quartz, calcite, chlorite and muscovite.

Section No. 1117.—West side of Manitou Lake, two miles north-east of Paddle Portage. A fine textured, green, altered diabase, which shews under the microscope the typical diabase structure. Small lath-shaped crystals of quite fresh plagioclase, occasionally bent, but never broken, are surrounded by hornblende which is partially altered to chlorite. Associated with chlorite are epidote, calcite, and pyrite in cubes. W. side Manitou Lake.

The following five specimens are taken from exposures of the same belt as exposed much farther to the east on the shores of Crow Lake, Pipestone Lake and Kishkutena Lake.

Section No. 25.—Extremity of point on Crow Lake, half way between Crow and Wade portages. Uralitic diabase porphyrite (?) shewing a fine-grained ground mass of calcite, epidote, chlorite, hornblende, quartz and leucoxene, in which are imbedded large, rather

S. W. side Crow Lake.

stout, lath-shaped crystals of plagioclase which are often partially replaced by calcite. These felspars are often torn asunder, and the intervening cracks filled with chlorite. The felspars are also frequently surrounded by a deep fringe of chlorite, which is bright green and slightly pleochroic in ordinary light, and deep olive green to opaque between crossed nicols. The fibres or scales of the chlorite are observed to stand perpendicular to the contours of the felspar. Hornblende in large porphyritic crystals, frequently twinned, is as plentiful as the felspar.

S. shore Crow Lake.

Section No. 108.—South shore of Crow Lake opposite Patch Island. A coarse greenish-grey rock, with yellowish-white weathering, appears under the microscope as a uralitic saussurite gabbro, made up of a granular aggregate of hornblende and saussurite, the former predominating and frequently twinned. There is present also considerable grey leucoxene, with sometimes an opaque nucleus of titanic iron, secondary quartz enclosing needles of actinolite and chlorite in veinules. The saussurite is chiefly made up of bright blue polarizing zoisite.

Near Shanty Point, Crow Lake.

Section No. 145.—Bay west of Shanty Point, Crow Lake. A medium textured altered diabase of mottled aspect, due to intermixture of greenish-grey chloritic mineral and greenish-yellow felspar. Under the microscope, the plagioclase is in well defined lath-shaped crystals, very largely changed to saussurite, which renders it cloudy almost to opacity. Interstitial hornblende altered, for the most part, to chlorite, and grains of leucoxene make up the rest of the section.

N. W. side Pipestone Lake.

Section No. 306.—Island off the north-west side of Pipestone Lake. Mottled green and white uralitic saussurite diabase. Under the microscope the lath-shaped plagioclase appears as a cloudy aggregate, which the analyser resolves into albite, zoisite, epidote, muscovite and calcite, constituting the decomposition aggregate known as saussurite. The original pyroxenic constituent is represented now by elongated, often twinned, crystals of hornblende. A little quartz is present, also leucoxene with opaque nuclei.

S. side Kishkutena Lake.

Section No. 1892.—Kishkutena Lake, south side. An altered trap of eminently porphyritic facies. Macroscopically, it appears as a fine-grained ground mass, of green color, in which are imbedded large white sharply defined crystals of felspar, often as much as an inch in diameter. These crystals are sometimes observed to enclose portions of the ground mass. Under the microscope, the ground mass is made up of an aggregate of small grains of felspar, quartz and hornblende. The hornblende is in long prisms and short, more or less granulitic or rounded grains, with which are associated a little calcite. The porphyritic felspars are almost entirely replaced by zoisite, calcite, albite and muscovite, the first named mineral predominating, making up the

saussurite aggregate. A veinule of mosaic quartz and albite traverses the section. The section does not satisfactorily reveal its original character, but there is no doubt of its having been the porphyritic facies of a basic massive rock.

Hornblende Schists.

Evidence of origin of hornblende schists.

In the rocks here considered there is no conclusive evidence as to their original character, whether they were massive or clastic. There is much presumptive evidence in favor of the view that they are partly altered massive rocks and partly altered volcanic ash beds (pyroclastic) but little or none that they are the alteration products of clays or other forms of detrital matter. The changes which these rocks have undergone have been so profound that only occasionally can a trace of their original character be discerned; and we have a new rock in which the constituent minerals have crystallized in situ, and have, since their crystallization, been practically undisturbed by pressure, except to this extent that the pressure was probably constant while secondary crystallization was in process. If dynamical influences were potent in the destruction of the original structure, as we must admit from the conditions of their occurrence, and their association with rocks that afford good evidence of crushing, chemical or metasomatic changes, have since been sufficiently active to have obliterated all or nearly all trace of crushing, and have replaced the crushed aggregate by an assemblage of minerals each of which has been formed under conditions implied by the contemporaneous crystallization of the others.

Diversity in microscopic aspect.

The rocks classed as hornblende schists exhibit within certain narrow limits a considerable diversity in their microscopic aspect. They are, however, for the most part, aggregates of hornblende and quartz, the common accessory minerals being epidote, zoisite and magnetite.

Two phases of first variety of hornblende schists.

In one variety a colorless base of quartz grains, which in section appear as a mosaic, forms a matrix in which are imbedded the hornblende individuals as the predominant constituent. Two fairly distinct phases of structure are observable in this variety, which are manifested particularly in the form and arrangement of the hornblende. In the first of these, the hornblende assumes sheaf-like forms, compact towards the middle, but frayed out into a radiating tuft of a more or less fibrous character at one or both ends of the somewhat elongated individuals, the elongation being, of course, in the direction of the *c* axis. These sheaf-like masses are thrown indiscriminately together so as to form a more or less intricate felt-work. In the second phase of structure the hornblende is uniformly compact, and assumes the form of

single prisms which are either short and oblong in shape, or have the shape of long slender needles or rods. These stout oblong prisms are in parallel alignment. The more slender rods or needles are less strictly so, and may cross each other at small angles and produce a felted aspect in section.

The structural features thus indicated are doubtless a function, both of the original character of the rock and of the conditions under which secondary crystallization has taken place, and although those conditions are not yet understood, it is altogether probable that a careful study of these schists will lead to as satisfactory a conception of the relations between structure and conditions of crystallization as has been established in the case of the massive rocks which have crystallized from magmas.

Two phases of second variety of hornblende schists.

2. In the other variety of these schists, plagioclase is a prominent constituent, and the rock approaches a diorite in composition, and in some cases even in structure. Two general phases of structure may also here be distinguished, viz.: that in which the disposition of the minerals is similar to that of the second phase of the first variety; and that in which the structure is more granular or dioritic.

Geological position of these schists.

The interesting feature of these rocks, when their petrographical characters are considered in connection with their field occurrence, is that they seem to be confined in the district under consideration mostly to the base of the Keewatin series, and then only when that base is in contact with the gneisses of the Laurentian, which shew abundant evidence of having existed beneath them in the state of a liquid or viscid magma, a condition of things which would amply account for their extreme alteration, especially if we consider the magma, which consolidated as the Laurentian gneiss, to have been one of hydrothermal and not necessarily of dry fusion.

Hornblende schist at contact with Laurentian gneiss.

At the contact of the Keewatin and Laurentian, at the south end of Crow Portage, the base of the former is represented by a compact, black glistening schist of freshly crystalline aspect. To the naked eye it appears to be made up of fine black needles of hornblende, all arranged approximately parallel, with an interstitial micro-crystalline greenish-grey material. Under the microscope (48A) the hornblende

Crow Portage.

appears in elongated shreds and patches of bright green color. These hornblende crystals shew a distinct, though rough alignment or parallelism. The interstices between them are occupied by quartz and felspar (?) with some epidote and zoisite. The quartz is dusty with inclusions of colorless needles, liquid inclusions with and without bubbles, and gas inclusions. The epidote is rather abundant, and occurs in large, pale greenish-yellow masses, and in small oval grains which frequently have a nucleus of iron oxide.

Some of the rocks higher up in the series, but associated with schists such as that just described, are very similar to those at the contact, but are more felspathic, less evenly schistose, and of a more massive aspect. A specimen taken from Turtle Portage may be described as a type of these rocks. It is a dark-green to black rock, with a small amount of greyish-white mineral peppered through it, which comes out distinctly on the weathered surface, shewing a streaked or linear disposition. Under the microscope, the rock appears as a granular aggregate of hornblende and plagioclase, and may perhaps be designated as a diorite. It is not apparently, however, one of those rocks which are often called diorite, but which are clearly altered forms of diabase. There is no trace of diabase structure nor any evidence that the hornblende is a paramorph of any variety of pyroxene. Both plagioclase and hornblende are fresh. A little epidote and magnetite are scattered through the section. Turtle Portage.

On the north-west side of the lower end of Pipe-stone Lake, the rock is a dark green hornblende schist. In thin section (318) it is seen to be made up of an intimate felt work of tufts of hornblende, with a little chlorite and epidote, and considerable quartz in interlocking grains. Leucoxene is also present in long slender lenses arranged in parallel position, thus giving a decided banded appearance to the section. Lower end of Pipestone Lake.

A somewhat similar rock occurs on the south-east side of this same lake. It is made up as seen in thin section (352) of a felt work of partially fibrous hornblende altered in places to chlorite. Considerable epidote is associated with the hornblende and magnetite in fine grains, generally disseminated. The colorless interstitial base of the rock is made of mosaic quartz.

A couple of miles along the same shore to the north-eastward in the same line of strike, the rock is a more massive, coarsely crystalline schist (355) in which the predominating mineral, hornblende, is present in the form of an intricate felt work of large hornblende individuals, and finer fibrous shreds, through which is distributed zoisite in short columnar crystals. Fresh plagioclase, probably albite, is present, as well as quartz and some leucoxene. The hornblende is in places partially altered to chlorite.

On the south-side of First-quill Lake, Kishkutena route, the hornblende schists are medium, grained, green, rather massive rocks. A specimen (1856) appears, under the microscope, to be made up of sheaf-like or double tufted masses of more or less fibrous hornblende, with a large amount of epidote and zoisite. Between these there is a fine ground-mass of felspathic material which polarizes in dull, bluish colors as an aggregate and partly shews an undulatory extinction. There are no sharply defined boundaries between the different grains. First-quill Lake

This ground mass shews a parallel or schistose arrangement, is in places decomposed to muscovite and epidote.

Lake Despair. A specimen of the hornblende schists which occur on Lake Despair, taken from the south-west corner of South Bay of that lake, is a fine-grained dark-green to black, hard schist seen to be made up in thin section (1743) of green hornblende, in small oblong grains, all in parallel position, with quartz in rounded oblong grains, epidote and probably some felspar. Quartz also occurs in nests or mosaics of large grains.

Cedar Narrows of Pickerel Lake. At the south end of Cedar Narrows of Pickerel Lake on the Manitou Route, the rock at the base of the Keewatin series is a compact black or dark-green, hard, slaty hornblende schist. A specimen from near the contact appears in thin section (988) to be made up chiefly of light-colored green hornblende in compact plates of irregular shape, but generally elongated parallel to the prism, and zoisite in colorless compact masses having the same orientation over wide fields, polarizing in soft blue colors and shewing parallel extinction and biaxial interference figure. A few sphenes are present in well formed crystals of the usual double-wedge shape, such as are common in the syenitic gneiss of the Laurentian immediately to the south of the narrows. Epidote and chlorite appear as decomposition products of the hornblende.

West side Pickerel Lake. A specimen from the band of hornblende schists which crops out on the west side of Pickerel Lake, north of the Narrows, is a dark-green, medium-grained, rudely schistose rock (1003) made up of a felt work of compact sheaf-like hornblende imbedded in a colorless base of quartz grains in mosaic arrangement with a little epidote and leucoxene as the only other constituents.

Lake along the Hill. On the south side of the Lake along the Hill, near its middle, the rock is a compact black-green finely crystalline hornblende schist which appears under the microscope (1208) as a close felt work of more or less sheaf-like hornblende imbedded in clear quartz, in mosaic grains. The only other constituent is titanic iron in aggregates of grains each surrounded by its margin of leucoxene. The quartz manifests a peculiar state of optical tension which causes different portions of the same grain to have slightly different orientations, so that the extinction is neither uniform nor undulatory, but jumps across the section from area to area between which there are no observable lines of demarkation.

Three Island Lake. A specimen from the south-east corner of Three Island Lake, Little Canoe River route, is a fine-grained, green, hornblende schist, which is seen under the microscope (1230) to be made up of a fine felt work of shreds of hornblende imbedded in a colorless base which consists

chiefly of quartz, with some epidote, zoisite and leucoxene scattered through it. The hornblende, though matted together, shews a rough tendency to parallel arrangement.

Big Turtle River. Hornblende schists penetrated by Laurentian gneiss.

At the mouth of the Big Turtle River, the hornblende schists of the Keewatin series are much penetrated by, and included in, the underlying Laurentian gneiss. A specimen of the schist thus intersected by the gneiss appears on cleavage faces as a black glistening rock of medium texture. On transverse fracture it appears peppered with grey-white felspar in minute specks. Under the microscope (A) it resembles the specimen from Turtle Portage, and appears as a dioritic or granular aggregate of deep colored green hornblende and fresh plagioclase, with a very little quartz, the hornblende greatly predominating. A little epidote is also present, together with some cloudy or finely granular matter shewing aggregate polarization as of a fine micro-crystalline admixture of muscovite and calcite.

Rocky Islet Bay entrance.

The rock at the entrance to Rocky Islet Bay on the west side (1492) is a compact dark-green finely-crystalline schist made up of hornblende, quartz, and plagioclase. The hornblende is in compact, oblong grains with rounded corners all arranged in nearly parallel position. The quartz and fresh plagioclase are less abundant and are interstitial, also shewing a tendency to an arrangement in long parallel areas alternating with the hornblende.

North shore Rocky Islet Bay

On the north shore of Rocky Islet Bay the rock is a dark-green, fine-grained, glistening hornblende schist. Under the microscope (1502) the hornblende occurs in broad, irregularly shaped plates generally closely interlocking, but often with considerable quantities of epidote, zoisite and fresh plagioclase between the hornblende grains. A granular, nearly opaque, brownish aggregate of kaolin-like material is also present. The rock, to the naked eye, is seen to be banded with yellow areas, and a section through one of these shews it to be made up almost entirely of epidote in regular shaped oblong grains, together with a little zoisite and some hornblende, all the minerals having a more or less distinct parallel arrangement of their longer axes.

Another specimen from the north end of the same bay (1503 D) is a fine-grained, greenish-grey, glistening schist made up of a mosaic of hornblende, non-striated felspar and quartz. All three minerals occur in grains of oblong shape being usually two or three times longer than broad. The hornblende grains are larger than those of the quartz or felspar, both of which are about the same size and difficult to distinguish without reference to their action on converged polarized light.

Grassy Island.

A specimen from the south side of Grassy Island, Rainy Lake, is a dark-green fissile or slaty hornblende schist, shewing in thin section (735) a felted arrangement of sheaves of hornblende of a

more or less fibrous character, lying in a colorless matrix of quartz and calcite, throughout which are also scattered a little epidote, magnetite and chlorite.

Otukamamoan Lake.

The hornblende schists which form the middle of the three tongues into which the Keewatin belt splits up on Otukamamoan Lake are fine-grained and of an eminently crystalline, glistening, black aspect. A specimen from the west side of the lake appears, to the naked eye, to be made up of needles or prisms of black glistening hornblende, closely compacted and in parallel position, peppered with a greyish-white subordinate constituent. Under the microscope (1526) it is seen to be made up of hornblende, felspar and quartz, the first predominating in compact, deep colored, strongly pleochroic green prisms from two to four or five times longer than broad. This compact prismatic character of the crystals is very constant. The ends are sometimes sharp or jagged but more often somewhat rounded or square. These prisms are so closely packed sometimes that there is but little interstitial space between them, but for the most part there are irregular spaces which are occupied by fresh felspar and quartz, which have their contours determined by the shape of the interstices. None of the felspar was observed to be striated, and it is usually quite fresh. In both felspar and quartz there are numerous inclusions.

Memekwisi Lake.

A band of hornblende schists is exposed on Memekwisi Lake; these shew in hand specimens a black glistening surface on cleavage faces, while on transverse fracture it appears as an alternation of very thin laminæ of black glistening hornblende and greyish-white felspar and quartz. Under the microscope the hornblende appears in deep colored green patches or shreds of irregular shape, which are, however, usually elongated in the direction of the prismatic cleavage and arranged rudely parallel. The hornblende is in some portions of the section closely packed together, while in others it forms a more open felting, the interstices being occupied by plagioclase and quartz in mosaic, the former being quite fresh. The section appears to have been cut at only a small angle to the plane of foliation so that the lamination, which is so apparent in tranverse fracture, is not a marked feature of the thin section. Shreds of hornblende, together with numerous other inclusions, occasionally arranged in lines, occur in the felspar and quartz.

Longue Sault Rapid, Rainy River.

On Rainy River, at the head of the Longue Sault Rapid, the Keewatin series is represented by a dark-green, very fine textured, compact hornblende schist, somewhat glossy on cleavage faces. Under the microscope (1609) the base of the rock is seen to be made up of a felt-work of distinct, well defined needles of light green hornblende only slightly pleochroic. These needles shew a decided tendency to parallel arrangement, and the felted aspect is due to their crossing each other

at small angles, although occasionally needles may be seen transverse to the rest. The interstices between these needles are occupied by bluish felspar and a little quartz. Where the interstices are small, the grains of felspar have their shape moulded against the long needles of hornblende, but where they are more open, as is often the case, the felspar grains form mosaics, the constituent grains having a decided granulitic or rounded appearance. Grains of magnetite are commonly scattered through the section. In this base are imbedded large grains of plagioclase, both in lath-shaped crystals and in shorter tabular crystals. These are, for the most part, fresh, being only occasionally cloudy, and shew twinning lamellæ. Some of them have retained their crystallographic outline, but most of them shew a rending or granulation due to pressure and shearing; and, in some cases, the crystal has been apparently reduced to the cataclastic state (*mörtel structur* of Törnebohm). Some of these crystals of plagioclase have a broad border in which hornblende needles similar to those of the base have been developed along the cleavage partings of the felspar. The needles are abundant but are smaller and shorter than those of the base, which are often of great length. In other crystals, the development of hornblende needles is not confined to a peripheral border, but has taken place throughout the crystal, the needles always lying in the cleavage partings. The rock is doubtless an altered diabase-porphyrite in which the porphyritic plagioclase has suffered less alteration than the base. It is an interesting case where a rock having the characters of a hornblende schist still retains features which indicate clearly its derivation from a massive igneous rock. The base of the rock does not differ essentially from the sections of many of the hornblende schists above described, and the analogy is suggestive of the derivation of some of the latter from ordinary diabases free from large porphyritic crystals.

Pine River.

On the Pine River there are two exposures of the hornblende schists of the Keewatin. That at the first rapid is a very fine-grained, compact, hard, dark-green hornblende schist. In thin section (1617) it resembles the base of (1609). It is, however, finer-grained, and the needles more intricately felted. They show also a less regular shape. These microscopic characters seem to correspond with the fact that the rock is much less schistose than the rock at the Longue Sault. The interstitial base or matrix in which the hornblende is imbedded, is mostly bluish felspar, with probably some quartz, but too small to determine optically. Scattered through this base are attenuated linear areas lying in all directions, which are occupied chiefly by mosaics of felspar with some epidote and quartz (?). Some of these appear to be the granulated remains of lath-shaped plagioclase crystals, while others

have rather the appearance of small cracks secondarily filled. Magnetite is sparsely distributed over the field.

The same description is applicable to the rock (1618) of the second rapids of the Pine River, except that the hornblende needles are larger and the texture, in consequence, appears coarser; and that remains of porphyritic felspar crystals are, perhaps, more distinct.

Soft Fissile Green Schists.

Clastic origin.

These are schists closely resembling the paste of some of the conglomerates. They are usually distinctly bedded. Their clastic origin can scarcely be doubted, though, as in the paste of some of the conglomerates, their association with bedded traps and their mineralogical analogy with the altered phases of those traps, renders it extremely probable they were never ordinary clays, but were originally fine-grained, volcanic ash beds, the constituent minerals of which have suffered alteration and decomposition along the same lines as those observable in the traps. They are metamorphic rocks probably only in the sense that they exemplify in bedded volcanic ashes of a certain character, those paramorphic, metasomatic and dynamic changes which are now so well known in the corresponding massive rocks.

It is often difficult to draw the line between certain varieties of this class of rocks and those which have, in another section been spoken of, as hornblende schists. In this connection it is, as I have elsewhere pointed out, interesting to note that the darker, harder, more compact, and less chloritic hornblende schists are usually found at the base of the Keewatin series where the basal portion is in contact with the igneous granitoid gneiss of the Laurentian; while, when the base of the Keewatin rests upon the Coutchiching, the soft, fissile, light colored chloritic, green schists abound, and are also found in portions of the Keewatin removed from the contact with the Laurentian gneiss. The darker, harder, more compact, often glistening hornblende schists appear to be in part an altered phase of the fissile green schists, and the alteration further appears to be a function of their proximity to the Laurentian gneiss, which gneiss has all the characters of an igneous irruptive rock.

Swell Bay.

Only a few specimens of this class of rocks have been microscopically examined. On the shores of Swell Bay, these schists are found intercalated with the massive or slightly schistose altered traps. A specimen was taken from one of these beds about one mile east of the Bear's Passage. It is very fine-grained, greenish-grey schist, glossy on cleavage surfaces. In thin section (1604) it appears as an irregular aggregate of masses of fibrous hornblende, zoisite in colorless grains,

brownish-grey leucoxene in rounded grains, chlorite, quartz and calcite.

In another specimen (1605) taken at the same locality from another bed, the hornblende appears in needles and fibrous shred-like masses with a decided tendency to parallel arrangement. Chlorite is abundant. The other minerals are epidote, zoisite and leucoxene, none very abundant.

On an island in the north-east corner of Swell Bay the rock is a glossy, greenish-grey fissile schist made up in thin section (1616) of a fine-grained aggregate of quartz, fresh felspar, zoisite, decomposed biotite in parallel arrangement, and masses of chlorite in which are imbedded crystals of epidote. In contrast to this ground mass are large grains of calcite and leucoxene, with often opaque nuclei. Iron oxide stains the rock somewhat. The general aspect of the section is perhaps less like that of a volcanic ash than the other sections.

Grassy Lake. The fissile green schists of Grassy Lake on the Seine River are in thin section (49) seen to be comprised of chlorite, a few shreds of hornblende, an abundance of calcite and a little quartz, all in a more or less parallel arrangement.

Bad Vermilion Lake. On the north side of Bad Vermilion Lake a similar fissile schist occurs. It is composed (51) of an irregular mosaic of quartz, mixed with anastomosing areas of green, feebly pleochroic chlorite. Where the chlorite is in largest masses, it encloses crystals of colorless to yellowish epidote. The quartz contains liquid inclusions, often with a moving bubble and microlites of a highly refracting mineral, probably zircon. A little leucoxene with opaque nuclei, calcite and pyrite are the only other minerals. Veinules of epidote traverse the slide.

Another specimen of a similar schist from the N.E. end of the same lake (19) is a dark-green fissile rock, which, in thin section, appears to be made up mostly of quartz and chlorite. with large grains of calcite and some magnetite. All the constituents shew a parallel disposition.

Seine Bay. A specimen of the dark-green fissile schists which are commonly interbedded with the altered traps on the north shore of Seine Bay, (17) is made up of quartz, felspar (in sparing quantity) hornblende and chlorite; with titanite, magnetite and epidote as accessory constituents. Some of the chlorite appears to be the result of the alteration of the hornblende, but for the most part its origin is indeterminate. The quartz and felspar form a mosaic ground-mass which, in places, is visible through the thin flocculent chlorite. The titanite is rather abundant in the usual double wedge-shaped crystals, and is disposed independently of the schistosity, which is evident in the arrangement of the other constituents. The crystals of titanite often have an opaque nucleus. The epidote is sparingly represented, and occurs in irregular grains.

Conglomerates.

Interest attaching to these rocks.

These rocks are of extreme interest inasmuch as they not only give us a distinct criterion of the extent of the alteration which may be effected in strata of indisputably clastic origin, but also give us a clew as to the stratigraphical relations of the series of which they are members, to the underlying rocks. The nature of the pebbles, further affords us evidence as to the approximately original character of these latter rocks.

Rat-root Bay, Rainy Lake.

On the shores of Rat-root Bay, Rainy Lake, a formation of pebble conglomerate is well exposed and possesses strongly marked characters. The matrix is a rather soft, dark, glossy green, fissile chloritic schist. The pebbles are of a rather heterogeneous character and comprise smoothly rounded, distinctly water-worn pieces of glassy or saccharoidal quartz, pebbles of a somewhat foliated felspathic rock, and boulders of granite.

Granite boulder

A thin section (708) of a boulder of medium textured flesh-red granite imbedded in green schist on the south side of the bay appears under the microscope as a granular or allotriomorphic aggregate of orthoclase and plagioclase, with inclusions of apatite in the usual stout needles, quartz and biotite, with some accessory magnetite and secondary epidote. The felspars are cloudy, but the twinning lamellae of the plagioclase are quite distinct. The quartz has liquid inclusions arranged in streams. The biotite is frequently bleached or is altered to chlorite and epidote. Some fresh secondary biotite occurs as a rim around grains of magnetite. Leucoxene and limonite are present also in small quantities.

Granite boulder in schist, Swell Bay.

At the south-east corner of the end of Swell Bay, Rainy Lake, a granite boulder less than a foot in diameter was found imbedded in a fissile green schist which is interstratified with other green schists and with altered diabases. The granite is coarse-grained and of yellowish red color. Under the microscope (1618) it is remarkably fresh, and is made up of a granular aggregate of quartz, glassy orthoclase and plagioclase, with occasionally a micro-perthitic structure, and biotite. The accessory minerals are pleochroic titanite, apatite, magnetite and a little calcite. The orthoclase in exceptional spots is cloudy with muscovite. Radiating tufts of an actinolite-like mineral occur in the quartz. The plates of biotite are occasionally curved, and are often associated with and include crystals of titanite.

Seine River.

On the north side of Shoal Lake and Grassy Lake, on the Seine River, near the base of the Keewatin series where it rests on the Coutchiching, there is a formation of pebble and boulder conglomerate. The pebbles are mostly small, not exceeding, as a general rule, three

inches in longest diameter. Not infrequently, however, they are six inches or even a foot in diameter. They are distinctly water-worn and are oval or rounded in contour. They are imbedded in a fissile, glossy green, chloritic schist. The rocks have been evidently subjected to great pressure, to which must be ascribed the development of the schistosity in the matrix of the conglomerate; but owing to the great discrepency in resisting power between the pebbles and the matrix, the former have escaped deformation, while the latter has been much squeezed, as is shewn by the planes of schistosity bending around and conforming to the shape of the pebbles.

Pebbles. A thin section (3003 a) of one of these smooth, oval pebbles appears, under the microscope, as that of an altered felsite, being made up of a compact micro-crystalline aggregate of quartz and felspar, both striated and unstriated, in which a large amount of sericite has been secondarily developed.

A section (3003 b) of another similar pebble from the same conglomerate appears somewhat coarser in texture than the last, and partakes of the nature of a porphyry. In a very fine-grained base of quartz and felspar, in which have been developed much sericite and epidote, there are imbedded crystals of microcline with sharp well formed boundaries.

Pickerel Lake. On the west side of Pickerel Lake, Manitou Route, a band of felsitic agglomerate assumes locally the characters of a true conglomerate, in which a greenish schistose matrix holds rounded pebbles and angular fragments of quartz porphyry. A thin section (1044A) of one of these pebbles appears under the microscope, as a fine grained felsitic base in which are imbedded large porphyritic crystals of orthoclase, plagioclase and dihexahedral quartz, with a few tufts of fibrous hornblende. Veinules of secondary quartz in mosaics of large grains traverse the section.

Matrix of conglomerate. The matrix in which pebbles of this character are imbedded, is a green hornblende schist (1044), made up under the microscope of an intimate felt work of sheaf-like tufts of fresh green hornblende which appear to be imbedded in a transparent medium or base of quartz in small interlocking grains, together with calcite in large separate grains, and in mosaics with the quartz. Associated with the hornblende there is considerable magnetite in small grains.

Among the soft fissile glossy gray schists of the Keewatin series at the west end of Schist Lake, Pipe-stone route, there are several beds of conglomerate, the pebbles of which are mostly quartz rock, and the matrix a soft, more or less calcareous, decomposed schist, stained yellowish with oxide of iron.

Schist Lake conglomerate.

A thin section (217) was made across the line of contact of a pebble and its surrounding matrix. Under the microscope the matrix appears to be made up largely of calcite, muscovite in nests, quartz in aggregates of fine grains and in single fragments, and of irregular masses of brownish and red translucent iron oxide.

The pebble consists almost entirely of quartz in a very fine mosaic aggregate, partly chalcedonic. The line of contact of the pebble and matrix has been a channel of infiltration; for close to the contact there has been deposited in the quartz aggregate an abundance of minute scales of muscovite, which become less and less plentiful towards the centre of the pebble, and eventually disappear. Sharp little rhombs of calcite have, also, been deposited in the quartz rock pebble near the contact, and extend in stringers towards the centre of the pebble, but are entirely absent in its central portion. These rhombs of calcite are sometimes observed to have been developed around quartz grains, so as to quite include them, thus simulating on a microscopic scale the well-known phenomenon of the calcite of the Fontainbleau sandstone.

Discussion of conglomerates.

In considering these conglomerates with regard to the light they throw upon the mineralogical development of the rocks with which they are associated, upon the relations of the series of which they form a part to older series, and upon the original character of the older series from which the pebbles are presumably derived, the fact must be borne in mind, that they are intimately associated with rocks which are of undoubted volcanic origin, and are in fact but a subordinate portion of a voluminous volcanic series. Fissile green schists, such as usually form the matrix of these agglomerates are frequently found intercalated with the bedded traps of the series. They appear in these cases to be altered basic volcanic ash beds. And even where these rocks appear as the matrix of a true pebble conglomerate, it seems far more probable that these fissile green schists were originally volcanic débris composed of augitic and basic felspathic material, which has been subjected to the ordinary process of mineralogical alteration, giving rise to uralite, chlorite, epidote, calcite and quartz, than that they were ever clays which have by processes scarcely known to us, been crystallized into minerals which now compose the schists. The augite and plagioclase of the bedded diabases of the same series are very largely decomposed into the same minerals which make up the schistose matrix of the conglomerates.

Their presence in an overlying series, also, is evidence of an interval or geological break, during which the Coutchiching rocks suffered erosion; such break and erosion being indicative of unconformity between the Coutchiching and Keewatin.

The presence of granite boulders in these conglomerates is an interesting observation, but one which is susceptible of more than one explanation. Either the granites may have been torn from the shores of the trough in which the Keewatin rocks were being deposited by ordinary forces of rock disintegration, or they may have been brought up from beneath by volcanic forces. It is altogether probable, however, that they indicate the existence of subaërial granite at the time of the deposition of the Keewatin rocks; and although all the granites, of the region appear to be in some degree later than the Keewatin rocks, this does not necessarily conflict with the supposition of a granite shore for the basin in which the Keewatin rocks were deposited. A study of the region leaves no room for doubt in my own mind but that the original floor of the basin upon which the Keewatin and Coutchiching rocks were deposited, whether it were granite or any other rock, was fused in times of disturbance, and appears now to us as the foliated granite known as the Laurentian gneiss. Thus the granite boulders in the Keewatin agglomerates may have been derived from a granite basement now obliterated by subsequent plutonic fusion. Granite boulders in conglomerates.

The felsites and quartz-porphyries which, as smooth, well rounded or oval, waterworn pebbles, are so largely represented in the Keewatin conglomerates, have no known analogues within the district examined in the underlying Coutchiching or Laurentian rocks. But if the Laurentian were fused at a time subsequent to the deposition of either the Coutchiching or Keewatin, these pebbles may possibly represent the condition of a portion of these rocks as they existed prior to the fusion. Or, these felsites and quartz porphyry pebbles may have been derived from the underlying Coutchiching series, and represent the original character of part of the rocks of that series. The alteration of quartz-porphyries and felsites would readily yield, under the influence of great pressure, the fine grained, evenly laminated, grey gneiss which is now found interbedded with mica schists in the Coutchiching series. The alteration would be quite analogous to that worked out by Lehmann*, for the derivation of the granulitic gneisses of Saxony, from quartz-porphyries. No direct evidence has, however, been observed of volcanic agencies having had a part in the building up of the Coutchiching series.

Sericite Schists, Felsitic Schists—Altered Quartz-Porphyries.

The rocks of the Keewatin series which, in field parlance, are referred to as felsitic schists, but which, in strict nomenclature, are for the greater part altered quartz-porphyries, occur sometimes as formations of enormous thickness, occupying extensive areas, and sometimes as Mode of occurrence.

* Ueber die Entstehung der Altkrystalliner schiefer gesteine. Bonn, 1884.

comparatively insignificant beds as little as a foot in thickness, intercalated with green schists. They are usually evenly stratiform in aspect, and by the development of secondary minerals as a concomitant of dynamic crushing and stretching, they pass on the one hand into the porphyroids and nacreous or glossy sericitic schists, and on the other, into granulitic biotite gneisses. They have very frequently associated with them acid volcanic tuffs and agglomerates, in which the paste appears to be simply the débris of the quartz-porphyry material, while the included fragments are, as a general rule, pieces of the massive rock. These quartz-porphyries are interesting geognostically in the fact that they represent a wide-spread extravasation of acid volcanic rocks, subsequent to the extravasation of the basic, volcanic rocks (diabases) which make up so large a part of the underlying or basal members of the Keewatin series in this region. From a petrographical standpoint they are interesting for the clear and unmistakable way in which they reveal the effects of rock-crushing and stretching, in the sundering of the felspars and quartzes, and the frequent reduction of the latter by granulation to lenses with tapering tails, as well as by the development of mica along the shearing planes, and its curvature around the porphyritic constitutents of the rock.

Sequence of acid after basic rocks.

Line Bay, Pipestone Lake.

No. 378.—On the east side of Line Bay, Pipestone Lake, in narrow bands, one to three feet wide, apparently imbedded with the green schists. The rock is a silver grey "porphyroid" sericite schist. Under the microscope it appears to be made up of a fine-grained ground mass of quartz and felspar, in which have been developed scattered scales of muscovite. In this are imbedded grains and crystals of varying size of quartz and felspar. These porphyritic constituents either retain the characteristic shape of felspar or the dihexahedral forms of quartz, or are in the form of lenses arranged with their long axes parallel. Besides the scattered scales of muscovite throughout the ground mass, there is a much more abundant development of that mineral along broad wavy parallel bands, which traverse the schists and flow around the porphyritic crystals. These lines, along which the muscovite has been so largely developed, would appear to have been shearing planes. These bands of muscovite, although flowing around the porphyritic crystals, rarely completely enclose them. For in the wake of the fragment or crystal there is usually congregated together a number of minute grains of felspar and quartz which, in some cases, appear to be a portion of the ground mass, which, in the shearing, has moved with the porphyritic grain in its shelter or shadow, and in others to be the result of the granulation of the larger mass. The muscovite in the wavy bands exists to the entire displacement of the ground mass; and would thus appear to have been developed during the

process of slipping and rending, the proof of which is seen in the dislocation and sundering of the porphyritic constituents, the cracks being filled with the ground mass and muscovite. The scales of the

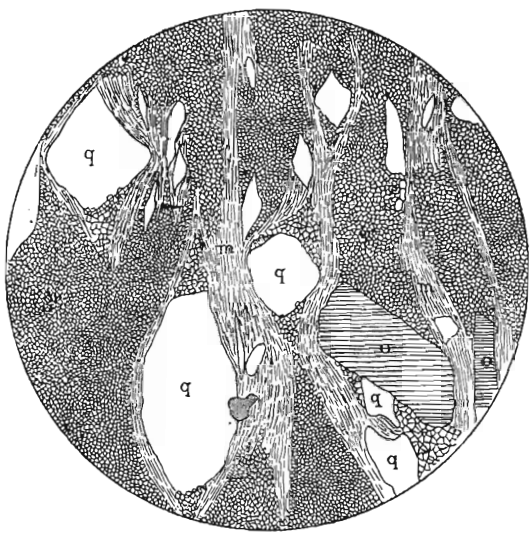


Fig. 8.—Section of porphyroid sericite schist (altered quartz-porphyry) from Line Bay, Pipestone Lake, showing more or less parallel bands of muscovite, (m) running through the rock and flowing around the porphyritic crystals of quartz, (q) and orthoclase, (o) some of which are reduced to lenses having their long axes approximately parallel. × 44.

muscovite of the wavy bands are, at any particular place, strictly parallel and closely compacted, so that the band extinguishes as a unit for as much of its length as may coincide with a section of the nicols. The relation of these bands of muscovite to the ground mass and to the porphyritic crystals is illustrated in Fig. 8 drawn with the camera lucida.

No. 1784.—South end of Clear-water Lake, Kishkutena route, west side. A flesh-tinted to purplish crypto-crystalline schist, with occasional porphyritic crystals of felspar, and with chlorite developed along the cleavage surfaces. Under the microscope, seen to be made up of a fine-grained ground mass of quartz and felspar, throughout which are disseminated the secondary minerals muscovite, chlorite, epidote and calcite. In this are imbedded large usually broken fragments of orthoclase and plagioclase, and areas of granulated quartz. Chlorite has been developed along the shearing planes. Clearwater Lake.

No. 1786.—Half a mile west of last locality at south end of Clear-water Lake. Light grey crypto-crystalline schist with rough, unctuous South end of lake.

cleavage surfaces, resembling the last in its microscopic character, particularly in the ground mass. The porphyritic constituents are crystals and broken fragments of felspar, and granulated lenses of quartz, indicative of intense crushing and stretching action. A large amount of muscovite has been developed in parallel position and frequently flows around the porphyritic grains. Small amounts of chlorite and calcite are scattered through the rock.

West side of lake. No. 1788.—West side of Clearwater Lake, towards the south end. A greenish-grey to yellowish quartz-porphyry, carrying large masses of quartz and felspar, in which have been developed considerable muscovite and some chlorite, and in which are imbedded in porphyritic development, orthoclase, plagioclase and quartz. The felspars usually occur in well defined, crystalline forms, but are frequently dislocated and sundered. They are largely decomposed to kaolin, muscovite and epidote. The quartz occurs in irregular grains and in more or less dodecahedral forms, which are often seen to have corrosion bays of the ground mass running into them; or to be parted, the fissures being filled with the ground mass.

Hazy Point. No. 1791.—South side of Hazy Point, Clear-water Lake. A flesh tinted to purplish quartz-porphyry, made up of a fine-grained ground mass of quartz and felspar, in which have been developed considerable muscovite in minute scales and a little chlorite, calcite and secondary quartz. In this are imbedded large porphyritic crystals of orthoclase, plagioclase, entire and in broken pieces, and quartz usually in lenses with granular margins. The long axis of the felspars and of the quartz lenses are parallel, and there is a flow structure of the muscovite and chlorite around them. There is present also a little epidote resulting from the decomposition of the plagioclase.

East side of lake. No. 1829.—South end of Clear-water Lake, east side. Grey quartz-porphyry merging in the field into a gneiss by the development of biotite in parallel position. Under the microscope, it appears as a fine-ground mass of quartz and felspar, with considerable quantities of epidote, muscovite and a little calcite. In this are imbedded crystals of orthoclase, plagioclase, quartz, muscovite and biotite. The orthoclase is in Carlsbad twins, and the plagioclase in the usual polysynthetic twins of the albite type. They are usually rounded or sub-angular in outline, though they are occasionally met with in sharp, crystal forms. The quartz is in irregular grains, and in more or less rounded dodecahedral crystals. The muscovite and biotite are only sparingly present in rather thick plates.

S. of Burnt Narrows. No. 1841.—South end of Clear-water Lake, east side, half a mile south of Burnt Narrows. This rock has the aspect of a micaceous granulitic gneiss, but is probably an altered form of the quartz por-

phyries with which it is associated. It is made up of a fine-ground mass of quartz and felspar, in grains. which, with high powers, are observed to be more or less rounded or granulitic, and the constituent grains appear to be larger than those of the ground mass of the quartz porphyries, above described. The porphyritic crystals are only observable in irregular and vague traces, with often a granular border. The porphyritic quartz is less abundant than the felspar. Biotite in irregular plates of varying size, but parallel in position, is scattered throughout the rock, together with a smaller number of rather large plates of muscovite.

Off Lake.

No. 2023.—South side of Off Lake. In association with the acid clastic tuffs, 2019, 2021 and 2022. Macroscopically, a purplish, crypto-crystalline sericitic schist. Under the microscope, it presents a fine ground-mass of quartz and felspar, throughout which an abundance of muscovite has been developed, and epidote in lenticular nests. In this are imbedded crystals of orthoclase in Carlsbad twins, plagioclase, and

Fig. 9.—Sundered crystal of tourmaline in quartz-porphyry from south side of Off Lake. × 11.

quartz generally in lenses with granulated margins. A crystal of tourmaline was observed in a long prism, showing the sundering or stretching effects manifested elsewhere in this rock. The sundered aspect of the tourmaline is shewn in Fig. 9. It does not appear to have been a completely developed crystal, but the separation of the once continuous parts is nevertheless quite apparent. The crystal is strongly pleochroic, ω very dark-green to greenish blue, ε very light brown.

Pickerel Lake.

No. 997.—West side of Pickerel Lake, north of Cedar Narrows, Manitou route. A light bluish-grey, quartzose schist of fine sugary texture, with large porphyritic blebs of quartz. Under the microscope, it appears as a fine-grained ground mass of quartz and felspar, throughout which shreds of muscovite are plentifully scattered, together with irregular aggregates of grains of epidote and a little calcite. In this ground mass are imbedded large grains of quartz, some of which have distinct dodecahedral outlines which give the rock the characters of a quartz porphyry.

One mile N. of Cedar Narrows.

No. 1001.—West side of Pickerel Lake, one mile north of Cedar Narrows. A grey aphanitic rock in which are imbedded grains of quartz

and crystals of felspar. Under the microscope, constituents of three generations are represented by three grades of fineness. The predominant of these are the grains of the second generation which consist of quartz and non-striated felspar in uniform-sized grains from ·1 to ·2 mm. in diameter. These are sometimes so closely packed as to leave no interstitial space, more frequently, however, there is an interstitial space between the grains, which is filled by the material of the third generation, which comprises grains of felspar and quartz from ·01 to ·04 mm. in size. The constituents of the second and third generations together with grains of epidote, shreds of muscovite, and a little leucoxene, make up a ground mass in which are imbedded large grains of quartz, crystals of orthoclase twinned on the Carlsbad law and filled with sharp little scales of muscovite and crystals of plagioclase twinned on the albite law, and largely altered to epidote. There is throughout a well marked flow structure manifested, seen in the bending of streams or bands of muscovite around the porphyritic grains which are further sometimes torn asunder.

Swell Bay. No. 54.—South shore, Swell Bay, one mile N. E. of Little Rocky Narrows. A dark grey crypto-crystalline schist made up of a fine-grained base of quartz and felspar grains of varying size, in which has been developed considerable muscovite. Coarser mosaic linear areas alternate roughly with finer or more sericitic areas, giving the rock a schistose or banded structure. In this base are imbedded grains of quartz, some of which are rounded or crushed into granulated lenses while others retain their dihexahedral form quite distinctly. Fresh biotite is observed to have been developed along shearing planes in the wake of the crushed or granulated quartzes. A good deal of calcite is interspersed throughout the base, and occasionally replaces the felspar.

No. 1619.—South shore, Swell Bay, near east end. A yellowish grey, feebly banded aphanitic schist, with sericitic gloss on cleavage surfaces. A very much squeezed and drawn out rock made up of a fine ground mass of quartz and felspar, with considerable muscovite arranged in streams or flowing bands along shearing lines. In this are imbedded grains of magnetite and lenses of granulated quartz, with liquid and dirty inclusions, so altered that it might possibly have been a quartz porphyry tuff rather than the massive rock itself.

Sturgeon Falls. No. 52.—Sturgeon Falls, Seine River. A glossy, grey, porphyroid schist made up of a very fine felsitic ground mass, in which has been developed an abundance of muscovite, and porphyritic crystals of orthoclase and plagioclase, both very cloudy, with irregular or pear shaped grains of quartz with undulatory extinction. There is a good deal of calcite in large individuals present as well as a considerable amount of fresh biotite, developed along parallel lines which probably represent shearing planes.

Fragmental Rocks—Grauwackes—Volcanic Tuffs, etc.

Two types of these rocks.

Besides the conglomerates and those fissile green schists which appear to be altered augitic volcanic ash beds, there are voluminous formations of other fragmental rocks which form prominent members of the Keewatin series in the region under consideration. These fall into two main types which, however, both in their conditions of occurence and in their petrographical characters are closely associated (1) grits or grauwackes, generally very distinctly bedded, varying in color from light-yellowish grey to very dark grey and presenting varying degrees of texture. These have sometimes the characters of quartzites, and occur generally on the same horizons with felsitic schists, from which they cannot be separated for purposes of mapping. (2) Volcanic agglomerates or tuffs, generally extremely felspathic, and having a paste quite similar, in many cases, to the grauwackes. The included fragments are, for the most part, either sharply angular or lenticular, and composed of a very felspathic rock, often a quartz-porphyry, which is usually of lighter color than the paste. The lenticular aspect of the fragments appears to be intimately associated with a pronounced schistosity of the rock, and is doubtless the result of deformation due to pressure. There is throughout the region a notable paucity of those greener or more hornblendic varieties of the agglomerates which were observed on the Lake of the Woods. Micaceous varieties are also not well represented. The agglomerates of the Rainy Lake region are remarkably uniform in their highly felspathic character, but are quite the same as the more felspathic varieties observed on the Lake of the Woods. A somewhat detailed account of the characters of a few specimens of these fragmental rocks will be of more immediate interest than any general statements that may be made concerning them.

First type.

Second type.

South side Crow Lake.

On the south side of Crow Lake there is an extensive development of bedded fragmental rocks, most of which being felspathic rather than quartzose, and having their constituent grains angular, rather than rounded, may be termed grauwackes. Some of them are, however, very quartzose, and of the character of indurated sandstones. The finer grained of these are probably partially of volcanic origin, i.e., the direct débris of volcanic material, and partially of sedimentary origin. A specimen (109) from the south side of Patch Island is a very fine-grained, dark grey, evenly banded, hard rock, with a brittle, conchoidal fracture. Under the microscope, it has a well marked clastic structure, being made up chiefly of angular broken fragments of quartz of varying size. Occasionally, the grains are rounded or pear-shaped. The rock shews the banding or bedding in the thin section, the demarkation between the different layers being an irregular wavy

line, along which has been deposited a finely granular, almost opaque material, probably iron oxide. Minute grains of epidote, pale green flakes of chlorite, and shreds of muscovite, are present, with a little leucoxene.

Patch Island. Half a mile west of Patch Island a little grey massive rock with blades of chlorite occurs. Under the microscope (98) it appears to be made up chiefly of angular, sub-angular and occasionally rounded grains of plagioclase containing needles of apatite, and quite fresh save for the presence of a few grains of epidote and shreds of muscovite. Larger grains of epidote and calcite are generally distributed through the section, together with a little leucoxene. Micaceous chlorite occurs in large patches as if pseudomorphic, after some pyroxenic mineral and pyrite with decomposition rims of limonite.

S.E. of Chase Point. Two miles south-east of Chase Point, on the south shore of Crow Lake, the rock is a grey to a yellowish white grauwacke, evenly bedded. Under the microscope (125) it is made up of a fine-grained ground-mass of more or less rounded grains of quartz and felspar, in which are imbedded large fragments of plagioclase, orthoclase and quartz. The section is cloudy with aggregations of kaolin and epidote. Well defined individuals of epidote also occur. Other secondary minerals are: quartz in mosaics, calcite in occasional grains, sometimes replacing the felspar, muscovite in minute scales, a little limonite and some elongated shreds of fibrous hornblende.

Shanty Point. On the shores of the bay east of Shanty Point, an agglomerate or tuff occurs, the finer-grained base which, under the microscope (146) is made up of a paste of minute particles of quartz and felspar, in which are imbedded angular fragments of the same minerals which have sometimes a jagged outline with sharp re-entrant angles. The plagioclase is spotted with small quantities of muscovite, epidote and zoisite. Shreds of hornblende with epidote are generally disseminated, as well as an abundance of epidote, unassociated with the hornblende, in single grains and in nests of grains.

Pipestone Lake Unde Rapids. At the south end Unde Rapids between Schist Lake and Pipestone Lake, a grey to yellowish compact rock occurs with whitish weathering. Under the microscope (234) it appears as a fine-grained ground mass of felspar and quartz, with interspersed scales of muscovite and grains of epidote, in which are imbedded rounded and angular fragments of plagioclase and quartz. The most prominent mineral in the rock, however, is calcite, which has been developed *in situ* in beautifully sharp rhombs. The calcite is also seen partially replacing the plagioclase fragments, and occasionally a well defined rhomb of that mineral occurs in the heart of a felspar grain. The calcite has occasionally a nucleus of almost opaque granular material.

On Pipestone Lake, half a mile west of Pivot Point, north side, a specimen was taken of a greenish grey clastic rock, which in thin section (286) is seen to be made up of a fine-grained paste of quartz grains, shreds of muscovite and chlorite and grains of epidote. In this are imbedded rounded and angular grains of quartz and some leucoxene. Pyrite and calcite are prominent secondary minerals. That the rock has yielded to pressure is indicated not only macroscopically by its schistosity, but also microscopically by the breaking and sundering of the quartz grains and the drawing out of the leucoxene into long stringers. W. of Pivot Point.

A quarter of a mile west of the last locality, a dark green, rudely schistose chloritic rock, spotted with fragments of quartz, occupies the shore. Under the microscope (266) it is made up of a matrix of

Fig. 10.—Fragmental rock from from near Pivot Point, Pipestone Lake, shewing sundering of individual of quartz, (q, q, q) into several pieces. Rending effects also seen in leucoxene (l), (q) quartz grains other than the sundered individual. The base of the rock is chlorite, (ch) in which, subsequent to pressure, have been developed sharp rhombs of calcite or dolomite. × 18.

chlorite and quartz in fine grains. In this are imbedded large rounded and angular fragments of quartz, felspar and leucoxene. The rock shews pressure effects to a remarkable degree, the quartz grains frequently being torn asunder into numerous fragments shewing the same, or approximately the same, extinction. The spaces between these sundered fragments are filled with chlorite, the scales of which are in Pressure effects

definite parallel position corresponding to the schist planes. The leucoxene shows the same sundering, though in a less degree. Felspar grains are abundant. Beautifully sharp calcites have been developed in the chloritic base of the rock, apparently at a period subsequent to the action of the pressure. The various features here described are illustrated in Fig. 10.

Three-quarters of a mile west of Pivot Point, on the south side, the rock (277) is a grey schist made up of a fine-grained ground mass of quartz grains and shreds of muscovite in parallel position with patches of chlorite and grains of epidote. In this are imbedded larger, rounded and pear-shaped grains of quartz, with occasionally more angular pieces. Aggregates of muscovite are massed together in parallel position, in areas having an oblong shape, apparently constituting a pseudomorph, after felspar. Scattered through the section are rhombs and irregular masses of calcite and magnetite in grains or loose lenticular aggregates of grains.

S.E. side of lake.

On the south-east side of Pipestone Lake there occur some subordinate beds of a grey-green, fine grained, though not uniformly textured rock, having a well marked schistose structure. It (356) is made up chiefly of small angular and sub-angular grains of quartz, shreds of partially bleached biotite in parallel arrangement, large and small grains and aggregates of grains of epidote, with areas of mosaic quartz and calcite of large grain, and a few crystals of pyrite.

Pickerel Lake, north end.

At the north end of Pickerel Lake, Manitou route, there is a large volume of compact, dark-grey quartzose, clastic slates, passing across the strike into fine grained clay slates. A thin section of this rock (1011) from the west side of the lake, shews it to be distinctly banded and made up chiefly of quartz in more or less rounded grains, with generally a black rim around the periphery where in contact with other grains. Over this are scattered cloud-like patches of yellowish-green isotropic chloritic material, and an abundance of opaque (carbonaceous) matter in irregular grains and ragged shreds. Grains of leucoxene with opaque nuclei and small plates of muscovite are also present. Microlites of apatite and zircon are included in the quartz.

East side of lake.

On the east side of the lake, another specimen of the same rock formation presents in thin section (1022) to the naked eye, or with a low power, a spotted appearance, due to the presence of round or pear-shaped areas, in rough parallel arrangement, which are clearer and more transparent than the rest of the rock. The base of the rock is an aggregate of minute quartz grains, intermixed with which is a considerable amount of finely divided opaque matter, probably carbonaceous. The rounded and pear-shaped clear spots are areas where there is a much less amount of carbonaceous matter, and where mus-

covite has been developed in little nests to its exclusion. The border of these clear areas is a comparatively sharp one. Muscovite in large plates and a little flocculent chlorite are also scattered throughout the section. The differentiation in the distribution of the carbonaceous matter recalls that in the Steiger Schiefer of the Bair-Andlau contact zone described by Rosenbusch,* although the process appears to be the reverse of that there observed; being an elimination of the carbon from certain areas, not its condensation into "Knötchen." The specimen described is from the proximity of the most easterly of the two granite bosses on Pickerel Lake.

Another specimen (1023) from the same formation near the same granite boss is a fine grained compact rock, made up of a fine quartzose base, through which are scattered small plates and ragged shreds of biotite of pale, greenish-brown color, and colorless muscovite, with occasional crystals of pyrite, the decomposition of which has stained the rock yellowish.

Manitou Lake.

On the south side of the lower end of Manitou Lake, the rock is a much finer grained and more slaty or fissile phase of the same formation as that from which the specimens just described were taken. It (1077) resembles the last in microscopic structure. Under low powers of the microscope it shews a distinctly marked lenticular structure identical in miniature aspect with that shewn by glaciated sections of squeezed agglomerates on the large scale. The lenticular areas are more transparent than the base of the rock. This base is made up of an irregular aggregate of quartz, actinolite (almost colorless), muscovite and calcite. Scattered through it and rendering it cloudy is a large amount of a grey, granular, semi-translucent substance resembling the product of the kaolinization of felspar. With high powers these grains in ordinary light are transparent, but almost opaque between crossed nicols. It is the absence of this cloudy granular material in the lenticular areas of the section that render them so transparent and prominent, since they do not appear to otherwise differ greatly from the rest of the rock.

Clearwater Lake.

On the west side of Clearwater Lake, Kishkutena route there is an extensive formation of felsitic (quartz-porphyry) agglomerate. A specimen taken from the shore one mile north of Hazy Point, appears as a greenish, clastic rock, or quartz-porphyry tuff, in which are included large angular and lens-shaped masses of flesh-tinted quartz-porphyry. Under the microscope, a section of one of these inclusions (1796) is that of a typical quartz-porphyry, shewing a fine grained, ground mass of quartz and felspar, in which have been developed secondary muscovite and a little epidote. The porphyritic minerals are orthoclase, plagioclase

* Mikr. Phys. der mass. Gestein. Stuttgart, 1886, p. 47.

and a few grains of quartz. The felspars are in well defined crystal forms, although some are broken.

The matrix of the agglomerate shews also a fine grained ground mass of quartz and felspar, but the grains are not of such uniform size, nor the structure of the rock so compact, as in the case of the porphyry. There is much more epidote, muscovite, calcite and chlorite; and in the porphyritic or pseudo-porphyritic grains, the felspar is much more fragmental or broken in character, and there is an abundance of irregularly shaped grains of quartz. It also shews a foliated structure, and might be mistaken for a much crushed quartz-porphyry, were it not for its association and known clastic origin.

Off Lake.

On the west shores of Off Lake, on the west side of the Kishkutena route, there occurs a coarse fragmental rock of a yellowish to greenish color, which under the microscope, (2019) is made up of an indiscriminate aggregate of quartz and felspar in angular fragments, with irregular shaped nests of epidote and chlorite, apparently the results of decomposition of included chips of a basic rock.

Pseudo-gneissic structure.

Farther along the shore to the southward, the rock passes into a more uniformly textured rock of yellow color, which has developed in it a well marked pseudo-gneissic structure. Under the microscope (2021) the rock appears to be much the same as that last described, but shews pressure and pulling effects to a remarkable degree. The quartz grains are reduced to long lenses surrounded by a granular border which runs out into a tapering tail at each end. The lenses all shew a decided undulatory extinction due to unequal tension. The granules surrounding these lenses closely interlock, and are freer of inclusions than the lens itself, indicating a re-crystallization of the grains as part of the process of granulation. These quartz lenses, with their granulated borders, tapering tails, and undulatory extinction correspond exactly with those described by Lehmann in some of the rocks of Saxony, as a result of pressure.* The felspars are shattered and torn apart. A considerable amount of muscovite, chlorite and epidote has been developed in the rock, and these minerals, together with the quartz lenses are all in parallel arrangement, giving rise to its gneissic aspect.

Resemblance to rocks of Saxony described by Lehmann.

On the south side of the lake the rock is still more gneissic in aspect, and under the microscope (2022) appears much more altered. It is made up of orthoclase, plagioclase and quartz. The felspars are in grains of usually crushed or lenticular appearance, with some broken fragments of less regular contours. The quartz is in mosaics, arranged in parallel stripes which appear to represent the granulation of large grains of quartz carried to an extreme. Larger lenses of quartz, with

* Cf. Intersuch. über die Entstehung der altkrystallinischen Schiefergesteine, p. 250.

granulated margins and tails are also observable. Muscovite and epidote are abundant and are generally arranged in long, narrow areas or in stripes in parallel position.

Grind-stone Narrows.

On the south shore of Rainy Lake, and on the off-lying islands in the neighborhood of Grind-stone Narrows, there occur rocks of clastic origin which appear, in some places, to be simply altered sandstones, while at others they are very felspathic, schistose and glossy, and are associated with occasional beds of agglomerate and true conglomerate. A specimen (743) from the shore of the lake one mile west of Grind-stone Narrows, appears, under the microscope, as a fine grained matrix of quartz, epidote, muscovite and felspar, in which are imbedded large and small broken fragments of quartz and plagioclase, which are usually quite sharply angular, though sometimes rounded. These fragments of quartz are full of fluid inclusions which are, for the most part, arranged in rows or streams. The other minerals present are magnetite, limonite and leucoxene in sporadic grains.

At Grind-stone Narrows the rock is a yellowish, quartzose schist made up, as seen in thin section (749), of a clastic aggregate of quartz and felspar grains of a generally angular or sub-angular shape, imbedded in a paste made up of the same minerals in a more finely divided state, and cemented by secondary minerals such as quartz, calcite, muscovite, chlorite, limonite and epidote.

Peridotites and Gabbros.

Peridotites not abundant.

Peridotite rocks are very poorly represented in the Rainy Lake region. They have been observed at only a few localities, and in these they occur in the extremely altered forms known as serpentine. They occur only in the Keewatin series, but their relations to the rocks adjoining them are ill defined, and have not been altogether satisfactorily determined. They appear, however, to be the alteration products of igneous masses which are of the same geological age as the traps and other volcanic rocks of the Keewatin series; and although their common boss-like character suggests that they are intrusive through the Keewatin rocks, such intrusion has probably taken place coeval with the bedded formations, volcanic and sedimentary, of the Keewatin.

Their geological relations.

Crow Lake serpentine.

One of these bosses of serpentine, apparently of quite small extent, occurs on the N. E. extremity of the point of land that projects into Crow Lake from the west side midway between Crow Portage and Wade Portage. The rock is of a fine, compact texture, and has a mottled, light and dark green aspect and shows a yellow weathered surface. It is associated with green altered traps and green schists.

Little can be determined from the microscopic examination of the rock (24) as to its original character. It is seen to be made up of rounded or sub-angular grains, now composed entirely of serpentine of a pale green color, but probably originally composed of olivine. Between these grains there is considerable interstitial calcite and a little chlorite, while granular or dusty magnetite is disseminated throughout the section.

Clear-water Lake.

On Clear-water Lake, Kishkutena route, the west shore of the lake, for a distance of about a mile south from the 49th parallel is occupied by a similar rock, which was observed to be traversed by small veins of coarsely fibrous serpentine or picrolite.

Serpentine of Lake Despair

Another locality at which this class of rock was observed is at the bottom of the South Bay of Lake Despair, to the west of the North-west Bay of Rainy Lake. Here it occupies the shore for the space of between a quarter and half a mile, with black hornblende schists on either side. Its relations to these schists could not be studied at the time the locality was visited, from the fact that the woods were on fire close down to the water's edge, and it was with difficulty that a few specimens could be secured. Two varieties of somewhat different aspect

First variety.

were observed in the same mass. One of these (1741) is a purplish, green, compact serpentine, speckled with glistening facets of mica. It weathers on exposed surfaces to a dull red color. Under the microscope, the only minerals that can be detected now are serpentine, magnetite and white mica. It is probably an extremely altered form of an olivine-enstatite rock of coarse-grained texture. The only traces of these minerals, however, that are now observable are the rounded or double-domed outlines of the one with fine dusty magnetite, heaped together in the middle, and the oblong nearly rectangular forms of the other with the cleavage lines still remaining. The magnetite is occasionally in distinct octahedra, but generally it occurs in irregular granules, and is nearly always associated with a mica which is either colorless, or pale green and pleochroic; some of it polarizes brilliantly and some in quieter colors, such as brown and grey. It all, however, gives a biaxial interference figure in converged polarized light, a fact which determines it as muscovite, and not bleached biotite, as might be suspected from its association with the iron oxide. The less brilliantly polarizing varieties shew between crossed nicols, the peculiar bird's-eye-maple mottling so characteristic of the micas.

Second variety.

The second variety (1742) of serpentine taken from this occurrence on Lake Despair, has a mottled aspect of a greenish, black base and silvery grey spots. Its microscopic aspect resembles that of the specimen just described, in all respects, except that there is an abundance of grey leucoxene. This often shews opaque nuclei of magnetite or titanic iron, but is more commonly without such nuclei.

Crow Lake olivine gabbro

On the north side of the south-east arm of Crow Lake there is boss-like area of gabbro which, in places, appears to be entirely altered to serpentine although retaining, for the most part, its granular character. A specimen of the less altered part of this mass appears in thin section (46 A) to be an olivine, hypersthene gabbro. It is composed of hypersthene, olivine, diallage and plagioclase. The hypersthene is the most abundant, the diallage and plagioclase are the least abundant, and occur in about equal proportions. The hypersthene is quite fresh and shews its characteristic pleochroism very strongly. Neither it nor the diallage are bounded by crystallographic contours, but are allotriomorphic. The olivine is in more or less well defined crystals, with characteristic dome faces, but is more than half altered to serpentine, anastomosing veins of which traverse the olivine in all directions. The plagioclase is in cloudy, lath-shaped, polysynthetically twinned crystals, and in small oval bodies included in the hypersthene. There is associated with the hypersthene a considerable proportion of magnetite.

Saussurite gabbro of Bad Vermilion Lake.

The area of gabbro which is exposed on the shores of Bad Vermilion Lake and River, differs from that just described from Crow Lake in the fact that plagioclase was, in the original rock, the dominant mineral, while the olivine and pyroxenic minerals were very sparingly represented. Thus, under process of decay and alteration, the rock has assumed, not the form of serpentine but that of saussurite, the condition determining the difference being doubtless the proportion of magnesia and iron in the original magma. The gabbro on Bad Vermilion Lake is, in many places, a fine white rock resembling at first sight a coarsely crystalline marble. It is, however, much harder, and is for the most part mottled, with the pyroxenic constituent. Under the microscope (47) there is little to be noted, save that the anorthite is almost entirely changed to the aggregate of zoisite and albite, known as saussurite, and that the pyroxene is non-pleochroic and rhombic, though much decomposed, and difficult to determine accurately.

In another section (2154) calcite is a prominent constituent of the saussurite, besides the zoisite and albite, and the pyroxenic constituent is altered entirely into serpentine in nests or aggregates of small grains.

The Coutchiching Series.

Geological position of series—its bedded character.

Around the east arm of Rainy Lake there is an enormously thick series of schists of remarkably uniform character underlying the Keewatin series. They are composed chiefly of quartz and biotite, with or without felspar, and are distinctly bedded in layers of varying

thickness, and in such a manner that it is difficult to resist the conclusion that the layers are the result of original deposition.

Section on shores of Rainy Lake and Nameukan Lake.

The series is best studied in its stratigraphical aspects in the excellent natural section afforded by the shores of the lake, on the Canadian side, from Bleak Bay to Kettle Falls and thence across Nameukan Lake to Sand Point Lake. Throughout this distance, about twenty-four miles in a direction more or less obliquely transverse to the strike, only the upturned edges of the beds of the Coutchiching series are seen, the dip varying from almost horizontal to quite vertical. The only interruptions are a few small intrusions of gneiss or granite which traverse the rocks in the neighborhood of the axes of folding.

Breadth of belt.

The breadth of the belt from Bleak Bay to Sand Point Lake, in a direction directly transverse to the strike is about eighteen miles. The limit of the belt on the north is its contact with the Keewatin rocks along the edge of the trough which runs down the Seine River and across Rainy Lake to the bottom of Rat-root Bay. Its southern limit is its contact with an area of gneiss and granite of which the full extent is not yet known, but which has been traced on the shores of the International Boundary canoe route as far as the east side of Basswood Lake. Within these limits this belt of the Coutchiching rocks comprises a three-fold repetition of the full volume of the series; and two axes of folding, one an anticlinal and the other a synclinal are clearly indicated.

Three-fold repetition of volume.

For six miles and a half southward from the northern limit of the belt of the Coutchiching series the dips are continuously to the north or under the above mentioned Keewatin trough, at angles which range from 15° to 85°. Then we come upon a line along which the rocks are in a perfectly vertical attitude, and to the south of which they dip southward. This line is taken to be the axis of a great anticlinal fold. It intersects the shore at a point midway between the mouth of the Rat River and Vague Point.

Anticlinal axis.

Similar disposition of rocks on United States side of the Lake.

A precisely similar disposition is observed in the section afforded by the shores of the lake on the United States side. From their contact with the Keewatin rocks, near the mouth of Black Bay, to the Brulé Narrows, the Coutchiching rocks run in continuous exposure, striking with the general trend of the shore and with a prevailing northerly dip at angles varying from 50° or 55° to 90°. At Cranberry Bay it is about vertical. After rounding Point Observe at Brulé Narrows and entering Saginaw Bay, it becomes lower and lower, the direction, however, of both dip and strike remaining constant. With the exception of an unimportant local or intermediate fold observable at the southwest corner of Saginaw Bay, this northerly dip at low angles is constant on all the shores and islands of the bay. South of Pine Islands, the dip

gradually becomes steeper, and at the Narrows between Big Island and the south shore, a line is reached along which the dip is vertical. This is the same axis as that observed between the mouth of Rat River and Vague Point. It is again found on the line of section afforded by the Pipestone River, about one mile up stream, the dip on the north side being distinctly northward, and on the south, southward. The total distance through which this axis is thus traceable is sixteen miles, and judging from the uniformity of structure it probably extends very much further. In the vicinity of this axis and to the south of it, on the islands and especially the south shore of the lake, there are numerous intrusions of granitoid gneiss and of a very coarse muscovite granite, in which the constituent crystals are often several inches in diameter. These are most prominent on the islands to the south and south-west of Vague Point and in the neighborhood of Big Island, as well as on the south shore east of Big Island.

Pipestone River section.

South of the axis the strata continue to dip south, to a line drawn parallel to the strike through Kettle Falls. This latter line constitutes a synclinal axis, the rocks to the south of it all having a southerly dip. The distance between the anticlinal and synclinal axis is about four miles and three-quarters. The distance between the Kettle Falls syncline and the southern limit of this belt of Coutchiching rocks where it comes against the granite and gneiss of Sand Point Lake is about six miles and three-quarters. In this three-fold repetition of the volume of the Coutchiching series an unusually good opportunity of forming an estimate of the thickness of the series is afforded, owing to the simplicity of the folding. In the first six miles and a half of the belt, from its northern limit southward to the anticlinal axis it is difficult to form an estimate of the average dip. The whole distance may, however, be divided into five portions, in each of which the average dip may be estimated with comparative accuracy, and the total thickness thus deduced be taken as that of the series. At the contact with the base of the Keewatin series on Bleak Bay and on the Seine River, the Coutchiching schists plunge under the higher rocks in an almost vertical attitude. A little away from the line of contact, however, they become more inclined and the average dip for the first mile may be taken as about 75°; the average dip for the next mile and a half is about 45°; for the next mile and three-quarters, 30°; for the next mile and a quarter, 45°, and for the last three-quarters of a mile up to the line of the anticlinal axis, 75°. The total volume estimated from these angles is 23,760 feet, or 4·50 miles.

Synclinal axis.

Estimation of thickness.

First measurement.

The second or southerly dipping portion of the belt between the anticlinal and synclinal axes, or between Rat River and Kettle Falls is four miles and three-quarters in breadth, and presents a greater uniformity

Second measurement

of dip, the general average of which may be taken at about 75°; giving a thickness of 24,224 feet or 4·588 miles.

In the third portion, or that between the synclinal axis at Kettle Falls to the southern limit of the belt against the gneiss and granite of Sand Point Lake, the dip again varies considerably. For the first two miles the average dip to the north is about 75°; for the next half mile, 50°; for the next mile and a half, 30°, and for the last two miles and three-quarters, 60°. Calculating in the same manner as before we find a thickness of 28,754 feet or 5·44 miles.

Third measurement.

Thus the three independent measurements of the series shew a fairly satisfactory agreement, and they seem to be sufficient to establish its enormous thickness. So far as the figures are to be relied upon, they indicate that the series is thickest towards the south, and diminishes in volume northward.

Diminution of thickness to the northward.

Two other distinct, but stratigraphically connected, areas or belts of the Coutchiching series are known. Both of these have an anticlinal structure and dip under the Keewatin formations on either side of the axis.

Two other belts of Coutchiching.

The first of these comprises the belt of mica schists (occasionally gneissic by addition of felspar) which extends from the neighborhood of the Bear's Passage across Rainy Lake in a W.S.W. direction to Coutchiching and thence down Rainy River. In the direction of its strike, the belt is traceable continuously for twenty-four miles, and it probably continues to the westward, under the post-glacial formations of the Rainy River, for a distance of at least sixteen miles. The breadth of the belt at the Bear's Passage and from that point to Open-water Narrows is about two miles and a quarter. Westward of Open-water Narrows the belt bifurcates around an area of gneiss, the more northerly spur running out to Gash Point, while the southerly or main spur keeps the general trend of the belt, and near Coutchiching is a little more than two miles wide.

Bear's Passage belt.

The anticlinal axis of the belt is marked by a line, or series, of three distinct and well defined oval or elliptically shaped bosses of Laurentian gneiss. The Coutchiching schists dip away from these bosses in all directions, so that the general anticlinal structure of the belt is made up of three anticlinal domes. These three bosses of Laurentian gneiss cut the Coutchiching schists in the same manner as an irruptive granite and displace a very considerable proportion of the series in the middle of the belt. The first of these, which is well exposed at the Bear's Passage and the shore to the south-west of it, is three miles long and one mile and a quarter wide. The second, in the neighborhood of Open-water Narrows, is three and a quarter miles long, and one and a quarter miles wide. The third is over eight miles long, and two

Bosses of Laurentian gneiss in anticlinal axis.

miles and a half wide. In each case the long diameter of the boss coincides with the general trend of the schists composing the belt.

At the north end of the Bear's Passage the Coutchiching schists dip away from the Laurentian gneiss (or granite, for here it is very indistinctly foliated) at an angle of 40°. Across the strike, for a distance of a little over half a mile to the north-west, the angles of dip diminish and the rocks finally pass under the altered traps of the Keewatin inclined at an angle of 20°. All around the north-east end of the boss of gneiss, whose limit in this direction is the Bear's Passage, the schists dip away from it at comparatively low angles. At the south-east corner of Redgut Bay, east of the Bear's Passage, they gradually assume a constant N.N.E. strike and dip E.S.E. at angles varying from 60° to 75°; at which angles, both at the extreme south-east of Redgut Bay and on Swell Bay, one mile east of Bear's Passage, the Coutchiching rocks may be observed to pass under the Keewatin. The southern edge of the belt along the line of its contact with the Keewatin has already been sketched in the description of the distribution of the latter series. The Coutchiching rocks along this line appear to be the return of those which, on the south side of the lake, dip northward under the Seine River Keewatin belt, the two being continuous stratigraphically, and forming a synclinal trough in which that belt of the Keewatin lies sharply folded. The northern edge of the belt, between the north end of the Bear's Passage and the bay north of Open-water Narrows is only partially determined to be as mapped, the mapping being inferred from the known disposition of the mica schists inland on the north side of the Bear's Passage boss of Laurentian gneiss, and between the latter and the Open-water Narrows boss, where they constantly dip away from the gneiss and towards or under the Keewatin at angles nowhere greater than 60°. At the entrance to Rocky Islet Bay on the west side, the Coutchiching schists dip under the Keewatin at an angle of 60°, but along the shore from Back Point to Gash Point the dip is vertical or somewhat inverted. The rocks forming the belt have not been observed on the shore of the lake opposite Gash Point, north of Coutchiching, and the spur of the belt which terminates at Gash Point appears to have been cut off either by a fault or by an analogous displacement of the rocks by the Laurentian gneiss.

Coutchiching rocks passing under Keewatin.

Limits of Bear's Passage belt.

Perhaps the most remarkable feature of this belt is the smallness of the revealed thickness, as compared with the great thickness determined for the same series in the south part of the lake only a few miles distant. It is difficult to find sections across the belt where a satisfactory estimate of the thickness can be formed, on account of the interruption of the bosses of gneiss which occupy its central part along the anticlinal axis. The volume is, how-

Comparative smallness of volume.

ever, evidently small compared with that already described. The maximum measurable thickness is that revealed along the south shore from Rat-root Bay to near Coutchiching, where it is probably between 8000 and 9000 feet. This diminution in volume agrees with the fact already stated, as observed elsewhere, that the thickness diminished regularly towards the north. This thinning out may, however, be due to absorption in the magma from which crystallized the Laurentian gneisses and granites.

Excessive metamorphism at Contact with Laurentian.

Those portions of the Coutchiching series which are in immediate contact with the bosses of Laurentian gneiss, are the most altered, and exhibit the strongly marked characters of contact metamorphism, being studded with nodule-like crystals of andalusite or staurolite. The rocks are, however, very much decomposed, and the metamorphic minerals have been much altered and removed by subsequent decay. The least altered portion of the series appears to be that which is seen on the south shore of the lake between Coutchiching and Rat-root Bay, where in places the schists have the character of bluish, somewhat micaceous quartzose slates.

Rice Bay area of Coutchiching.

The third area occupied by the Coutchiching series is that on the shores of Rice Bay. Here again the structure is that of a beautifully distinct anticline, the rocks dipping away at angles of 45° from the axis, and passing beneath the Keewatin rocks on either flank at the somewhat steeper angles of from 60° to 75°. The axis passes through the centre of the peninsula which separates the two arms of Rice Bay, but at the extremity of the peninsula, where it can be closely located, the base of the series is not revealed, and no estimate can be formed as to its full thickness at this place. A minimum thickness may be calculated from a revealed breadth across the strike of about one mile, the average dip being taken at about 60°. This gives a thickness of about 4,600 feet. The Laurentian gneiss appears in the axis of the anticline at the north-east end of the north arm of the bay. But the irruptive character of the gneiss precludes the assumption that the beds in contact with it are the proper base of the Coutchiching. The south-eastern flank of this anticline appears to form with the northern flank of the anticline of the second belt above described, a synclinal trough in which lie the Keewatin rocks exposed on the shores of Redgut Bay to the north of the Bear's Passage and on the shores of Grassy Portage and Rocky Islet bays. The connection of the two areas and their stratigraphical relationship is further seen in the band of Coutchiching rocks which surrounds the north-east end of the area of Keewatin rocks, and forms the rim in that direction of the basin or trough in which the latter lie.

Minimum thickness.

Stratigraphical relationship of different areas of Coutchiching rocks.

Relations of the Coutchiching Series to the Keewatin and Laurentian.

Without being able to conclusively prove it, there appears to be much presumptive evidence in the facts cited to shew that the present eminently crystalline state of the Coutchiching series is the result of the metamorphism of strata which were originally in large part ordinary quartzose sediment, although part may possibly have been acid volcanic rocks, such as quartz-porphyries or felsites. In many parts of the series garnets abound, and if the rocks were carefully examined other metamorphic minerals would doubtless be found. That percolating siliceous solutions were active agencies in effecting the metamorphism of these strata, is proved by the fact that in many places, particularly on the north side of Saginaw Bay and east of Brulé Narrows, the partings between the beds have served as fissures for the deposition of vein quartz. This vein quartz is very abundant in lenses or lens-like sheets, and is clearly a secondary product in the rock. The same watery solutions which deposited the quartz in these lenses in the more open portions of the formation, must have saturated the rock throughout, and given rise, probably, to much of the quartz and felspar in it. Only in one instance has hornblende been observed throughout the whole series. There are no intercalations of basic volcanic rocks, and none that can now be distinctly recognized as acid volcanic rocks. There are no limestones or dolomites in the series, nor have any conglomerates been observed.

The Coutchiching metamorphic series.

Vein quartz between strata.

The advent of the time of the formation of the Keewatin rocks was the inauguration of a period of intense volcanic activity. Prior to that there is no certain record of volcanic action; while a very large proportion of the total volume of the Keewatin is made up of volcanic rocks, such as diabase and quartz-porphyry, with their tuffs and agglomerates.

Period of volcanic activity following quiescence of Coutchiching.

Such a change in the conditions of rock formation does not in itself necessarily imply any great lapse of time between the cessation of the accumulation of the Coutchiching and the deposition of the first rocks of the Keewatin. That there has been a certain interval, however, during which erosion has taken place is indicated by the conglomerate at the base of the Keewatin on Seine River and Rat-root Bay. If the question of the conformity of the two series is to be decided merely by the parallelism of the structural planes in the vicinity of the contact, the two series should be described as conformable. But if the question is considered more broadly, and the term unconformity is to be regarded as expressive of a geological break, or profound change in the conditions of rock formation, then the two series are unquestionably unconformable.

Nature of break between Coutchiching and Keewatin.

A. C. LAWSON, PHOTO, 1888. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Angular inclusions of schist of Coutchiching series, inclosed in Laurentian gneiss, a few yards from the contact of the two, on island off south shore of Rainy Lake, three miles east of Coutchiching.

Relations of Coutchiching to Laurentian.

With regard to the relationship of the Coutchiching series to the underlying Laurentian, little need be added to what has already been said. Wherever the contact of the two is observable that contact is igneous and more or less brecciated, the conditions being precisely the same as those which prevail at the contact of the Keewatin and Laurentian at places where the Coutchiching rocks do not intervene. The contact is well seen on a small island just three miles east of Coutchiching. The north half of the island is occupied by Laurentian gneiss, which is presumably continuous with the area of the rock so well exposed on the islands between Open-water Narrows and the vicinity of Gash Point. The south half of the island is occupied by the schists of the Coutchiching series. The line of contact runs across the island in a direction parallel to the strike of the schists. Apophyses from the gneiss cut the Coutchiching schists transversely, and these are distinctly foliated; while fragments of the schists of irregular angular contour, which have very evidently been detached from the main mass of the Coutchiching, are found imbedded in the gneiss at a few yards from the contact. Plate I. shews the nature of these inclusions, as well as the distinct foliation of the gneiss in which they are imbedded, close to the contact. The same phenomena are very apparent at many places on the islands where the contact of the Coutchiching is mapped between Open-water Narrows and Gash Point, and at many places where the contact is not seen, large masses and bands of the Coutchiching schists may be seen imbedded in the gneiss, the schist, where in large bands, being more or less shattered and penetrated in all its fissures by the gneiss which retains its foliation usually parallel to the walls of the fissure as shewn in Plate II. representing a contact on one of the islands between Back Point and Gash Point. The exposures in the vicinity of Open-water Narrows and Bear's Passage afford good instances of the intrusion of the gneiss through the schists, although here the former is more granitoid than it is farther west on the islands in the neighborhood of Gash Point. Plate III. shews the contact of the Laurentian gneiss and the Coutchiching mica schists at the south-east part of Redgut Bay, where the gneiss cuts the schists sharply and the latter abut upon it obliquely.

Irruptive character of contact.

Penetration of schists by gneiss.

Contact on Redgut Bay.

The rocks of granitic composition, which cut the Coutchiching series on the shores and islands of Rainy Lake between Brulé Narrows and Kettle Falls, are in some places distinctly foliated and gneissic, while in others they are quite undifferentiated or granitoid in structure. The same is true of the Laurentian rocks which break through the same series on Nameukan Lake. In both cases the gneiss or granite cuts the schists in the most irregular fashion and numerous detached portions of the latter are imbedded in it. The same conditions prevail at the contact across the north end of Sand Point Lake.

Sporadic intrusions of granite and gneiss.

A. C. LAWSON, PHOTO., 1886. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Contact of Laurentian gneiss and schists of Coutchiching series, Redgut Bay, two miles and a half east of Grassy Portage, Rainy Lake. The schists (on the right) abut obliquely upon the gneiss, which appears to cut them as an irruptive mass.

COUTCHICHING SERIES.

The rocks of the Coutchiching series deserve a much more thorough microscopic investigation than I have had an opportunity of giving them. A close comparison of their detailed structure with that of the Laurentian gneisses, which in this region appear to the writer to be beyond question irruptive, would, he is convinced from a consideration of their field conditions, throw much light upon the vexed question of the distinction between gneisses (?) which are truly altered sediments, and gneisses which are nothing more than foliated granites. Need of more extensive study

The leading macroscopic characters of the rocks of the series have already been given, and it only remains to add a description of the microscopic character of the few typical specimens which have been examined, in order to put on record all that is up to the present known of these rocks.

Mica Schists and Granulitic Gneisses.

Near the Coutchiching Rapids the rocks are typical mica schists of the series. They are dark, fine-grained slaty rocks made up essentially of quartz and biotite. A thin section (690) of a specimen from the shore of the lake to the east of the rapids shows it to be an aggregate or mosaic of rounded or sub-angular grains of quartz of a generally uniform size. The quartz is characterized by a more or less undulatory extinction, suggestive of unequal tension. Biotite is in irregularly shaped plates lying in parallel position, determining the schistosity of the rock. A little muscovite accompanies the biotite, and epidote in yellowish to colorless crystals, and in aggregates of such crystals, is sparingly present. Limonite is generally distributed in large and small grains. Apatite also is an accessory constituent. Coutchiching rapids.

On the south side of Knuckle Island, about a mile and a half east of Open-water Narrows, the mica schist is observable in immediate contact with the southern margin of the Open-water Narrows area or boss of Laurentian gneiss. The line of contact of the gneiss and mica schists is parallel to the shore of the island, and close to the waters edge, so that the accessible contact zone of schists is a narrow one. The schist is a fine-grained, light grey, fissile rock, with lumpy or nodular cleavage surface, due to the presence in the schist of large rounded or stoutly spindle-shaped bodies, (occasionally square or rectangular in outline) which give it a gnarled or knotted appearance. The rock is rather soft and fissile, due to decomposition under weathering influences. Under the microscope, (1560) the mass of the rock is seen to be a fine-grained aggregate of granulitic quartz and brown biotite in small plates all arranged parallel. In this, as base, are imbedded large, oblong Contact zone.

plates of muscovite with parallel basal boundaries, but ragged and shred-like at the ends. These plates of muscovite are congregated together in nests with some of the base of the schist, in a modified form, as interstitial cement. This cement differs from the rest of the schist in having more biotite and less quartz in its composition. Besides these nests of large plates of muscovite, there are larger, light-colored areas of oval outline, but of irregular boundaries, which appear to have been probably occupied by crystals of andalusite, or some allied mineral as a product of contact metamorphism. In the present altered condition of the rock the original mineral is replaced by a grey mass of minute particles of muscovite and kaolin, which polarize as an aggregate. The quartz of the schists is seen occasionally to enclose minute shreds of biotite. The total absence of felspar in a rock which has undergone contact metamorphism at the contact with a granitic mass is an interesting fact. It is in harmony with Rosenbusch's observations on the contact zone of Barr-Andlau.*

Absence of felspar in altered rock at contact.

Rock from top of series.

A specimen from the top of the series near the contact with the Keewatin at the west end of Red-pine island is a dark, grey, fine-grained, micaceous schist. Under the microscope, (1436) it appears as a fine-grained quartzite, made up mostly of grains of quartz with a little felspar and a good deal of brown biotite. The quartz grains appear in section as a mosaic, but present a distinctly rounded or granulitic aspect. There are, however, areas in which mosaics of coarser texture appear with the grains more interlocking. These are probably secondary. There are also occasional larger broken pieces of plagioclase and quartz, which shew a partial rounding of the contour, as if by abrasion. Calcite and a little muscovite are also present as secondary minerals.

South shore Rainy Lake.

On the south shore of Rainy Lake near Coutchiching Rapids there is in association with the mica schists an iron grey, micaceous gneiss differing from the former only in the possession of a felspathic constituent. It might perhaps be rather called a felspathic mica schist than a gneiss. In thin section (690 b) it is seen to be composed of quartz, orthoclase, plagioclase, biotite and muscovite. A more or less distinct rounded or granulitic appearance is presented by the orthoclase, though not by the plagioclase. The quartz contains inclusions of apatite in characteristic jointed needles, besides opaque minutely granular bodies.

Bleak Bay.

The rocks on the south side of Bleak Bay are fine-grained, grey gneisses or felspathic mica schists. A specimen (53) in thin section, cut parallel to the schist planes, appears as a more or less granulitic

* Die Steiger Schiefer und ihre Contactzone and en Graniten von Barr-Andlau, Strassburg, 1877.

mosaic of quartz, orthoclase and plagioclase, with an abundance of fresh biotite, mostly arranged in parallel position. Both quartz and felspar contain numerous liquid inclusions, some with bubbles, together with minute microlites. A number of opaque grains of uncertain character are also present. A similar rock, from one of the islands in this part of the lake, in which the section (55) is cut perpendicular to the schist planes, resembles the last closely. The orthoclase is cloudy, while the plagioclase is quite fresh. The quartz contains liquid inclusions with moving bubbles, and hair-like needles of rutile, besides oval grains of apatite. There is a well marked tendency to granulitic structure in the quartz and orthoclase, while the plagioclase is usually in irregular shaped grains. The biotite is in plates of various thickness lying in parallel position.

Another specimen from the south side of Bleak Bay resembles (53). It is very quartzose, and the disposition of the biotite is such as to give it a spangled appearance. Under the microscope, the rock has a strongly marked granulitic aspect, the grains of quartz and felspar having a prevailingly rounded shape. The grains are of varying size. The quartz preponderates very much over the felspar and is full of liquid inclusions arranged mostly in streams. Fresh, brown biotite is distributed throughout the section in small shreds and large plates all in parallel position.

Rocks near Cranberry Bay.

A specimen from the south shore of the lake between Cranberry Bay and Brulé Narrows, resembles the last in general appearance. In thin section (1239) it is seen to be made up of quartz, plagioclase, biotite, muscovite and garnet. The granulitic or rounded character of the constituent grains is confined to the quartz, part of which, however, is also in elongated, irregular lenses. The plagioclase occurs in grains of quite irregular shape, adapted to the contours of adjoining grains, in other words, is granular in the sense in which Rosenbusch defines the word. The biotite is much more abundant than the muscovite and occurs in large plates. Both micas are in parallel position throughout the section. A few garnets of a purplish grey color occur, some of which are the largest individuals of all the minerals in the rock. These are of irregularly rounded shape, and sometimes enclose portions of the base of the rock.

Lob-stick Island.

On the east side of Lobstick Island the series is represented by a dark, pepper-and-salt grey, glistening schist of very fine-grain. Under the microscope (680) it is seen to be composed of quartz, orthoclase, plagioclase and biotite, with a little hornblende. The biotite is very abundant in irregular shaped plates, lying in parallel position. The orthoclase exhibits a zonal structure, the outer portion being of different optical orientation from the inner perfectly shaped crystal which

forms the nucleus of the irregularly shaped grain. The same structure is less commonly exhibited by the plagioclase. In many of the felspars, ocherous or dusty matter, together with minutely granular or granulitic matter, is congregated in more or less spherical bunches in the centre of the grain. Otherwise, the felspars are fresh and glassy. The hornblende is usually in elongated, but irregularly shaped grains. The structure is for the most part granular.

Rocks of Rice Bay area of Coutchiching.

The rocks of the Rice Bay area of the Coutchiching series differ somewhat from those of the same series farther south. They are as before all very quartzose and fall into two varieties, those containing felspar and those free from it. In the latter, which are probably the more prevalent, the rock is either made up of a very schistose interleaving of thick layers of quartz and thin films of dark green scaly chlorite, apparently an alteration production of biotite; or is composed of a similar but less even interleaving of quartz and muscovite, the latter being more abundant than the chlorite in the first case. In the felspathic variety, both biotite and muscovite are usually present, the biotite predominating, and the rock assumes the form of a gneiss of peculiar character, in which the quartz is disposed in lenses usually from one-eighth to one-quarter of an inch in diameter, and from one

Macroscopic characters.

thirty-second to one sixteenth of an inch thick at the middle. If not in lenses the quartz is in very distinct sheets often one or two inches across, and one sixteenth to one eighth of an inch thick. These sheets taper towards their periphery and are, indeed, also much flattened lenses of great diameter. In these rocks orthoclase occurs sometimes in large crystals from half an inch to an inch across, with their greatest diameter parallel to the schist plane, and the plane of composition of the Carlsbad twins inclined at an angle of about 45° to the same. These crystals of orthoclase usually have long tails as in the felspars of augen gneiss. Whether the habitus of the quartz and orthoclase are the result of pressure analogous to that described in the Saxon granulites by Lehmann, or whether they partake of the nature of vein minerals due to the percolation of heated solutions, is a question which can only be decided by a much more careful microscopic study of the rocks than I have had an opportunity of giving them. Apart from these augen-like orthoclases, which are only of occasional occurrence along certain lines, particularly in the rocks on the west side of the narrows of the north arm of Rice Bay, there is a considerable proportion of felspar associated with the quartz throughout the rock. The schists, or gneisses, in which the augen-like felspars were observed, are in proximity to the very coarse mica-syenite or syenite gneiss on the south-east side of Hopkins Bay which appears to be of irruptive origin. Only a few characteristic specimens of these rocks have been examined microscopically.

Entrance to Rice Bay.

At the entrance to Rice Bay, on the west side, the series is represented by a fine-grained, evenly laminated grey gneiss. Microscopically (1506) it appears as a granulitic aggregate of quartz, orthoclase, plagioclase and biotite, with some muscovite and epidote. As a rule, the granulitic or rounded character of the quartz and felspar is very marked. The quartz contains liquid inclusions. All the mica plates are in parallel position.

Rice Bay narrows.

On the west side of the Narrows of the north arm of Rice Bay, a rock occurs whose macroscopic characters have been described on the last page. Under the microscope, (1519 A) it appears as an eminently granulitic aggregate of quartz, orthoclase, microcline, plagioclase and biotite, with some muscovite and epidote. The granulitic or rounded character of the grains is, however, characteristic only of the quartz and orthoclase, while the plagioclase often presents irregular or granular shapes. The felspars are all quite fresh.

East arm of Rice Bay.

A specimen from the north shore of the east arm of Rice Bay, is a schist made up of muscovite and quartz. In thin section (67) the quartz appears in areas of granulitic grains surrounded by muscovite which is very abundant, both in broad plates and in compact aggregates. The quartz is full of colorless microlites. The plates of muscovite are in parallel position.

North arm of Rice Bay.

A specimen from the north end of the north arm of Rice Bay is a schist composed of alternate thick layers of quartz and thin films of green biotite or biotite altered to chlorite. Under the microscope (66) the quartz is granulitic, and contains liquid inclusions and microlites.

Coutchiching on Rainy River.

On an island in Rainy River, a little over four miles above Manitou Rapid, there is an outcrop of a rock which has provisionally been classed with the Coutchiching, although its isolated character renders its stratigraphical relations a matter of conjecture. It has the aspect of a very fine-grained, grey gneiss of even lamination, but microscopically (1604) it appears to be little more than a micaceous sandstone or quartzite. It is made up mostly of quartz, with a little plagioclase in grains of varying size, partly rounded and partly angular. It is evidently a clastic rock, the chief alteration which it has undergone being the development of secondary quartz in mosaics and of muscovite and brown biotite in small irregular plates lying in parallel position. The rock is scarcely schistose. The rounded shape of the constituent grains of quartz appears to be due to water-wearing action in an original sand. There is a good deal of cloudy, kaolin-like material scattered through the section.

A.—Laurentian.

It will be convenient in describing the Laurentian of the region under consideration, to deal with each area separately, dwelling particularly only on that which has been most closely studied, viz.: the Stanjikoming area.

Stanjikoming area

The limits of this Laurentian area have been already described and are shewn on the map of the region which is being prepared. It has a north and south diameter of thirty-two miles, and its greatest diameter is an east and west direction, from Clear-water Lake to the east end of Redgut Bay, is about forty-six miles.

Dimensions

Area separable into two parts.

The area is naturally separable into two distinct parts, according to the character of the rocks which compose them, viz., (1) an inner nucleus, and (2) a broad peripheral zone. The distinction between these is very clearly and sharply defined in the northern half of the area, but much less so in the southern half. The inner nucleus is composed essentially of a biotite-granite gneiss of medium texture and grey color, which is very quartzose and distinctly foliated. The rocks of the peripheral zone are more basic than those of the inner nucleus. The prevailing habitus is that of a syenite, or hornblende-granite, quartz being either absent or only sparingly present. The color is either grey or reddish; the texture is coarse-grained and the gneissic foliation very much less pronounced than it is in the biotite gneisses of the inner nucleus.

Line of demarkation between peripheral zone and inner nucleus.

From the west end of the North-west Bay the line of demarkation between the inner nucleus and the outer zone of hornblende-syenite gneiss, with its local facies of hornblende-granite, and even biotite-granite, gneiss, has been traced very satisfactorily as mapped, around in an irregular crescent, concave to the south, to Redgut Bay. From Lake Despair, across the Despair River and the various arms of Jack-fish Lake, through Loon Lake, across the Manitou River above the Devil's Cascade, and thence across Vane Lake and Capt. Cuttle Lake to Black Sturgeon Lake and Crow Rock Inlet, the line is very sharp, and can be located at all of these various points of intersection very closely, there being a sudden change from one rock to the other. This line is rudely parallel to the line of contact previously sketched between the Keewatin and Laurentian. Between these two roughly parallel lines the zone of syenitic gneisses has a breadth which varies from three to to six or seven miles. That the whole of this breadth is occupied by the same kind of rocks is established by the examination of the well bared shores of the half dozen or more canoe routes, which traverse it at intervals sufficiently close to afford the necessary data for mapping.

At the two ends or horns of this crescent-like zone it appears to become confused with the biotite gneisses of the inner nucleus, and to blend with them in a manner which seems only explicable on the supposition that the two rocks were both in a more or less plastic or fused state at the same time. This lack of sharp distinction between the two kinds of rock begins on the west side on Lake Despair and becomes more and more apparent as we endeavor to trace the syenite gneiss across the end of North-west Bay to Half-way Inlet. A band of these syenite gneisses certainly crosses the North-west Bay in the direction indicated, such direction being coincident with the strike of the evenly foliated biotite gneisses. But in this band are portions which are scarcely distinguishable from the ordinary biotite gneisses, except, perhaps, that they are rather coarse-textured, and which do not appear to be inclusions, but pass into the syenitic phase of the rock by gradations. In the adjacent biotite gneiss, also, which occupies the greater portion of the shores of North-west Bay, there are local developments of a syenitic facies. These are intimately associated with what appear to be included masses and bands of hornblende schist, or massive dioritic rock, in the more acid biotite gneiss, and it would appear in these cases that the coarse syenite gneiss, whether it be mica-syenite or hornblende-syenite, has resulted from the fusion and intermixture of the more acid with the more basic rock. The first occurrence of this coarse syenite gneiss observed in going up the bay is on the south shore opposite Shelter Island, where it has the facies of a porphyritic mica-syenite with frequently a little quartz. At all the available exposures on the shores of Half-way Inlet, this gneiss appears to be the prevailing rock, from a point a quarter of a mile north of Cliff Narrows to the bottom of the inlet. It also appears on the S.E. shores of the terminal expansion of the North-west Bay and occupies probably a mile and a half of the shore. It occurs also on the north, or north-west shore of this same expansion of the bay, opposite Gusty Point. Here, however, as at other places, it is much mixed with the ordinary biotite gneiss, so that the relationship that exists between the two is difficult to make out. In some places it appears to cut the latter as an intrusion through it, but this appearance only extends to the sudden and boss-like presence of the syenite in the midst of biotite gneiss, and contacts where the relationship can be satisfactorily studied, are difficult to find.

Breadth of zone.

Local blending of two kinds of rock.

Gneisses on shores of North-west Bay.

In its continuation to the S.E. the band appears to thin out to a narrow width between Half-way Inlet and the west shore of Rainy Lake, where nothing but biotite gneisses are found, except at a point three-quarters of a mile N.W. of Standing-stone Point, where a small patch of syenite was observed; and some on the latter point itself.

Continuation of zone of syenite gneiss on Rainy River.

It seems probable that the zone of syenite gneiss which thus begins, at the west end of the North-west Bay, to become confused and mixed with the biotite gneiss, is continued in the area of hornblende syenite gneiss, which is exposed on Rainy River between six and seven miles above the Manitou Rapid, and also in the area of coarse mica-syenite gneiss which is exposed on Rainy River at Fort Frances and thence northward for about six miles on the west side of the lake to Stanjikoming Bay. The small area of hornblende and mica-syenite gneiss observable on the south-east side of Hopkins Bay seems to serve as a link of connection between the last and the first described crescent-like zone at its eastern extremity on Redgut Bay. On the Big Canoe River route, the syenite gneiss occupies the whole of the breadth between the inner nucleus of biotite gneiss and the base of the Keewatin. South-eastward of this, however, the zone of these rocks appears to diminish rapidly in breadth, and on Black Sturgeon Lake and Crow Rock Inlet is little more than a mile wide. In this interval, moreover, the rocks composing it are no longer in direct contact with the Keewatin, for the exposures on Big and Little Saw-bill lakes, Porter Inlet, and the north end of Redgut Bay, shew that an area of ordinary quartzose, biotite gneiss lies between the Keewatin and the zone of syenitic gneiss. The latter seems to taper to a point on Redgut Bay, and where it does so, it appears in places to be intimately mixed with the biotite gneiss and appears further, in certain cases which have been examined carefully, on the north side of the bay opposite the Indian village, to result from the fusion of the biotite gneiss with certain included bands or masses of hornblende schist and diorite, which will be alluded to more particularly in the discussion of inclusions in gneisses.

On Big Canoe River route.

Distribution of two gneisses north of Redgut Bay.

Relationship of structural planes of two gneisses at contact.

Above the Devil's Cascade, on the Manitou route, the biotite gneiss may be seen very clearly dipping under the syenite gneiss at an angle of about 60°. On the south-east side of Loon Lake the two rocks are in the same relative attitude, the angle of dip varying from 45° to 60°. At the lower end of Loon Lake, and across Jack-fish Lake, the dip of the biotite gneiss is much less regular, being sometimes away from and sometimes towards the syenite gneiss, the former being the prevailing dip on Jack-fish Lake and on Reserve River. On Vane Lake the planes of foliation of the gneiss are not sufficiently regular to afford an indication of the dip. At the contact here of the biotite gneiss with the hornblende-syenite gneiss, the former is traversed by dykes of granite, while the latter is not. At the contact on Captain Cuttle Lake, no very exact line of demarkation could be detected, but rather a passage from the biotite-granite gneiss, through hornblende-granite gneiss to the syenite gneiss.

The only portion of the zone where the rocks vary so much from their general character as to pass completely from the syenitic facies, and become prominently quartzose and granitic, is at its extreme east end. On the shores of the west arm of Jack-fish Lake, the rocks are somewhat quartzose, and the quartz becomes more abundant on Clear-water Lake, where the rock is a coarse-granite, foliated in some places, and scarcely at all, in others. Variation from normal character.

The biotite gneisses of the inner nucleus of the Stanjikoming area of Laurentian rocks, are, as regards their field characters, chiefly remarkable for the constancy of their composition and general aspect, the uniform regularity of their foliation, the regular dip of such planes of foliation, generally at angles of from 45° to 60°, and the ease with which the strike of their edges can be traced in curves which, in one notable instance at least, close upon themselves in concentric circles. The gneiss is characterized, too, by holding included fragments of foreign rock, which resemble the rocks of the Keewatin and Coutchiching series. These inclusions will be considered more in detail in the next section. The contact with the geologically higher series of Coutchiching and Keewatin rocks is always of a more or less distinctly brecciated character, the gneiss sending apophyses into the schists, and holding imbedded in it detached angular fragments of them. The geologically colored map, taken with the detailed descriptions of typical specimens of the rocks, renders a lengthy account of the geological features unnecessary. Attention may, however, be directed particularly to the structure of the rocks of this portion of the area. The plotting of the observed strikes and dips shows that if we follow the strike of the planes of foliation from the Devil's Cascade southward, it curves gradually to the south-west and west on the shores and islands of Manitou Sound and the bays to the west of it; then north-west along the shores of the North-west Bay and Foot Print Lake, north to north-east through Jack-fish and Loon Lakes, and finally south-east at the south-east part of Loon Lake where the rocks trend directly towards the starting point at the Devil's Cascade, joining in a complete circle. This circular trend of the strike of the planes of foliation of the gneiss is constant in a zone which has a considerable breadth measured on the radii of the circles or in a direction transverse to the strike. The breadth of the zone bears no relationship to the angle of dip, being no greater where the dip is low than where it is high. Thus from the north side of Ash Bay to Ami Point, the rocks have a constant dip to the south-eastward of from 30° to 45°, and the breadth of the zone is much the same as at the opposite side of the circuit where, on Loon Lake and Jack-fish Lake, the dip is at a much higher angle. The angle of dip is also high along the North-west Bay. The concentric circles thus formed by the inter-

Biotite gneisses of inner nucleus.

Concentric structure of foliation.

Focus of concentric structure.

section of the planes of foliation with the horizontal plane of the present surface have their centre in a point which appears to lie in the north arm of Ash Bay, the rocks in that vicinity being at extremely low angles, almost flat in some cases, and the strike consequently difficult to trace. The dip is away from this centre all the way around, so that the structure is the same as that which would be revealed by a section across a low cone or dome laminated concentrically to its surface. The simplest explanation that suggests itself to account for the structure, is that of an upheaving force acting on a plastic mass, such force acting with greatest intensity in the vertical line which would correspond to the axis of the cone or dome. This would correspond to an anticlinal dome in ordinary bedded formations. With this difference, however, that in the latter the structural planes existed as planes of bedding prior to the application of the force which bulged it into a dome, whereas in the case of this Laurentian gneiss, all the evidence goes to show that the structural planes are the result of such upheaval and a differentiation, from the homogeneous character of the rock, produced by the deformation incident to it.

Synclinal and anticlinal structure.

South of a line drawn from Ami Point to the entrance to the North-west Bay, between Hay-marsh and Woodchuck Islands, the dip is very suddenly reversed and we have what appears to be a synclinal axis, the strike on either side of the line diverging to the eastward. A parallel line four miles to the southward, drawn from Frog Portage to the neighborhood of Standing-stone Point, appears to be the corresponding anticlinal axis, for on the south side of this, the dip is again to the south or south-east.

Sporadic intrusions of granite.

Between these two lines, the dip is constantly to the north, and the rocks lying within them are much traversed by local or sporadic intrusions of red granite accompanied by pegmatitic veins. Along the line of the anticlinal axis just mentioned, the biotite gneisses are observed locally to give way to hornblende granite and syenite gneisses. To the south of the line a considerable number of observations have been made as to the strike and dip, but no general statement as to the structure can be deduced from them beyond the fact that the dip is prevailingly south-eastward or eastward on the west side of the lake where the strike curves around to a north and south direction. In this part of the area, inclusions of rock fragments resembling the formations of the Coutchiching series are more abundant in the gneiss than farther north. Indeed in some places, notably between Blaze Point and Frog Portage, the gneiss appears to be quite composite in character, as if made up of shattered fragments of such rocks as occur in the Coutchiching series which had become immersed in a felspathic magma, partially fused and drawn out into lenticular bands. Some

Composite character of gneiss locally.

phases of this variety of the gneiss present a remarkably evenly ribbanded aspect due to alternations of sheets of dark, fine-grained, very micaceous rock, with others of light grey color, of coarser grain and mostly felspathic, with little or no mica.

Bosses of Laurentian gneiss between Bear's Passage and Coutchiching.

The three small bosses of biotite gneiss that lie in the axis of the anticlinal fold of Coutchiching rocks which stretches from the Bear's Passage to Coutchiching have already been alluded to at sufficient length (p. 102). It only remains to be noticed that the gneiss of the most westerly of the three exhibits the most pronounced, and that of the most easterly the least pronounced foliation, or is most granitoid. In all three the evidence of their protrusion through the Coutchiching rocks is most clear, and also that the protrusion has been one of slow upheaval of a magma which must have been very thickly viscid, or tough and coherent, rather than fluid. For the gneiss has not simply filled a dyke-like fissure in the Coutchiching schists, but has displaced the latter in such a way that the strata have everywhere accommodated themselves to the shape of the protruded boss, i.e., the strike conforms to the shape of the boss, and runs around it, while the dip is constantly away from it. The dykes that emanated from the gneiss and penetrate the schists at the contact are of a local character, and do not extend far within the schists, being originally rather of the nature of a plastic mass forced into fissures and crevices by great pressure, than fluids filling cracks in the crust like regular dykes.

Sabaskong Laurentian area.

The rocks of the Sabaskong Laurentian area, so far as they are known, on the Kishkutena route, Sabaskong Bay, and the shores and islands of the south part of the lake, are mostly quartzose gneisses. An exception to this general rule is found in a mass of hornblende-syenite gneiss, of very coarse texture and very indistinct foliation, which occupies about two miles of the south-east shore of Lake of the Woods, beginning at a point one mile north of the 49th parallel. A patch of the same rock also occurs on the extremity of Pork Point. All the other rocks are either biotite-granite gneiss or hornblende-granite gneiss, the latter being usually only a local facies of the former. Thus the rocks of Sabaskong Bay, as a whole, resemble very closely those of the inner nucleus of biotite gneiss of the Stanjikoming area, but on the islands at the mouth of the bay, on the south shore where it opens out to the lake, the proportion of the quartz is less, hornblende replaces a part of the biotite, and finally the rock passes into a hornblende-granite gneiss in which there is no mica. At the east end of the bay, the proportion of mica becomes less, and that of quartz increases, and the whole aspect of the rock is more granitoid and perhaps coarser grained. This increases along the Kishkutena route, till on Kishkutena Lake the rock is a very quartzose, coarse-grained,

Variation in character of rocks.

reddish granite, with a foliation only occasionally developed, but still geologically the same as the evenly foliated gneisses of the western and middle portions of Sabaskong Bay. The strike of the planes of foliation of these gneisses exhibits a marked tendency to a disposition in concentric circles similar to that observed on Rainy Lake. The gneisses both here and on the south-east shore of the lake towards the mouth of Rainy River are often charged with inclusions of hornblende schist and dioritic or amphibolitic rock. In Sabaskong Bay their foreign and included character is much more apparent than in the gneiss south of the mouth of Little Grassy River, where the schist and gneiss are either confusedly mixed, or appear in remarkably even inter-bandings, due, doubtless, to pressure deformation, such as that discussed by Teall,* with this difference, that, whereas, Teall regards the more basic bands as the squeezing or pulling out into sheets of the more basic early secretions from the magma, the evidence here points to their having been fragments detached from the once overlying Keewatin series, or pipes of volcanic rocks that filled vents in the floor upon which the Keewatin was deposited, and which by fusion and recrystallization gave rise to the Laurentian gneiss. Even where they are most evenly banded, there is occasional evidence of the gneiss having been the matrix, since it traverses the schists locally transversely to the strike. Many of these inter-bandings appear, too, as I have before stated, to have been produced by the penetration of the gneiss in a plastic condition along fissures which are coincident with the cleavage planes of the schist, the latter having been parted on the large scale in a manner similar to that shewn in Plate VI for a comparatively small inclusion.

Inclusions of foreign fragments.

Turtle Lake Laurentian area.

In the Turtle Lake Laurentian area, so far as it comes within the limits of the region examined, the greater part of the gneisses are quartzose, biotite gneisses, similar to those of Rainy Lake and Sabaskong Bay. Going northward from Rainy Lake to Manitou Lake, by way of the Otukamamoan route, all the shores of the lakes as far as the outlet of Kinojé Lake are composed of this rock. Between this point and the Manitou Lake, however, we come upon rocks of the character of hornblende-granite and syenite gneiss of much less distinct foliation and coarser texture. These are very similar in character to those of the peripheral zone of the Stanjikoming area, and occupy a similar position relatively to the biotite gneisses and to the Keewatin series. These hornblende-granite and syenite gneisses are well exposed on all the shores of Kionjé, Kahwawiagamak, Memekwesi (west end), Downgrade, Smooth-rock, and Windigons Lakes. All the Laurentian rocks observed on the shores of lakes and rivers between the Otukamamoan

Zone of syenitic gneiss similar to that of Stanjikoming area.

* On the origin of certain banded gneisses, Geol. Mag., Nov., 1887.

route and Big Turtle River, and on Big Turtle River itself, to a point one mile north of Jones Lake, are quartzose, biotite gneisses. At the point above Jones Lake just mentioned, however, we come upon coarse, reddish, hornblende-syenite gneiss. This is probably geologically the same with the hornblende-syenite and granite gneiss observed at the north end of the Otukamamoan route, and if so, they would appear to form a zone quite as extensive as the peripheral zone of the Stanjikoming area.

Lake Harris Laurentian area.

The Lake Harris Laurentian area on the northern limits of the region mapped, has only been partially examined. The small portion of it which comes within the limits of the Rainy Lake sheet appears to be continuous with the Laurentian known to occupy the shores of the middle and eastern parts of Deer Lake and which, according to Bell,* also occupies the shores of Hugh Osbourne's Lake, and of lakes Rowan, Hill and Lawrence. If this be so, then the Lake Harris area is an immense pear-shaped area of Laurentian rocks completely encircled by the rocks of the Keewatin series, and so quite analogous to the Obabicon, Sabaskong, and Stanjikoming areas. From Dr. Bell's account of the distribution of the (Huronian ?) Keewatin on Wabigoon and Eagle Lakes, and our own knowledge of the distribution of the Keewatin on the Manitou route and thence continuously by way of Pipe-stone Lake, Crow Lake and White-fish Lake to the west end of Deer Lake, there appears to be no doubt but that the area is completely encircled, as stated, by these rocks. The interior of the area has not yet, however, been examined and all that can be said at present is that it is very probably entirely occupied by Laurentian gneiss. The greatest length of the area in a N.E. and S.W. direction is forty-five miles, and its greatest width, from Lake Harris across to near the outlet of Deer Lake, is about twenty-five miles.

Encircled by Keewatin schists.

Lake Harris.

On Lake Harris the gneiss is coarse and granitoid with very indistinct foliation, or none at all. Hornblende-granite and biotite-granite both prevail, the former, however, being probably more abundant than the latter. Both kinds are simply different facies of the same geological mass. No varieties were here observed which are entirely devoid of quartz.

Bluff Lake.

On Bluff Lake, however, the Laurentian rocks in the vicinity of the contact with the Keewatin are very basic, and have the facies of a uralitic gabbro. Towards the north this passes into a hornblende-syenite gneiss and then into a hornblende-granite gneiss, the rocks at the north end of the lake being distinctly quartzose.

* Geological map of the Lake of the Woods and adjacent country, 1881.

Petrography of the Laurentian Rocks.

Hornblende-Granite and Hornblende-Syenite Gneiss.

Different facies of same rock mass.

The hornblende-granites, foliated and non-foliated, are not separable, geologically, in the Rainy Lake region, from the hornblende-syenites. In the former, the quartz is never, as a rule, very abundant; and in the same geological mass, specimens may be taken which, regarded in themselves, would be classed as hornblende-granites, while others, not far distant, may be taken in which it is difficult to find a trace of quartz, and which would, therefore, be placed with the syenites. In view of the sparing amount of quartz, when present, and of the geological identity of the quartzose varieties with the quartz-free, it has been found convenient to refer generally to these rocks as syenite, particularly those of the peripheral zone of the Stanjikoming area. When foliated they are called syenite gneiss. It is, however, just as difficult to draw a hard line between the foliated and non-foliated varieties of those rocks as between the quartzose and quartz-free. The one grades into the other, and rocks which are non-foliated may sometimes be referred to as gneisses, because of their being a mere local facies of a mass which is prevailingly foliated or gneissic. Although distinctly foliated, the rocks here considered rarely, if ever, assume that evenly parallel lamination or banding which is commonly observed in the biotite gneiss.

Stone-dam Lake.

The Laurentian formation with which the Keewatin rocks are in contact at the north end of Stone-dam Lake is a coarse-textured, hornblende-granite gneiss. In thin section (375) it is seen to be made up of a granular aggregate of orthoclase, plagioclase, hornblende and quartz, with some rounded prisms of apatite, a few grains of magnetite and a little secondary biotite and epidote. The quartz is in large water-clear grains, including apatite and other less determinate microlites. The orthoclase is partially altered to kaolin and muscovite. The plagioclase is usually fresher, but is occasionally cloudy. There are included in it long, perfectly straight, extremely fine rods which are sometimes in perfect continuity for great lengths and sometimes disjointed. Part of the hornblende is somewhat fibrous, and has associated with it epidote as an alteration product. On its margin it is in places altered, also, to biotite, which in turn has epidote developed in it.

North shore Loon Lake.

Another specimen from this part of the zone, taken from the north shore of Loon Lake, is a coarse, foliated, mottled, black-green and white granite. Under the microscope (525) the structure is granular. The orthoclase and plagioclase are usually quite fresh, with exceptional small patches of decomposition products. The hornblende is in

deep green colored, compact grains, with sometimes a nuclear, light yellowish colored portion, which shews brilliant polarization colors and large extinction angle, evidently the remains of an original pyroxene of which the hornblende is a paramorph. The cleavage of the pyroxene is coincident; and the latter, although not at all fibrous, appears to be developed along the cleavage of the pyroxene well within the nuclear area occupied by it. Biotite is sparingly present associated with the hornblende, from which it is probably derived. Epidote occurs in large, yellowish masses with well defined cleavage ($\infty P\bar{\infty}$) to which the extinction is parallel. It is sometimes associated with the hornblende, but is often quite apart from it. Apatite is of rather frequent occurrence in small oval and stout columnar crystals shewing pyramidal terminations.

Jack-fish Lake north-west arm

On the shores of the north-west arm of Jack-fish Lake, the same geological mass or zone is represented by a coarse-textured, flesh-tinted rock made up, so far as can be determined, macroscopically, of felspar and black hornblende. Under the microscope (562) the hornblende is compact and of a deep color, with the usual pleochroism, and is frequently observed to have a core of foliated pyroxene. The pyroxene (diallage) polarizes in brilliant colors and shews a high extinction angle, it is colorless and not perceptibly pleochroic. The encroachment of the paramorphic hornblende upon the pyroxene along the cleavage traces is shewn very beautifully. The felspars are cloudy orthoclase, microcline and fresh plagioclase, with inclusions of apatite. Larger crystals of apatite and sphene in idiomorphic development are sparingly distributed. Small quantities of brown mica and a very little quartz are also present. Epidote occurs in separate, well-formed, pleochroic crystals of greenish-yellow color, often with an opaque nucleus of iron oxide. It also occurs in the plagioclase. Besides this, chlorite is present as an alteration product of the hornblende.

Cores of pyroxene in hornblende.

Another specimen from the south-west side of the same bay is a coarse-grained, pepper-and-salt, grey, hornblende and felspar rock. Under the microscope ($560\frac{1}{2}$) the structure is granular. The hornblende possesses distinct cores of foliated pyroxene (diallage) which demonstrate very perfectly the secondary origin of the former, and point to the paramorphic derivation of all the hornblende in these rocks from pyroxene of some form or another. The diallage appears to pass into a pale, green colored variety of the hornblende first, and then into deeper colored varieties, the pyroxene itself being of a light grey to lavender color, and very slightly pleochroic. The angle of extinction is about 40°, and the polarization colors are the brilliant ones common the pyroxenes. Plagioclase and orthoclase are present in abundance, but the former predominates very much over the latter.

Apatite is fairly abundant as an inclusion in the other minerals, and biotite is present but is probably an alteration product of the hornblende with which, together with epidote, it is closely associated. The remains of foliated pyroxene and the preponderance of plagioclase taken together with the granular structure, suggest that this rock perhaps belongs with the gabbros rather than the syenites.

Foot-print Lake S. W. side.

On the south-west side of Foot-print Lake, the biotite gneiss is interrupted by a rather ill-defined area of hornblende syenite. The rock is a coarse-textured aggregate of flesh-tinted to red felspar and greenish, black hornblende. Under the microscope, the structure is granular, and the section (642) is made up of fresh microcline, inter-grown with albite, giving regular perthitic structure; plagioclase, slightly cloudy, in patches; compact, green hornblende, with occasionally a core of the original pyroxenic mineral to suggest the secondary origin of all the hornblende. Sphene and apatite are generally distributed, though not abundant, the latter in stout, rounded or pyramidally terminated prisms, and the former in its characteristic double-wedge shaped forms. Epidote is plentiful and has, in some instances, apparently been formed around a grain of magnetite or other iron oxide, but is generally associated with the hornblende from which, and from the felspar it is derived. A small proportion of the hornblende or of the pyroxene of which it is a paramorph, has been changed to nearly isotropic chlorite.

Foot-print Lake lower end.

At the lower end of the same lake, the rock, evidently the same geologically as the last, is a coarse-textured, salmon-tinted gneiss, made up of felspar with a small proportion of epidote and chlorite in rough but distinct gneissic arrangement. Under the microscope (646) the felspars are seen to be fresh orthoclase, microcline and plagioclase (albite). The lamellæ of the latter are frequently bowed and the twinning of which they are indicative is, in some instances, probably secondary and due to pressure. Other pressure effects are observable, such as the minute faulting and dislocation of crystals, and the abrupt termination of twinning traces upon cracks.* The pyroxenic or hornblendic constituents of the rock have been so decomposed that they are represented now only by intermingled aggregates of epidote and chlorite. The only other minerals observed are a little limonite and some secondary quartz.

North-west Bay Rainy Lake.

At the west end of the North-west Bay of Rainy Lake a decomposed syenite rock interrupts the biotite gneiss much as it does on Foot-print Lake. It is a coarse-grained, granular aggregate of flesh-red felspar, faded-green hornblende and yellow-green epidote. Under the microscope (918) the felspars comprise orthoclase, microcline and

* Cf. Judd. Tertiary and Older Peridotites of Scotland, Q. J. G. S., 1885.

plagioclase with inclusions of apatite. The hornblende is very largely altered to epidote, which is closely associated with it. Besides this there is an abundance of epidote, in large masses and in aggregates of grains, whose origin is less apparent. Quartz is only sparingly present, and is dusty, with liquid and granular inclusions.

Above Devil's Cascade.

On the Manitou Canoe route from the Devil's Cascade to Cedar Narrows, on Pickerel Lake, the whole breadth of the peripheral zone of the Stanjikoming Laurentian area, is well exposed. The rocks are gneissic, hornblende-granites and syenites, of which a number of typical specimens have been critically examined. Half a mile above the Devil's Cascade, the rock is a grey, distinctly foliated gneiss, which in thin section (951) is seen to be a granular aggregate of orthoclase, plagioclase, hornblende and quartz, with some idiomorphic apatite included in all these, and epidote in considerable abundance associated with the hornblende. The felspars are all fresh and the hornblende is compact, but of rather pale shades of green, and not so strongly pleochroic as it is usually; it is in irregularly shaped grains, which, however, are generally elongated in the direction of the prism. The quartz contains, as inclusions, long, straight, extremely fine, rod-like bodies.

Sphene Lake.

About a mile W.N.W. of the last locality, on the shores of Sphene Lake, the rock is of the same microscopic characters. Microscopically (959) it is a granular aggregate of orthoclase, microcline, plagioclase, hornblende and quartz, the last in sparing quantity. The accessory idiomorphic constituents are brown, pleochroic sphene, apatite in jointed needles and oval bodies, a few zircons, and a slender, pink-tinted, limpid, pleochroic prism, with parallel extinction, and low refractive index, probably tourmaline. The latter is included in the orthoclase. The felspars are fresh, and there is probably more than one variety of plagioclase, some of the crystals shewing broad twinning lamellæ, while in others these are excessively fine. The hornblende is compact, deeply colored and stoutly pleochroic. It is usually full of inclusions of apatite, sphene, and grains of magnetite. The quartz plays a very subordinate rôle, and may be regarded as an accessory.

A mile and a half north of the Devil's Cascade, on Sphene Lake, the rock is very much the same as that last described, a distinctly gneissic, coarse-grained, hornblende-syenite, with accessory quartz, apatite and sphene, together with a little secondary biotite associated with the hornblende. The quartz is dusty, with inclusions of an indeterminate character, together with microlites of apatite, small, stout, brown bodies and long, straight, excessively thin rods, probably rutile, many of which have a parallel arrangement, but which, taken altogether, have no apparent regularity. The most interesting point to be observed in the

Twinned sphene.

section (961) of the specimen from this locality is the beautiful instance of the twinning of sphene according to the law first described by Dr. G. H. Williams,* as explanatory of the apparently perfect cleavage in

Fig. 11. Section of hornblende-syenite gneiss from west side of Sphene Lake shewing a crystal of titanite polysynthetically twinned parallel to—4 P (Dana), probably as a result of pressure. Nicols +. × 44.

t. Titanite	*a.* Apatite
o. Orthoclase	*b.* Biotite
h. Hornblende	*q.* Quartz
p. Plagioclase	*p′.* Plagioclase, dislocated, and shewing pressure twinning.

American varieties of this mineral. The sphene is rather abundant in brown, slightly pleochroic crystals of the usual double-wedge shape, and the crystal shewing the twinning parallel to —4 P (Dana) is cut approximately perpendicular to the prismatic zone. The aspect of the crystal between crossed nicols will be gathered from a glance at (Fig. 11). There is a well pronounced set of lamellæ of varying width, inclined at a small angle to one of the prismatic faces; and feeble traces of another set of polysynthetic lamellæ are also observed as nearly parallel to the other prism, or inclined to the first set of lamellæ at an angle of 113°. This twinning law, which gives rise to the parting commonly regarded as cleavage in the largest sphenes found in many crystalline limestones does not seem to have hitherto been observed in the sphenes occurring in massive rocks. Dr. Williams in his paper, suggests that this twinning is probably due to pressure, and its occurrence, in the present instance, is under such conditions as lend interesting confirmation to this view. Faulted and secondarily

Probable pressure effects.

* Cause of the apparently perfect cleavage in American sphene, Am. Jour., Sci. XXIX, June, 1885.

twinned plagioclase occurs in such relation to it as to shew that there must have been pressure exerted at right angles to the best developed twinning lamellæ, while at right angles to the feebly developed lamellæ, there is no such evidence of pressure.

Cedar Narrows.

At Cedar Narrows, Pickerel Lake, the gneissic hornblende-syenite is in contact to the north with dark green, hornblende schists. Near the contact the syenite gneiss loses its foliated aspect, and becomes very much darker in color, the hornblende greatly predominating, and at the contact, the appearance is such as might be produced by a partial fusion of the green schists and their absorption into the magma which solidified as the syenite. There is a transition of several yards between the schists and the coarse-textured, foliated, black and white syenite, whose general character may be described as that of an aggregate of hornblende crystals in which are included reddish crystals of orthoclase. Under the microscope (1054 A) this transition rock is seen to be made up, besides orthoclase and hornblende, of large quantities of epidote and zoisite, with muscovite, derived from the decomposition of the felspar in scattered shreds. In another section (1054 B) of the same rock, where it is coarser-grained and farther from the contact, the structure is that of a hornblende syenite. The hornblende sometimes shews a pale colored central area, suggestive of its derivation from pyroxene, and carries numerous inclusions of apatite, besides which there are larger oval apatite crystals scattered through the slide. The felspar is cloudy and is sometimes stained red with oxide of iron. Epidote occurs in large individuals and in aggregates of grains.

Transition rock at contact.

Among these hornblende-syenite and granite gneisses the most interesting point, is, perhaps, the frequent detection of either a pyroxene core, or evidence of the former presence of one, in the middle of the hornblende crystals, demonstrating the secondary origin of a portion at least of the hornblende of these rocks. This, of course, raises the question of the extent to which the hornblende is secondary; and it seems not improbable that all the hornblende of the hornblende-syenite and granite of this region is of secondary origin. Such a view appears to be quite in harmony with the growing conviction of petrographers and geologists as to the general paramorphic origin of hornblende in cases where it is not distinctly basaltic. Irving* sums up his conclusions, at the end of a valuable paper on this question, in these words: "Thus, after an examination of about a thousand thin sections, representing the crystalline schists, acid eruptives and basic eruptives of a region some 400 miles in length by 300 in width, and of three distinct geological systems, I have found no hornblende that is

Secondary character of hornblende.

Irving's conclusions.

* On the Paramorphic Origin of Hornblende of the Crystalline rocks of the North-western States. Am. Jour. Sci., 1883. Vol. XXVI, p. 27.

Wadsworth. not either clearly, or very probably secondary to augite." Wadsworth had previously expressed a similar opinion with reference to the greenstones of the Marquette district.* The development of the idea of the Williams. secondary origin of hornblende is succinctly sketched by Dr. Williams and a number of instances are described by him shewing the passage of augite into compact hornblende.† In view of these and many other observations, and of the fact that the hornblende of the syenite and granites of this region frequently has a remnant of the original pyroxene clearly discernable in its centre, I feel warranted in stating that these rocks, hornblende-syenites and granites, foliated and non-foliated, seem to bear the same relation to pyroxene-syenites and pyroxene-granites as do many of the old greenstones, commonly called diorites, to original diabases and gabbros.

Mica-Syenite Gneiss and Biotite-Granite Gneiss poor in Quartz.

Texture and structure. These rocks resemble closely the foliated, hornblende syenites and granites in their conditions of occurrence, but are sometimes in geographically separate masses. Their texture is coarse to very coarse, and they are usually of gneissic habit, although they can be traced into varieties in which it is difficult to detect any sign of foliation. They are usually characterized by the porphyritic development of orthoclase in large crystals twinned according to the Carlsbad law, and, when the rock is gneissic, the long axes of these porphyritic crystals are in parallel alignment. The planes of foliation are, however, in their detail undulatory, owing to their flowing around the large felspars as in the case of augen gneiss. It occasionally contains rounded or ovoid secretions of finer grain, or more rapidly cooled portions of the rock which are of identical composition with the bulk of the rock mass.

Falls of Fort Frances. The rock at the Falls of Fort Frances on Rainy River belongs to this class. On the islands below the fort and on the shores of Sand Bay, the same rock is more distinctly foliated than it is at the falls. A section (65) of this rock shews it to be a granular aggregate of orthoclase, plagioclase and biotite, with a little accessory hornblende and quartz, in which are imbedded porphyritic crystals of orthoclase. Other accessory constituents are sphene, apatite and magnetite. The twinning lamellæ of the plagioclase are very fine and the extinction determined on a cleavage slice parallel to $\infty P\bar{\infty}$ is about 1°, so that it is very probably oligoclase.

Sand Bay, Rainy Lake. At the bottom of Sand Bay, near the Half-breed village, the rock is much the same as that at the falls, but it is distinctly gneissic and

* Bull. Mus. Comp. Zool., 1880, pp. 37, 39, 42, 46.

† On the Paramorphosis of Pyroxene to Hornblende in Rocks. Am. Jour. Sci., 1884, Vol. XXVIII, p. 259.

shews areas of finer grain enclosed in the coarser, probably as earlier secretions. The composition and structure of these, as revealed by the microscope, present no marked difference from the rest of the rock except in the texture. The thin section (662) is that of a granular aggregate of fresh plagioclase, orthoclase, biotite, hornblende and quartz, with some epidote.

Stanjikoming Bay.

Another specimen of this same gneiss was taken from the east side of Stanjikoming Bay near the channel leading into it from the lake. The rock is here a coarse, grey gneiss with porphyritic crystals of orthoclase in Carlsbad twins. Under the microscope (793) it is a granular aggregate of orthoclase, microcline, plagioclase, biotite and quartz. Apatite and sphene are accessory original constituents and limonite and epidote secondary products. None of these are very abundant. The quartz is in sparing quantity and is intergrown with orthoclase in micro-pegmatitic structure. Only an occasional crystal of hornblende is observable. The epidote is derived apparently from the biotite with which it is associated as large, well-formed crystals of yellowish color.

Near Standing-stone Point.

Farther north, on the west side of Rainy Lake, three-quarters of a mile N.N.W. of Standing-stone Point, a decomposed, flesh-red, porphyritic gneiss of coarse-texture interrupts the biotite gneiss of that part of the lake. It is made up of large crystals of felspar around which the micaceous constituents flow. Under the microscope (833) the felspars are seen to be orthoclase, microcline and plagioclase with some included zircons. The mica is altogether changed to epidote and chlorite, there being none of the fresh mineral left. A little leucoxene is also present.

Biotite Gneiss.

Comparison of foliated and non-foliated varieties.

The biotite gneisses of the region have not been made the subject of extensive microscopic study, such an investigation being unnecessary for ordinary determinative purposes. A few typical specimens from different parts of the region have, however, been examined, chiefly with the object of instituting a comparison between the minute structure of the more distinctly foliated and the less or non-foliated varieties. Such a comparison failed to establish any essential distinction between the two varieties beyond that observable with the naked eye in the parallelism of arrangement of the constituent minerals in the gneiss as contrasted with their indiscriminate disposition in granite. In both the structure is granular.

Crow Portage.

At the south end of Crow Portage, Sabaskong Bay, the gneiss which has been described as forming a brecciated contact with the basal, hornblende schists of the Keewatin series, is a medium grained, flesh-

tinted to grey rock of unusually even foliation. In microscopic section (48 B) it is seen to have a well-defined granular structure, all the minerals being allotriomorphic, except a few large porphyritic felspars of an earlier generation than the mass of the rock. The constituents are quartz, orthoclase, plagioclase, and biotite. The last mentioned mineral always lies in definite parallel planes, while the quartz and felspar grains exhibit a corresponding but much ruder tendency to a similar arrangement. The felspars are usually quite fresh. When decomposed to kaolin or muscovite, the decomposition is nuclear or central rather than marginal, and shews itself in sporadic flakes or cloudy aggregates sometimes along cleavage lines. The orthoclase is occasionally seen in Carlsbad twins, and the plagioclase is as usual twinned on the albite law, or a combination of this and the pericline law. The felspars are occasionally observed to be broken and parted with a shear, the intervening fissure being filled with secondary quartz or muscovite. The quartz carries inclusions of apatite, liquid inclusions with dancing bubbles, and darker bordered round inclusions, probably of gas, besides dusty or granular indeterminate matter.

Loon Lake. On the south side of Loon Lake, on the Pipestone canoe route, there is an extensive exposure of the biotite gneiss of the inner nucleus of the Stanjikoming Laurentian area. A specimen taken from the west side of the lake, about a mile north of Speak-no-bad-language Portage is an evenly, foliated, flesh-tinted to grey, fine-grained rock. Microscopically (476) it is built up of allotriomorphic grains of quartz, orthoclase, plagioclase, biotite and epidote, the structure of the rock being granular. Quartz is the most abundant mineral. It contains fluid inclusions with moving bubbles, fine straight, rod-like bodies, probably rutile, and besides these a number of small yellowish, highly refracting, oval or oblong bodies. The orthoclase is perfectly fresh, and is only distinguished from the quartz by the bluish color between crossed nicols and its biaxial interference figure in converged polarized light. The plagioclase is also quite fresh and is as usual recognized by its polysynthetic twinning. The biotite is of a greenish, brown color. Stout, oblong crystals of apatite and epidote in aggregates of grains are also present.

Stanjikoming Bay. The medium grained, biotite gneiss on the west shore of Stanjikoming Bay, towards its north end, differs but little from that last described, except that it is much less distinctly foliated and looks more like an ordinary grey granite. In thin section (776) the structure is granular. The felspars are usually fresh and the plagioclase is probably more abundant than the orthoclase, although the rock is decidedly quartzose. Apatite and sphene are sparingly present. The biotite is in places altered to chlorite.

From the west coast of Rainy Lake, about two miles north of the entrance to Stanjikoming Bay, a specimen was taken which may be regarded as typical for a very large proportion of the gneiss of the inner nucleus of this Laurentian area. It is a medium-textured, evenly foliated, biotite gneiss, which, in thin section (801), appears as a granular aggregate of quartz, orthoclase, plagioclase and biotite, with sphene and apatite as accessory constituents in their usual idiomorphic forms, included in the first named minerals. Besides these there are a few small, stout, highly refracting, brilliantly polarizing bodies which are probably zircons. Some epidote, derived from the mica and a few grains of magnetite complete the list of constituents. The quartz is water-clear and shows streams or rows of liquid inclusions with moving bubbles. This mineral shews in all its sections a strongly marked undulatory extinction. The undulatory character manifests itself in two ways, (1) the extinction passes across the quartz section like a wave, as is ordinarily the case when a crystal is subject to unequally distributed tension, and, (2) a somewhat abrupt break in the optical orientation in different parts of the crystal without any apparent break in its individuality. The angle, however, through which the stage of the microscope must be revolved to make these diversely orientated portions of the same individual coincide in intensity of extinction, is very slight. West coast Rainy Lake.

Of the more granitoid or less foliated varieties of this gneiss, a specimen from the north side of the Open-water Narrows is a good example. Under the microscope (1464) it appears as an aggregate of orthoclase, microcline, plagioclase, quartz, biotite, muscovite and some epidote. The rock has a granular structure and is a true granite according to Rosenbusch's classification since it contains the two micas. The foliation is only observable on the large scale. Open-water Narrows.

On the north-west side of Pipestone Lake a mass of granite breaks through the Keewatin schists, which appears to be identical geologically with the Laurentian granite and granitoid gneiss of Kishkutena Lake which pass into distinctly foliated gneisses along the route to Sabaskong Bay. A thin section (326) of this rock is seen under the microscope to consist of hypidiomorphic orthoclase and allotriomorphic quartz and plagioclase with bleached biotite. The accessory minerals are apatite, sphene, magnetite, and leucoxene. The orthoclase is usually quite decomposed, the kaolin and muscovite having often a very distinct zonal arrangement. The sphenes are in sharply defined crystals, often surrounded by a rim of varying width of grey or brownish leucoxene. The biotite is often of a green color, and has epidote associated with it. Pipestone Lake.

Clear-water Lake, east side.

On the east side of Clear-water Lake, Kishkutena route, the peripheral zone of syenite gneisses of the Stanjikoming Laurentian area, presents the local facies of a medium-grained, flesh colored granite of porphyritic aspect which, in places, is distinctly foliated. In thin section it consists of large idiomorphic or hypidiomorphic crystals of felspar (orthoclase, microcline and plagioclase) and allotriomorphic quartz, felspar and biotite, the latter mostly altered to chlorite and epidote. The felspars, even when quite allotriomorphic, shew a distinct zonal structure, the different zones having a different optical orientation, indicating difference of composition. The decomposition in some zones is much greater than in others, so that the alteration products have a zonal arrangement. The quartz is water-clear and comparatively free of inclusions. A few small sphenes are present.

Laurentian gneiss at contact with Coutchiching.

The Laurentian gneiss at the contact of that formation with the schists of the Coutchiching series on a small island three miles east of Coutchiching, is a grey, medium grained, distinctly but not evenly foliated rock. It forms the matrix in which are imbedded the detached fragments of Coutchiching schist shewn in Plate I. Under the microscope (693) it is an eminently granular aggregate of grains of orthoclase, plagioclase, quartz and biotite. The felspars are partially decomposed, the cloudy, grey kaolin exhibiting a definite zonal arrangement, though occasionaly confined to the central portion of the crystal. Shreds of muscovite are generally distributed as an alteration product of the felspar. The biotite is only sparingly represented. It is often bleached green, and is then usually associated with epidote into which it has partially altered. Apatite occurs included in the biotite. Pyrite is also present in small quantity and limonite in various brown grains.

Inclusions in Laurentian Gneiss.

Shape of inclusions.

The Laurentian gneisses of the region, both of the granite and the syenite type of composition, frequently form a matrix in which are imbedded portions of foreign rock either as sharply angular, sub-angular, or somewhat rounded blocks, or as more or less attenuated bands drawn out parallel to the foliation of the gneiss and confused with it. This phenomenon is perhaps more commonly observed in the granite gneisses than in the syenite gneisses. As in the Lake of the Woods region these inclusions are most abundant in the vicinity of lines of contact with over-lying rocks. They are, for the most part, indistinguishable from the basal portions of either the Keewatin or the Coutchiching series. Where they present points of difference, the difference is such as is readily

explicable as a result of the conditions to which the inclusions must be conceived to have been subjected. Near the contact with the Coutchiching series the Laurentian gneiss holds as inclusions generally only fragments which are identical with Coutchiching rocks where examined *in situ;* whereas near the contact of the Laurentian with the Keewatin fragments resembling the Coutchiching rocks are very rarely met with, and those resembling the basal formation of the Keewatin abound. These facts, taken in connection with the prevailingly shattered character of both the Coutchiching and Keewatin strata at the contact with the Laurentian gneiss, which allows apophyses or dykes from the main area of gneiss to ramify through the schists both parallel and transverse to their planes of schistosity, leave no room for doubt but that these inclusions are detached portions of overlying formations, which, in a firm and brittle condition, have become immersed in the underlying viscid magma which subsequently crystallized out as the Laurentian gneiss and granite. It seems probable, too, that such shattering and detachment of fragments took place at the last stages of crumpling of the crust in this region. This opinion is based on the fact that while both the Coutchiching and Keewatin rocks afford ample evidence of having yielded to pressures and earth stresses, the Laurentian gneisses do not, except very locally, and to an insignificent extent. This fact proves that after the solidification of the Laurentian gneisses there was no farther very violent deformation of the crust and no shattering subsequent to the time at which those gneisses were solid, hard rocks as they are now. All the violent disturbance of the region, and the folding and crumpling of the strata of the Coutchiching and Keewatin series appears to have transpired antecedent to the final solidification of the Laurentian rocks, and while the latter were yet in the form of probably a thick, viscid magma upon which floated the slowly shrinking and crumpling strata of the Coutchiching and Keewatin series. The scattered fragments of the overlying series which we now find imbedded in the Laurentian gneiss do not, of course, represent the whole of the shattering and decrepitation, as it were, of the overlying rocks. Large portions of these rocks have very probably been absorbed by fusion with the magma, for the Laurentian rocks appear to have resulted from the fusion not simply of the floor upon which the Coutchiching and Keewatin rock first rested, whatever such floor may have been, but, also, with it, of portions of those series. The inclusions which we now see are probably only those fragments which were detached, as I have stated, at the later stages of the development of the Laurentian gneiss, when the heat was less intense and the temperature of the magma was approaching the fusion point or the point of solidification, for the pressure and other modifying influences to which it was subjected.

Comparison with Keewatin and Coutchiching rocks.

Shattered character of strata at contact with Laurentian.

Period of shattering.

Probable absorption.

Meaning of contact of upper and lower Archæan.

This conception of the development of the Laurentian gneiss, which seems necessary in order to give a consistent explanation of all the phenomena of this field, involves the belief that the present line of demarkation between the lower and upper Archæan, or the contact of the Laurentian with either the Coutchiching or Keewatin, represents what was once the contact of the lower surface of the crust, in this region at least, with the magma upon which it rested.

Inclusions in gneiss remote from contact.

While these inclusions are, as a rule, most abundant near the contact of the Laurentian with the Keewatin and Coutchiching series, they are by no means wanting in the gneisses many miles remote from such contact. On the shores and islands of Sabaskong Bay there are revealed the most unequivocal evidence of the brecciated contact of Laurentian and Keewatin rocks, the penetration of the latter by the former, and the inclusion of angular broken pieces of the Keewatin schists within the gneiss. Scores of the the most beautiful instances of fragments and groups of fragments of rocks indistinguishable from those which form the base of the Keewatin, may be seen in a day's paddle among the well bared rocky islands of this intricate labyrinthine portion of the lake. They occur here almost as abundantly away from the contact as close to it. So long as these inclusions retain their broken augular shapes, there is never any confusion of their boundaries with the enclosing gneiss. The contrast of matrix and inclusion is as sharp and distinct as it possibly could be, and indeed much more so than one would naturally expect. The size of the fragments varies usually from the dimensions of one's fist to those of a house. Many are much larger than a house, but these are not always traceable around their entire contour. Some are acres in extent, and some take the form of bands one or several miles in length, by hundreds of feet in breadth, which, in single sections, might easily be mistaken for inter-stratifications with the gneiss. When groups of these fragments are found in the gneiss together, they are arranged more or less distinctly in lines corresponding with the foliation of the gneiss, and the whole appearance of the horizontal section, presented by the glaciated surface of the rocks, is suggestive of the thick, crystallizing magma, in which they were once immersed, having been subject to a fluxion or flowing, to which is due both the foliation of the gneiss and the alignment of its included fragments of foreign rock.

Conditions observed on Sabaskong Bay.

Microscopic characters of inclusion.

A specimen of one of these angular inclusions in biotite gneiss taken from an island south-east of Rabbit Point, Sabaskong Bay, is a glistening black to iron grey schist made up of glistening hornblende in minute needles, and a greyish-white mineral, which modifies the color of the schist, but which is too minute to show crystal faces to the naked eye. In thin section (1709) the rock is seen to be banded, owing to the dis-

tribution of the hornblende. All of the latter mineral occurs in compact, stout prisms or needles arranged parallel. In certain parallel linear areas, however, these hornblende prisms are much larger than in the rest of the section, and are much more closely crowded together, with but little interstitial space. In the broader areas lying between these, the hornblende prisms are much smaller and much less crowded, the interspace being occupied by felspar in small irregular grains with some quartz. In exceptional areas the felspar predominates, and the hornblende prisms stand out very sharply in direct light from the colorless base, and present an appearance analogous in miniature to a bird's eye view of a run of saw-logs in a broad stream. Grains of magnetite are scattered throughout the section.

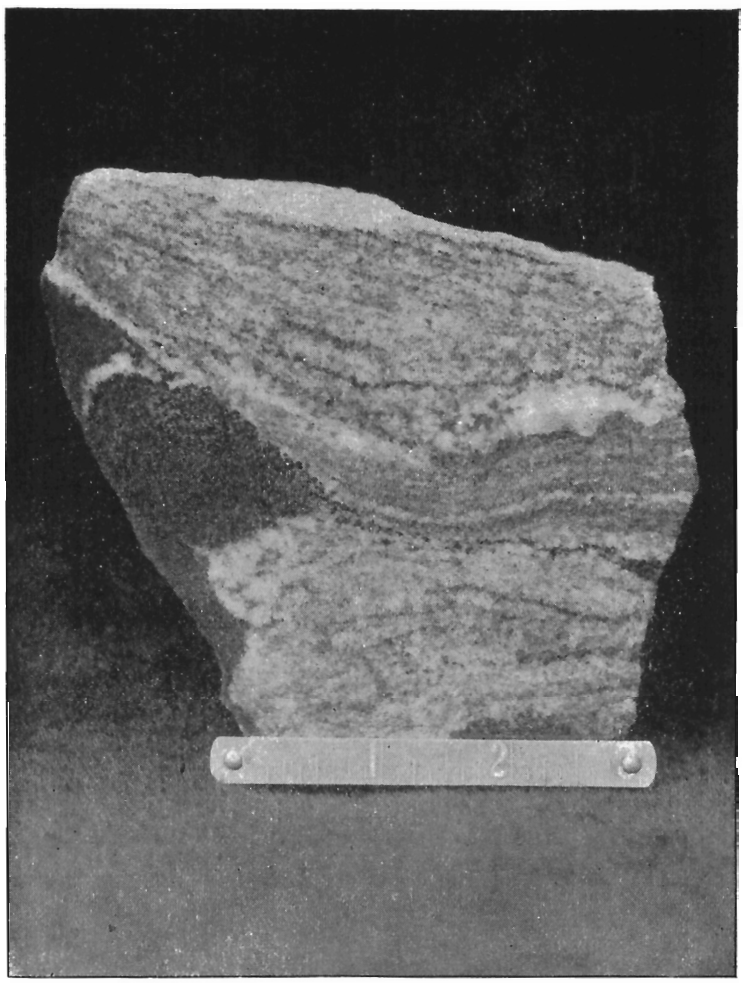
The description of the microscopic characters of this specimen shews that it differs in no essential feature from those rocks of the Keewatin series which have been classed as hornblende schists, and described in a previous part of this report.

Cases of apparent fusion of inclusions with matrix.

In many instances, however, these inclusions, as observed on Sabaskong Bay and elsewhere, have lost their sharply angular contours and have rounded, oval, or more or less attenuated, lenticular shapes. In these cases the line of demarkation between matrix and inclusion becomes less sharply defined, and in many cases there is evidence of the included fragment having been reduced by total or partial fusion to a condition admitting of its deformation and drawing out into lenses. In these cases the condition of fusion must have been one of thick viscidity which did not permit of the complete mingling of the magma of the inclusion with that of the matrix or gneiss. In those cases where magmas had by higher temperatures been sufficiently liquid to mix, the inclusions have probably been entirely absorbed by the gneiss leaving no trace of their existence, except a more basic local facies of the gneiss. When the inclusions have been so deformed and drawn out by partial fusion and recrystallization, there is a partial admixture of the two at the contact, and a transitional rock exists which is midway in character between the matrix and the inclusion. The inclusion in these cases, too, has lost its schistose character, and has become more felspathic in composition and more granular in structure, having the facies of a diorite. The felspar seems to have been absorbed from the inclosing magma probably rather by the agency of the penetrating watery solutions from the granite magma, than by a direct addition of a portion of the latter in the dry state.

Inclusions on Jackfish Lake

A good example of this kind of inclusion is one taken from the west side of Jackfish Lake, Pipestone route. Here the biotite gneiss assumes locally the aspect of a breccia, in which a very quartzose, biotite gneiss forms the matrix for angular blocks of foreign rock of an essen-



G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Polished surface of specimen of biotite gneiss, with included fragment of amphibolite partially drawn out into a "tail." West side of Jackfish Lake, Pipestone route.

tially hornblendic or dioritic character. The specimen taken is from the shore about two miles north of Foot-print Portage. It is of interest as shewing on the small scale in a hand specimen a condition of things which is very common on the large scale, and yet difficult to describe clearly without specimens. In the field the foreign and included character of the angular blocks of amphibolite or diorite is very apparent and can be examined critically in numerous well-exposed examples on the glaciated surfaces of the country rock. The specimen in question was cut through the middle and polished. Plate IV is a reproduction of a photograph of the polished surface, and shews the sharp well-defined character of the inclusion. The foliation of the gneiss flows around the inclusion, and the longest diameter of the irregularly shaped fragment lies parallel to the general trend of the foliation. A portion of the fragment has been drawn out into a "tail" analogous to those which may be observed in the porphyritic crystals of quartz-porphyries, and other rocks that have been subjected to excessive pressure. The two cases are, however, not entirely analogous, for the "tail" of the lenses in squeezed porphyries seems to be due to actual rupture of the solid brittle crystal, with probably a certain amount of recrystallization, while the "tail" of the dioritic inclusion in the biotite gneiss would seem to be due to a partial fusion and recrystallization of the hornblendic material, while the matrix was in a plastic condition and in process of solidification. On the large scale, by a similar process, blocks seem to have been, under the combined influence of pressure and partial fusion, drawn out into flat sheets which have all the aspect of intercalated beds, so even and sharp is the banding, and yet so unmistakably due to a simple stretching of the viscid and crystallizing magma with its included blocks of foreign material. The rock composing the matrix of the specimen figured is an evenly foliated grey, biotite gneiss of medium texture. Under the microscope (568 A) it is seen to be made up of a granular aggregate of orthoclase, plagioclase, quartz and biotite, with a few crystals of apatite and some secondary epidote. The felspars are fresh and glassy. The quartz is very abundant in water-clear grains with minute inclusions arranged usually in rows. The biotite is in the form of greenish-brown shreds. The epidote is in greenish-yellow crystals, and in aggregates of grains.

Stretched appearance of inclusion.

Microscopic characters of matrix.

Another thin section (568 B) from the same hand specimen was made across the line of contact of the inclusion and matrix. The line of contact was observed even in thin section to be quite sharp and decided, though not a simple straight line. The gneiss is identical with that last described. The included block is made up of a medium-grained, granular aggregate of compact, deep colored green hornblende, fresh plagioclase and quartz. Hornblende is the predominating

Microscopic characters of inclusion.

mineral. There is no biotite. On the other side of the line of contact biotite is abundant, and there is no trace of hornblende to be found. The ragged character of the contact is such as would be presented by a section of the surface of a broken rock fragment of medium grain. There are traces of fusion and inter-penetration, but within very narrow limits, at the place where the section was cut. The inter-penetration is much more apparent, where the block is drawn out into a "tail."

S.E. side of Lake of the Woods.

The biotite gneiss of the south-east side of the Lake of the Woods, between the mouth of Big Grassy River and that of Rainy River is characterized by an abundance of these inclusions, in sharply angular blocks, in more or less attenuated lenses, and even in sheets which simulate strata.

Inclusions in gneiss near 49th parallel.

Plate V is the reproduction of a photograph of a horizontal glaciated surface of the rock on an island off this shore about three-quarters of a mile north of the 49th parallel. It illustrates very beautifully what is common on a scale usually much too large for photography, and shews in one small horizontal section a representative variety of the shapes of these inclusions, and their relationship to the gneiss in which they are imbedded. Some, it will be observed, have rectilinear boundaries and sharply angular contours, others are oblong in shape, but more or less rounded, and some are distinctly lenticular. The foliation of the gneiss is well shewn, as is also its flow around the inclusions. The sundering of the included fragments, the penetration of the gneiss into the crevices, the drawn out or tapering ends of some of the fragments and the alignment of all of them parallel to the foliation of the gneiss, also are features which come out very clearly in the photograph and which are full of suggestion and instruction.

Inclusions in Stanjikoming area.

The biotite gneisses of the inner nucleus of the Stanjikoming area of Laurentian rocks is, in some places, charged with these inclusions, while in others it is remarkably free from them. Here they do not always resemble the rocks of the overlying series, but are frequently very coarse-textured and massive, and would be classed as massive amphibolites or diorites rather than hornblende schists. In this connection it should be observed that on the supposition that the Laurentian gneiss is the result of the fusion and recrystallization of the floor or basement upon which the Keewatin rocks were deposited, we should expect to find other inclusions than those of rocks such as occur in the Keewatin. The Keewatin series being largely made up of volcanic rocks, the vents from which these volcanic rocks emanated must have existed in the acid crust or floor at the time the latter succumbed to the process of fusion, whatever the exact nature of that process may have been. These pipes or vents would be filled with the

A. C. LAWSON, PHOTO., 1887 G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Angular and lenticular fragments of hornblende schist similar to that of the Keewatin series, included in Laurentian gneiss, on island off S.E. shore of Lake of the Woods, three-quarters of a mile north of 49th parallel. The flow or "pulled" structure is in the field very pronounced, the fragments being arranged in streams.

deep seated, coarser, granular phases of the rocks, which, as flows and loose ejectamenta, formed the Keewatin strata at the surface. When these vents were filled with basic rock, they would, in a fusion which only reduced the rocks to a thickly viscid magma, and did not permit of their mingling, or the complete absorption of the one by the other, still retain their distinctive characters, and on solidification present a strong contrast to the general gneissic matrix. Such appears to be the probable origin of some of the more massive coarse-textured amphibolitic or dioritic inclusions in the biotite gneiss of Rainy Lake. They are usually very much more irregular in shape, and their relations to the gneiss much more confused, than in the case of those inclusions which are recognizable as identical with the schists at the base of the Keewatin. Their size varies very much, and some are so large that their character as inclusions is not directly determinable, but is inferred from their analogy with the smaller inclusions adjacent to them. They are often traversed by irregular veins or dykes emanating from the main area of gneiss. As an example of this class of inclusion, a specimen was taken from an island in Rainy Lake opposite the mouth of the North-west Bay. The inclusion is a large block of irregular outline, the greatest diameter of the exposed surface being twelve or fifteen feet. A microscopic examination of a section (3000 B) of the rock shews that it is made up of a granular aggregate of deep colored green hornblende, with a little felspar, both cloudy and glassy, striated and non-striated. A small amount of epidote is associated with the cloudy felspar. No biotite is present. The hornblende is greatly in excess of the felspar, so that the rock may be classed as an amphibolite rather than a diorite, particularly as light colored central areas occur in the hornblende occasionally, which suggest the probability of its derivation from pyroxene.

Origin of certain inclusions.

Example of a class of inclusions.

The matrix in which this block is imbedded is a medium-grained, grey, distinctly foliated gneiss. Under the microscope (3000 A) it is made up, like the other similar gneisses of the region, of a granular aggregate of quartz with liquid inclusions having dancing bubbles, fresh orthoclase, microcline, plagioclase and biotite, partially altered to epidote. There is no hornblende present.

Matrix in which inclusion is imbedded.

The biotite gneiss of Redgut Bay, opposite the Indian village, is much like that already described from other localities. It is medium grained, light grey in color and distinctly foliated. Under the microscope (1600 A) it appears as a granular aggregate of orthoclase, plagioclase and biotite, the latter largely altered to epidote, together with a sparing number of apatite crystals in slender, round-ended prisms and in oval bodies.

Gneiss of Redgut Bay.

Included in this gneiss is a dark green, medium grained amphibolite rock. The inclusions do not here retain their angular forms, but are drawn out into attenuated lenses or sheets, which have the appearance of being intercalated with beds of gneiss, and give the rock a pronounced laminated or banded structure. The appearance is, however, deceptive, and it is far more satisfactory and more consistent with all the facts observed to ascribe the banded structure not to any intercalation or stratification, for it is very local, but to the attenuation of inclusions by the combined action of pressure and a process of slow fusion and recrystallization. The amphibolite in thin section (1600 B) appears as a granular aggregate of hornblende and cloudy felspar, the former greatly predominating. Some of the felspar is striated, but for the most part the twin structure, if present, is obscured by the decomposition. Attenuated lenses.

The rock along the line of contact of the attenuated inclusion and the matrix of biotite gneiss is not of a simple nature, but is made up of a fused mixture of the two. This mixed character of the margin of the inclusion was observed in the field, and the conclusions there arrived at as to the relations of the amphibolitic lenses and the gneiss, and as to the conditions to which the rocks must have been subject, to produce the appearance presented, have been sustained by a microscopic study of the normal gneiss, the core of the lens and the marginal or transitional rock. This transitional rock is a mica, hornblende and felspar rock with some quartz. Microscopically, the additional constituents, apatite, leucoxene and epidote, are observable. The structure is granular, with porphyritic crystals of orthoclase, which are somewhat cloudy. Some of the biotite seems to be an alteration product of the hornblende, and much of it is observed to have altered very largely to epidote. In some of these lenses, the interfusion of matrix and inclusion has been so complete that they are entirely made up of this transitional rock, which has the facies of a syenite, while in other cases, probably where the imbedded mass has been larger, the inter-mixture has been only marginal. Transition between inclusion and matrix.

The syenite gneiss which crops out on Rainy River on Mr. Geo. Singleton's farm about six miles and a half above the Manitou Rapid exhibits some very beautiful and instructive instances of inclusions of fragments of h ornende schist. One of these is represented in Plate VI from a photograph of the bare rock surface close to the water's edge. The gneiss is distinctly foliated, as appears in the photograph. The figure illustrates, in a very forcible manner, the drawing out and sundering of the included fragments. The large, central, pear-shaped piece of schist appears to be only the remnant of a much larger block which has been reduced in size by the tearing off of fragments which Inclusions in gneiss on Rainy River.

are still in its immediate vicinity, and whose relationship to the central mass is quite apparent. All these detached pieces, as well as the central pear-shaped mass, have their longest diameter parallel to the foliation of the gneiss, and there seems little room for doubt but that the foliation of the gneiss and the alignment of these fragments of schist, are due to the same unequal pressures upon the mass as a whole, and to a general flow in the rock at a time when the matrix was plastic, and not yet completely crystallized. To have produced these effects, the matrix in which the inclusions are imbedded, although yielding to pressure and flowing like a liquid, must have been very nearly solid, or at all events a very thickly viscid and tough magma, such perhaps as some laboratory preparations of soluble silica, or molten glass at low temperature near the point of solidification. That the matrix could not, at the time it yielded to pressure and exercised such rending effects upon the included blocks of schist, have had the form of a crystalline aggregate such as it now is (a syenite), is shown by the fact that there is every evidence of the constituent minerals of the present rock, in all the minute crevices and corners into which it penetrates, having crystallized *in situ*, and no evidence of such minerals having been subjected to excessive pressure since the rock solidified and assumed its present form of a hornblende-syenite. The effect of the same pressure on a solid crystalline rock is seen in the shattering and sundering of the inclusion of the hornblende schist, which here seems not to have been fused to any extent, even on its edges. Had the matrix, at the time that it yielded to pressure, been a solid crystalline rock, we cannot conceive of the deformation, such as it indicated by its flow, its penetration of the schists, and its accommodation to the most intimate parts of the schist, taking place without a similar shattering of the rock, or of its constituent crystals, and without their granulation and reduction to the cataclastic state.

Conditions affecting the sundering of included fragments.

In the Laurentian gneiss of the southern part of Rainy Lake there are numerous inclusions of fragments of rock which are indistinguishable from the rocks of the Coutchiching series, which is largely developed in that part of the lake. These inclusions occur both in the regular biotite gneiss and in the coarser gneiss of the syenitic type. As an instance of these inclusions in the latter rock, may be mentioned those which are observable at the north end of the island which lies opposite the entrance to Stanjikoming Bay. The inclusions are most plentiful in the gneiss in the vicinity of the contact with the Coutchiching series. Plate I. will serve as an illustration of these. It is reproduced from a photograph of a rock surface a few yards distant from the contact on an island off the south shore of Rainy Lake, three miles east of Coutchiching. The distinct character of the inclusions,

Inclusions of fragments of rocks of Coutchiching series.

A. C. LAWSON, PHOTO., 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Fragments of hornblende schist, similar to that of the Keewatin series, enclosed in Laurentian gneiss. The fragments are arranged in a stream, and there is a distinct pulled or stretched appearance. The large, pear-shaped inclusion in the centre appears to be the remains of a larger mass, the sundering of which has given rise to the more attenuated lateral fragments. The gneiss is distinctly foliated, although it does not appear so in the illustration. Geo. Singleton's farm, Rainy River. R. XXVIII., Tp. 5 S., Sec. 8.

the foliation of the gneiss and the penetration of the latter within the fissures of the inclusions is very clearly shewn in the photograph. There is not the remotest doubt of the derivation of the included fragments from the edge of the Coutchiching formation a few yards to the south. That edge is ragged and shattered, and the schists are traversed by apophyses, from the main mass of gneiss, which retain their foliation distinctly.

Shattered edge of Coutchiching schists.

Summary of Archæan Geology.

The broad results which have been arrived at by my study of the Archæan geology of the Rainy Lake region may be briefly summarized. They are :—

1. The primary separation of the Archæan complex of this region into two great natural sub-divisions, viz. : A lower division, Laurentian, and an upper division, composed of at least two distinct geological series, the Coutchiching and the Keewatin.

Primary division of Archæan.

2. The Laurentian is composed entirely of rocks, which are of the nature of granites and syenites in mineralogical composition and granular structure, but which, by reason of their more or less distinct foliation, are known as gneisses.

Laurentian.

3. Abundant evidence has been adduced to shew that these gneisses behave in all essential particulars precisely as irruptive granites do; and that they are plutonic rocks which have crystallized slowly, probably under an extremely gradual diminution of temperature from a thickly viscid, coherent or tough, hydrothermal magma.

Irruptive and plutonic character of Laurentian.

4. There is evidence that such magma, up to the time of its final solidification, when it became approximately rigid, was subjected to differential pressures, which, by causing a yielding or deformation, induced a flow in the mass. To this flow is ascribable, with great probability, both the foliation of the gneiss, and the parallel alignment of certain inclusions of foreign rock imbedded in in it, presently to be mentioned.

Differential pressures on magma.

5. Whatever may have been the more remote history of the Laurentian rocks of this region, it appears clear that the magma from which they crystallized as foliated granites and syenites, was immediately or proximately produced by the fusion of the basement or floor upon which the formations of the upper division of the Archæan were originally deposited. With the fusion of this floor it seems probable that portions of the superincumbent strata, which once formed integral parts of either the Coutchiching series or the Keewatin, have also been absorbed into the general magma, and reappeared on crystallization as Laurentian gneiss.

Origin of magma.

Extent of fusion.

6. This fusion, however, only extended up to a certain uneven surface, which surface constitutes the demarkation between the present upper and lower Archæan.

Relation of crust to magma

7. Above this surface, or upper limit of fusion, the formations of the Coutchiching and Keewatin series retained their stratiform or bedded disposition, and rested as a crust of hard and brittle rocks upon the magma, subject to its metamorphosing influences.

Disturbance of crust.

8. There is abundant evidence that while resting on this plastic magma the crust was violently disturbed, folded, crumpled and in places shattered. This disturbance probably served to accentuate the sharpness of the line of demarkation between the fused and unfused rocks, and accounts for the sharp contrast to-day visible along the line of contact of upper and lower Archæan.

Relative age of rocks of upper and lower Archæan

9. The normal condition of things along this line of contact proves very clearly that the schists of the upper Archæan, while in a hard and brittle state, were shattered; and that detached fragments became immersed in a magma which at the same time penetrated within the main mass of schists and filled their fissures and crevices. This magma which thus permitted fragments of foreign rock to sink into it, often to great distances from the contact, and which filled the cracks of the overlying schists, crystallized eventually as the Laurentian gneisses; which, therefore, as rocks, must be considered of later age and newer formation than the overlying schists.

Period of yielding to pressure.

10. After such crystallization and final solidification, there appears to have been no further violent disturbance; for while the rocks of the upper Archæan afford abundant evidence in their folded and crumpled condition, in their prevailingly schistose character, and in their microscopic structure, of their having yielded to excessive differential pressure, there is no such evidence in the Laurentian, except locally and to an unimportant extent. The Laurentian gneiss formation, regarded generally, does not appear to have been affected to any notable extent by pressure deformation after it had assumed its present crystalline form of foliated granite or syenite; the foliation being regarded, as above stated, as due to a flow in the magma prior to crystallization, and while crystallization was in progress, but not after the rock was wholly crystalline.

Bedded character of upper Archæan

11. The rocks of the upper Archæan occur in bedded formations, and afford no evidence of having ever been reduced to a fused or plastic state after their deposition.

Coutchiching series.

12. The lower of the two series of the upper Archæan or Coutchiching series is a very voluminous formation of mica schists and felspathic mica schists, or fine grained, grey, evenly laminated gneisses. The latter differ very much in their field appearance and in microscopic

structure from the granite and syenite gneisses of the Laurentian, the constituent grains having a prevailingly rounded or granulitic aspect in thin section. All the rocks of the series are very quartzose, and no other rocks than those mentioned occur in its entire volume, which, in measured sections where the series is at its maximum development, varies from 22,000 to 28,000 feet.

Origin of Coutchiching series.

13. It seems entirely probable that this series is of metamorphic derivation from sedimentary strata, deposited in a quiescent epoch, with little or no volcanic disturbance; and that such metamorphism has been largely effected by the upward percolation of heated, watery solutions from the underlying magma upon which the series rested after the fusion of the floor upon which it was deposited. Evidence of the percolation of such waters is seen in the numerous lenses of vein quartz which occupy the partings between the strata in many parts of the series.

Origin of Keewatin series

14. The Keewatin series is also largely metamorphic, but the rocks composing it are mostly of volcanic origin, either as flows or in the pyroclastic state. With these are associated rocks of undoubted erosive sedimentary origin, and others, such as some of the hornblende schists, which, from the extreme metamorphism to which they have been subjected, do not reveal with certainty their original characters; such extreme metamorphism being displayed most prominently at the contact with the irruptive Laurentian gneiss and granite.

Division of Keewatin series.

15. In a general way, the Keewatin series in the Rainy Lake region is naturally divided into two parts, an upper and lower. The lower part is prevailingly made up of the more basic rocks, such as bedded diabase and hornblende schists, while the upper part is composed rather of acid rocks such as quartz-porphyries and their tuffs and agglomerates with felspathic greywackes and other rocks of distinctly clastic origin. There is, however, no hard and fast line between these two upper and lower parts of the Keewatin, and they are of interest chiefly in shewing the change in the character of volcanic ejectamenta or the sequence of volcanic rocks in the earliest epoch of which we have any record. This sequence of acid after basic rocks accords with the evidence of the sequence of extravasation from the Archæan volcano whose roots are exposed on Bad Vermilion Lake.

Archæan volcano.

Break between Coutchiching and Keewatin.

16. The break between the Coutchiching and Keewatin is important, geologically, as indicating a profound change in the conditions of rock formation, the advent of the Keewatin epoch being the beginning of a wide-spread and intense volcanic activity. There is evidence also in the pebble conglomerates at the base of the Keewatin on Rainy Lake and Seine River of an interval of erosion such as is required by the definition of a stratigraphical unconformity.

Relative distribution of upper and lower Archæan.

17. An important discovery has been made in the mapping of the relative distribution of the upper and lower Archæan, whereby it appears that the latter, consisting of Laurentian gneiss and granite, occurs in large, isolated, central areas more or less completely surrounded by the schists of the upper Archæan, the encircling belts anastomosing and forming a continuous mesh work.

The Granites.

Character of granites.

The rocks here considered are of an eminently granitic, non-foliated aspect, usually of a reddish color and a texture that varies from medium to fine grained, although some of them are extremely coarse and partake of the characters of pegmatite. They occur in various parts of the region, irruptive through Laurentian, Keewatin and Coutchiching rocks. Where they have broken through the Laurentian gneisses their age is determinable at once as post-Laurentian and post-Archæan. When, however, they break through the formations of the Keewatin or Coutchiching series, it is a matter of considerable doubt as to whether

Age of granites

they are of later age than the Laurentian gneiss, or whether they are portions of the gneiss that have broken through the schist under such conditions that there was developed in them no gneissic foliation. That some of these masses are of such a character is extremely probable, as will be shewn farther on. On account of this difficulty of identifying the age of those granites which cut the Laurentian gneiss with that of those cutting the Keewatin or Coutchiching, and of discriminating between the latter and certain facies of the Laurentian rocks, the

Classification.

granites of the region will be considered under two heads, viz.: (1) Those cutting the Laurentian gneiss, and (2) those cutting the formations of the Keewatin or Coutchiching series.

Granites cutting Laurentian Gneiss.

Distribution.

These granites may be studied under their least equivocal and most characteristic conditions of occurrence in an area twenty miles long and five miles in maximum width, at its middle part, which extends across Rainy Lake in an east and west direction from the end of the North-west Bay on the west side, to Macdonald's Inlet on the east. The Laurentian biotite gneisses of this area are intersected by innumerable sporadic masses and irregular ramifying dykes of granite. The largest of these masses do not extend a mile in diameter, so far as observed, while the dykes may have apophyses only a few inches in width. The granite is most plentiful and occurs in largest masses on the shores of the eastern half of North-west Bay. Its characters are very uniform.

It is a reddish, usually fine-grained, biotite granite and has, commonly associated with it, veins of very coarse pegmatite of the character of the so called "contemporary veins."

Relation of granite to Laurentian gneiss.

Although there is the clearest evidence that these granites have cut the gneiss, after the gneiss was in approximately its present condition, yet it seems not improbable that they are more or less intimately associated in age and in origin with the Laurentian gneiss itself, and that they represent simply the up-welling through fissures, of the same magma as that, which, in its more superficial portions, under the influence of fluidal motion had solidified earlier as Laurentian gneiss. But however probable this conjecture may be, the evidence of their having broken through the gneiss after the latter had assumed its present form, is so clear, that we have no option but to classify them as post-Laurentian and post-Archæan. They are always perfectly devoid of foliation, a fact which would seem to indicate that they had solidified in fissures or vents in a comparatively quiescent condition.

Granite of Hanging-stone Point.

One of the largest of these granite masses is that which occupies Hanging-stone Point at the entrance to the North-west Bay. In thin section (840) it appears as a granular aggregate of quartz, orthoclase, microcline, plagioclase and biotite, the last very largely altered to epidote and chlorite. Apatite in long needles is included in all of these minerals. The felspars are in some instances quite fresh, while in others they are charged with kaolin, epidote and muscovite. The quartz is full of liquid inclusions with dancing bubbles. Another specimen (922) from a similar but smaller mass at the west end of the bay, near Hope Portage, is almost identical with the one from Hanging-stone Point. The only difference to be noted is that the biotite, as a rule, is fresher, shewing very beautifully between crossed nicols its characteristic bird's-eye-maple shimmer, though sometimes it is bleached colorless. Both quartz and felspar shew undulatory extinctions.

Hope Portage granite.

Granite near Squall Point.

Of the granites associated with the Laurentian gneisses in other portions of the region, only one has been microscopically examined. It is a fine-grained, purplish, hornblende granite, which interrupts the gneiss on one of the islands off the S.E. corner of Squall Point. Only a small patch of it was seen, and the actual contact with the gneiss was not observed. A thin section (665) shews it to be made up of a granular aggregate of orthoclase, plagioclase, quartz and hornblende, with some accessory biotite, magnetite and leucoxene. A little apatite is also, as usual, present. The quartz and felspar shew a crude granophyre structure, and the quartz is besides observed to occur commonly in spherical blebs included in the felspar. The quartz contains numerous inclusions of rod-like microlites. The most prominent constituent after the felspar is the hornblende. This has sometimes a

roughly radiating, fibrous structure, though usually quite compact, and in basal sections shews the usual prismatic cleavage. An occasional plate of biotite, probably original, is observable, while there is a good deal more that has been formed as an alteration product of the hornblende with which it is closely associated, and a little that has been secondarily developed around grains of magnetite.

Bat Lake granite.

On the Little Canoe River route from Rainy Lake to Manitou Lake a boss of red, medium textured granite is crossed, the north and south diameter of which is about seven miles. The boss is apparently irruptive through the more or less syenitic, coarse-grained, Laurentian gneisses, and extends from the northern portion of Bat Lake to the south end of Respite Lake. The contact of the granite with the gneiss is more closely observable on its southern confines than on its northern, and at the south end of Respite Lake the gneiss is traversed by dykes of the granite. The rock is composed of a red orthoclase, quartz and biotite, the latter being often replaced by hornblende, so as to give rise to a hornblende-granite. On Bat Lake the line of contact can be traced approximately, as mapped, without, however, affording any satisfactory exposures of the actual juxtaposition of the two rocks. The granite is well exposed on Bat Lake and Bat Creek, the latter being a sluggish stream in a gorge, flanked on either side by precipitous granite hills. On the shores of Bend Lake the facies of the rock is that of a hornblende granite. No specimens from these granites have been examined microscopically. A similar mass of red granite projecting through an area of Laurentian gneisses is observable on the shores of Spawn Inlet, and has a length in a north and south direction of at least three miles and a half.

Other granites cutting Laurentian.

The only other granitic masses cutting the Laurentian gneisses in the region mapped are small and unimportant, and are usually rather of the character of a plexus of dykes than simple irruptive bosses. A few of these are, however, deserving of brief mention. The gneiss on the shores Blue-beard Lake is interrupted by a mass of red granite, which occupies the west shore of the lake for three-quarters of a mile at the north end, and the east shore for about one-eighth of a mile as mapped.

At the north end of Heron Lake, a number of dykes cut the gneiss in different directions.

On the south-east shores of Big Turtle Lake the gneiss is similarily traversed by dykes, and small, irregular masses of red granite, so much so that in some places of limited extent the granite predominates over the gneiss.

Granites cutting the Keewatin and Coutchiching.

Two granite bosses on Pickerel Lake.

On Pickerel Lake, Manitou route, two apparently distinct bosses of granite occur, one on either side of the lake, cutting the Keewatin rocks. That on the west side is a flesh-red, coarse-textured granite, which under the microscope (1008) is seen to be made up of orthoclase, microcline and plagioclase, with epidote and chlorite in nests replacing the biotite, a little of which, however, still remains. Some of the orthoclase is idiomorphic, being of earlier generation than the rest of constituents, though it does not differ from them in size sufficiently to present a marked porphyritic aspect. The felspars are full of inclusions of microlites and needles of apatite. Beautiful, double-wedged sphenes are common, often in close association with an opaque substance, brownish in reflected light, as if secondarily derived from it.

Extent of boss on W. side.

The extent of this mass of granite is only known from its exposure on the shores of Pickerel Lake. The rocks through which it is intrusive are partly volcanic and partly clastic rocks, those on the south side of the boss being felsitic schists (schistose quartz-porphyries) and on the north side, greenish-gray, schistose, clastic rocks. The actual contact on either side was not observed, although it could be located very closely.

Boss on E. side.

The granite from the east side of Pickerel Lake presents on its margin the facies of a porphyry, which, under the microscope (1032) is seen to consist of a fine-grained, ground mass of quartz and felspar in which are imbedded large crystals of orthoclase, twinned according to the Carlsbad law, and finely laminated plagioclase, both comparatively fresh. Biotite generally much decomposed occurs in ragged patches and pyrite partially changed to limonite is occasionally observed.

Its limits.

The limits of this boss have been fairly well determined, from the fact that it occupies a portion of a peninsula on the greater part of whose shores the rocks are well exposed. It is apparently an oval mass whose long diameter, one and one-eight miles, has a N.E. and S.W. trend and the short one, three-quarters of a mile, a N.W. and S.E. The rocks through which it protrudes are mostly felsitic grauwacke, and conglomerate on the south and west side, and finer schistose or slaty clastic rocks on the north.

Granite of Bad Vermilion Lake

On the shores of the south-west side of Bad Vermilion Lake and on Bad Vermilion River there occurs, as is represented on the map, a boss of granite between three and four miles in diameter. This granite is peculiarily interesting from the fact of its intimate association with a still larger mass of saussurite gabbro. The granite is, for the most part, unusually acid or quartzose, while the gabbro, being made up

mostly of an altered lime felspar, anorthite, with but a small proportion of the foliated pyroxenic constituent, is among the most basic rocks with which we have to deal. This granite and gabbro are intimately associated, the latter surrounding the main mass of the former as a zone or collar. A smaller area of granite lies to the south beyond the zone of gabbro which encircles the main granite mass. Portions of this, in places, exhibit an indistinct sort of foliation, and hornblende occasionally replaces the biotite. The geological relations of this granite and gabbro have already been discussed in the account of the section K-L across this part of the Keewatin belt.

Bad Vermilion River.

A few specimens of the granite have been examined microscopically. One from the second falls of the Bad Vermilion River, appears under the microscope (2150) as a simple granular aggregate of quartz, cloudy orthoclase and plagioclase. The biotite is never abundant, and is almost all changed to chlorite and epidote. The quartz contains fine dusty inclusions and liquid inclusions with bubbles.

Another specimen (48), from the larger of the two masses into which the granite is divided by a band of gabbro, taken from the extreme south of Bad Vermilion Lake, differs from this in having quartz in large, rounded blebs, imbedded in the granular aggregate of quartz, felspar and biotite, which forms the base of the rock. These blebs of quartz shew a well marked ecto-peripheral rim, composed mostly of small, brightly polarizing needles, sometimes arranged perpendicularly to the outline of the quartz, and sometimes arranged parallel to it or interwoven in a felt work. The quartz includes microlites of apatite, rutile and zircon; and rutile is common as an inclusion in the biotite which is sometimes bleached, or altered to chlorite; calcite is present as an alteration product of the felspars which are more or less cloudy.

Specimens.

At the S.W. end of Bad Vermilion Lake this granite is in thin section (50) a granular aggregate of quartz, orthoclase, microcline and plagioclase, with idiomorphic apatite, zircon and sphene. The quartz is full of liquid inclusions with moving bubbles. The felspars are somewhat cloudy with kaolin, muscovite, etc.

Boss of granite on Pipestone Lake.

On the north-west side of Pipestone Lake, near its lower end, a boss of granite breaks through the Keewatin schists and is entirely surrounded by them. The granite is exposed for three-quarters of a mile on the shore of the Pipestone Lake, but the greatest diameter of the boss is probably a mile or over. Although detached from the great area of Laurentian gneiss and granite which extends to the westward of Kishkutena ridge by the Keewatin schists which constitute the ridge, it is probably in geological continuity with the gneiss and granite. It is quite devoid of foliation, but not more so than many portions of the Laurentian gneiss on Kishkutena Lake. It is, therefore,

regarded as Laurentian and is described petrographically with the Laurentian gneisses.

Granites cutting the Coutchiching.

A large number of sporadic masses of granite and gneiss cut the rocks of the Coutchiching series in the south-east arm of Rainy Lake. Some of these are distinctly gneissic and are indistinguishable from the ordinary Laurentian gneiss of the region. Others are of the character of very coarse non-foliated granites or pegmatites. These masses are usually of small extent and break through the schists in the most irregular manner. On the United States side of the lake, however, the peninsula between Rainy Lake and Nemeukan Lake appears to be largely occupied by the coarser variety of these granites. Most of them from their analogy with the Laurentian gneisses should probably be placed with the latter, although it is possible that some of them may be correlated in age with the post-Laurentian granites. Their distribution is shown on the map. None have been microscopically examined.

Post-Archæan Diabase Traps.

Questions of interest.

These are the youngest of the crystalline rocks with which we have to deal. Their occurrence is one of the most interesting of the geological features of the field we are considering. The chief questions of interest arising from a consideration of these rocks may be stated to be :—1. Their relations *in space* to other rocks—mode of occurrence. 2. Their relations in time of formation to that of other rocks, as inferred from such mode of occurrence. 3. The physical conditions under which they finally solidified as rocks. 4. Their geographical distribution. 5. Their petrographical character, comprising their mineralogical composition, structure and metamorphism. Upon these various heads, which include most of the interest attached to any formation, we have more precise and definite information than can be cited with respect to perhaps any other geological formation in this region.

Mode of occurrence of dykes.

By far the greater number of the occurrences of these post-Archæan traps are of the nature of dykes with sharply defined, approximately parallel, confining walls. Occasionally they are found in more diffuse masses with less regular boundaries, without, however, losing their dyke-like characters, if we consider, as the essential feature of a dyke-rock, the fact of its having solidified from a magma within a fissure in pre-existing rocks, whether the walls of such fissure be comparatively close and parallel, or widely separated and of irregular contour. These traps may then, for the most part, be referred to as occurring in dykes.

Strike of dykes

The strike of these dykes is commonly transverse to the strike of the gneisses, schists and other rocks of the region. And they are always, when bounded by parallel walls, in a more or less vertical attitude. The fissure walls are remarkably sharp and are brecciated only to a very limited extent. It is only occasionally that fragments of the country rock are found imbedded in the dyke, and when this is the case it is often possible to trace the fragment to the place from which it has been detached, as has been noted in the case of the dyke crossing Thompson Island, Lake of the Woods.* Even rarer than

Lateral apophyses.

inclusions of country rock in the dyke is the occurrence of lateral apophyses penetrating the country rock. In the few instances where these have been noted, they usually run out obliquely from the main dyke at a small angle, and are very insignificant in size compared with the parent dyke. An inspection of the occurrence of any of these dykes leaves no room for doubt, but that the fissures that have been filled with dyke matter were made after the rocks of the region had been tilted into their present attitude or had solidified in approxima-

Age of dykes.

tely their present form. They traverse indifferently all the other rock formations of the region, and pass from one to another transverse to the line of their contact. The few inclusions that have been caught up by the dykes are identical, in every respect, with the adjacent country rock. Local metamorphism along the line of contact has not been developed so as to be macroscopically apparent, a fact probably due to the generally highly crystalline state in which the rocks were before the molten dyke matter came in contact with them. It is very probable, however, that a microscopic study of the country rock near the contact would shew that chemical and physical changes had been induced. There is no evidence whatever in the dykes themselves or in their relations to the rocks they cut, of their having been subjected to those forces of upheaval, folding and deformation that have so profoundly affected the other rocks. They have been practically undisturbed since

Width of dykes

the time of their solidification. The dykes which are contained by parallel walls have a generally uniform width of from about 60 to 150 feet. Their strike is, for the most part, in a remarkably constant direction, being N.W. and S.E. There are, however, some exceptions to this rule as will be noted below. Their continuity along the same straight line for great distances across country, not as the same dyke, perhaps, but as a prevailing line of fissure, is one of the most interesting features of these dykes, as will appear in the discussion of their geographical distribution.

A constant character of all these dykes is the very marked differentiation observable in the texture of the rock as one passes from the

* v. Annual Report, 1885, p. 121 c c.

A. C. LAWSON, PHOTO., 1887. G. E. DESBARATS & SON, ENGRAVERS & PRINTERS, MONTREAL.

Diabase dyke, with lateral off-shoot, cutting Laurentian gneiss through which runs an earlier dyke (lightest colored portion) of felsite or microgranite. Rainy River, opposite the east end of the town of Fort Frances or Alberton.

contact with the country rock on either side towards the central portion of the dyke. At the immediate contact with the fissure walls, the dyke rock is, in every case observed, a very compact, greenish, black rock, either entirely aphanitic, or made up of an aphanitic base in which are imbedded minute, glistening, porphyritic crystals. A little distance away from the contact, often only a few inches, the rock rapidly, but by insensible gradations, assumes a granular aspect, being made up entirely of minerals which appear to the unaided eye to be distinct crystals, although very minute. This fine-grained rock passes gradually into a coarse-grained, mottled, dark grey rock in the middle of the dyke where the greenish-white felspar, the lustrous black augite, and the metallic-grey magnetite may be distinguished at a glance. This transition in the texture of the rock appears to be practically the same in all the dykes; and a specimen from the middle of a large dyke does not appear to be of coarser texture than that from the middle of a small dyke. Hence the transition in a small dyke must be more rapid than in a large dyke.

Differentiation in texture.

The texture of the rock being a function of its distance from the containing walls, it is inferred that it is also a function of the rate of cooling and solidification. If this inference be just, and it is of wide acceptance among geologists in analogous cases, it has its bearing upon the general question of the relation of rock structure and rock texture to conditions of solidification. Important investigations have of recent years been made upon this subject, particularly by Stelzner,* Judd,† Hague and Iddings,‡ and Lotti§. The general tendency of these investigations has been to establish the intimate relationships existing between the structure of igneous rocks and the *pressure* under which they have cooled. In the case of the dykes which we have been considering, however, the differentiation in texture and structure is not a function of pressure. For, in the horizontal plane, which the present surface affords us, we must conceive the pressure in the liquid mass, now represented by the dyke, to have been practically uniform and the same near the walls of the fissure as in the middle of the mass. We have the same magma cooling at the same depth and under the same pressure, presenting a very rapid differentiation in structure and texture, in a comparatively short space, so that we are forced to admit that the structure and texture of these rocks is a function of the rate of cooling quite independent of the pressure. This conclusion does not, of course, preclude the possibility that, under a *varying* pressure, a

Differentiation due to variation in rate of cooling.

Variation in pressure *vs.* variation in rate of cooling.

* Beiträge zur Geolog. u. Palæont. der Argentinisshen Rebublik. 1885.

† Gabbros, Dolerites and Basalts of Tertiary age in Scotland and Ireland. Q. J. G. S., Vol. XLII., 1886.

‡ Development of crystallization in the igneous rocks of Washoe. Bull. U. S. Geol. Survey, No. 17, 1885.

§ Paragone fra la roccie ofiolitiche italiane e le roccie basiche pure terziare della Scozia e dell' Irlanda (Boll. d. Com. geol. ital., 1886, 93).

differentiation in structure might be induced of an entirely different order to that which is a function of the rate of cooling simply. It would appear that no attempt has yet been made to discriminate between that differentiation of structure which is due to difference in rate of cooling, and that which may be due to varying pressure simply, or that which may result from a combination of these two varying influences.

Prominence of dykes.

These dykes stand out more or less prominently from the rocks they cut, their steeply rounded or domed glaciated surfaces contrasting strongly with the more gently inclined *roches moutonnées* of the schists and gneisses. On the smooth glaciated surfaces of the dykes there is sometimes observed a peculiar pitting arranged in remarkably even and straight, uniformly spaced lines which run across the dyke transverse to its strike. These lines seemed to correspond to the surface limits of vertical structural planes of some sort, though what the real nature of these planes is, I have not been able to discover.

Weathering.

The aërially weathered surfaces of the dykes assume usually brownish tints, and are rougher than those surfaces below high-water mark, which are of a black color, and retain a smooth, fresh aspect.

Dykes on Lake of the Woods.

On the Lake of the Woods it has been observed that a line of dyke filled fissures extends in a N.W. and S.E. direction from the vicinity of Rat Portage to the E. side of White-fish Bay near the S.E. corner of the area embraced in the Lake of the Woods sheet. The intervals at which these dykes have been observed on the northern part of the Lake of the Woods are probably much greater than the actual occurrences of them warrant, as, at the time of the geological examination of these shores, they were not particularly looked for, and their characters were less familiar than they are now, and less easily distinguished from those of the more massive altered diabases of the Keewatin series. However, there is enough evidence to indicate a well marked line of fissure. The dyke which cuts the S.W. end of Scotty Island is very probably identical with that which traverses Thomson Island from N.N.W. to S.S.E.; and this, together with the dyke which cuts the Keewatin schists on the main shore S.S.E. of Yellow-girl Point appears to be in the north-westward projection of the remarkable line of dykes which my assistant, Mr. A. E. Barlow, traced across White-fish Bay in 1885, at intervals, for sixteen miles, with a strike of 140°. If we follow this line south-eastward we find these dyke-filled fissures continued at intervals, as far as our explorations have gone, to the south side of Rainy Lake on the International Boundary. The first of this linear series of dykes is one which cuts the green schists of the south side of Crow Lake a little over a mile to the N.E. of Crow portage. The next observed crops out on Clear-water Lake just where the 49th

Line of dyke-filled fissures for 100 miles.

parallel intersects the N.W. shore of the lake. In nearly the same line a large dyke crosses Jack-fish Lake less than a mile east of Totem Point. Still further to the S.E. on the shores of the North-west Bay of Rainy Lake there is another at the west side of the entrance to Brown Inlet. At the north-east corner of Stanjikoming Bay and on the north shore of the adjoining Shoe Bay, there is a group of three parallel dykes not far separated, all having a common strike of N.W. and S.E. The most easterly of these appears to be the strongest and probably represents the dominant fissure. On the north shore of Shoe Bay it is between 60 and 70 feet wide, and occupies two small islands which lie off shore in the mouth of the bay. It is probably identical with the dyke which cuts the gneiss on the N.E. side of Home-stretch Island, and occupies the southern extremity of Risky Island. About a mile and a-quarter to the south-east of the latter, in almost the same line, we have a large dyke occupying the east half of Memento Island, crossing Gash Point, and appearing again on Lobstick Island and the adjacent small islands. On the south side of Rainy Lake in the line of the strike of the dykes of Shoe Bay and Gash Point, two large well defined dykes have been observed which have a N.W. and S.E. strike but which are not quite parallel, being convergent at a small angle towards the south. The more easterly of these is more nearly in a line with the Gash Point dyke than the other. It traverses Stop and Grassy Islands, and some of the adjacent smaller islands, and has been traced for one mile and three-quarters from its most northern exposure to where it cuts the rocks of the south main shore. The other more westerly dyke traverses Medouganak Point and crosses the mouth of Rat-root Bay, being observable on both shores.

Dykes between Shoe Bay and S. shore.

I have thus sketched briefly the distribution of a series of dykes which, in a very remarkable linear arrangement, and all with a common strike, extend from the north end of the Lake of the Woods to the south shore of Rainy Lake, a distance of 100 miles. The line of their occurrence has a bearing of 140° to 145°. The fissures of which they are *prima facie* evidence, whether they be absolutely continuous or be made up of a series of ruptures with intervening planes of strain, have probably played an important part in the post-Archæan earth movements which have affected the region. It is difficult to positively assert that any profound faulting has occurred along this line, since there is little direct evidence to warrant such an assertion. That it is a line of fault, however, seems extremely probable, and it is worthy of note that the whole rocky surface of the country to the S.W. of this line of dykes and to the south of the 49th parallel, is on a level distinctly lower than that of the country to the N.E. of that line, being covered with the flat-bedded, low-lying, post-glacial deposits through

Line of fissure, and probable faulting.

which Rainy River has cut its way. Although the linear arrangement of these dykes is very marked, it does not follow that the fissure was confined to any single line. Indeed, as has been noted, the dykes occur in triplicate and duplicate; but, in these instances, the dykes have been so near together as to leave no doubt as to their close relationship, all being in the same linear area. There are a few dykes, however, which have been observed to lie a little out of the line of fissure, as above sketched, and although they have the same strike, are to be regarded rather as belonging to parallel but subordinate and less pronounced fissure lines than the main line. One of these dykes occurs on the east side of Clear-water Lake, three miles and a-half south of the 49th parallel. Another crosses the south shore of Pipestone Lake one mile west of Stone-dam Portage. In this category also may be classed the dyke which crops out on the United States side of Rainy River opposite the east end of the town plot of Fort Frances. (*v.* Plate VII.)

Parallel fissures.

The dykes enumerated do not comprise all that have been observed. In the south part of the Lake of the Woods a line of post-Archæan irruption has been noted and mapped on a string of small islands extending some eight miles N.W. from the N.W. point of Big Island. This irruption does not appear to be a simple parallel-walled dyke, but seems in places to have a very considerable width, and its exact distribution cannot be determined on account of its occurrence on a number of small islands. The arrangement of these islands in a line which runs N.W. and S.E. is eminently suggestive of the strike of the longitudinal axis of the irruption. The contact of the irrupted trap has, moreover, been observed on two of the islands, viz., on Massacre Island and on a small island two miles W.N.W. of the north end of Bear Island, and in each of these cases the strike of the fissure wall is N.W. and S.E., and all the conditions of contact are identical with those observed in dykes of more limited dimensions and contained within observable parallel walls. The north-westward projection of the line in which these trap islands lie, passes through a small boss of trap that projects through the sand at the south end of Shoal Lake. And with this is probably associated a mass of trap which cuts the schists on a small island off the west shore of Shoal Lake between Berry Point and Calm Bay.

Line of dykes from Shoal Lake to Little Grassy River.

The south-eastward projection takes in a dyke which cuts the gneiss on the west side of Bigsby Island near its south end, and another which occupies part of a small island opposite the mouth of Little Grassy River. Thus we have again sketched for us by the occurrence of a line of dykes, another line of fissure extending for over forty-five miles in a general N.W. and S.E. direction, and again the surface of the country is lower to the south-west of this line than it is

to the north-east. This line is not strictly parallel to the White-fish Bay line of fissure, but varies from parallelism only by a very small angle, the two lines being convergent towards the south-east at an angle of between 5° and 10°. Assuming their continuity across the state of Minnesota, they would meet near the head of Lake Superior. The line of fissure indicated above as extending from the bottom of Shoal Lake to the mouth of Little Grassy River appears to be distinctly traceable for the distance of forty-five miles. There is evidence, however, of its much greater extension to the S.E. The country to the S.E. of the mouth of Little Grassy River is covered with post-glacial formations, and no occurrence of dykes has been noted along this line for thirty-five miles. After this interval, however, we again meet with them in great strength on Rainy River. The Manitou Rapid on Rainy River flows over a large dyke, whose strike appears to be N.W. and S.E. The actual contact with the enclosing rocks is not exposed, but a distinct gradation from a fine to a coarse texture can be observed, indicating that the containing walls of the dyke cannot be far distant from the part with the finest texture; and the dyke presents a distinct ridge at right angles to the stream which is taken to be its strike. For three miles north from the river this trap can be traced through the bush at intervals on the Indian Reserve. It seems to lose its dyke-like characters to the northward, and to merge into a rather extensive boss of uniformly coarse gabbro. About six miles further up Rainy River, above Manitou Rapid, there are two other dykes which may perhaps be classed with that at the rapid, and so be considered as belonging to the same line of fissure. They both have a strike of from N.W. and S.E. to N. and S. One of these occurs on the American shore projecting through the post-glacial formations as a prominent bluff, and cuts through green hornblende schists. The other occurs on the Canadian side, about one mile and a-half from the river at the back of Mr. Lutterel's farm. Like the first it projects boldly through the post-glacial deposits with a width of about 150 feet without, however, shewing the rock which it traverses. On either side of the middle part of the exposure the rock becomes finer-grained towards the sides, so that it may safely be inferred that the exposure represents very nearly the width of the dyke, although the contact is concealed. The coarser portions of the dyke shew, in places, a very distinctly foliated, possibly a "flowed" structure. Thus if these dykes on Rainy River be assumed to be part of the same system of fissuring as that traced from Shoal Lake to Little Grassy River, and they are approximately in the same line, that system will have a linear extent of over eighty miles, and is then comparable, in its minimum length,*

Convergence of two lines of dykes.

Dykes on Rainy River.

Foliated structure in dyke.

* Of course either of these lines of fissure may extend to the N.W. and S.E. beyond the limits of the field of exploration.

with that of the White-fish Bay system of fissuring. Two other trap dykes have been observed on the river which do not fall into line with any others. One of these crops out on the south side of the river one mile below the foot of the Longue Sault. The other crosses the river in a N.W. and S.E. direction, and causes a slight rapid in the stream, about half a mile above the mouth of Rapid River. Neither of these is sufficiently exposed to afford positive evidence of their being dykes, and that they are so, is inferred chiefly from the similarity of the rock to that of the other dykes of the region. One other dyke remains to be noticed and that is unique in having a strike of N.E. and S. W. It occurs on a small island two miles and three quarters W.N.W. of Halleluiah Point near the mouth of Seine Bay, with a width of sixty feet cutting the Bad Vermilion Lake saussurite-gabbro formation.

Other dykes.

Petrographical characters.

The petrographical characters of these dykes have only received a preliminary study so that no exhaustive statement regarding them can be made. A few notes on the microscopic features of some of them which have already been published elsewhere,* are, however, incorporated here, so that taken with the foregoing description of their field occurrence they may make the general account of these dykes as complete as possible to date.

Jack-fish Lake dyke.

One of the most characteristic of these dykes traverses the coarse granitoid gneiss of the west arm of Jack-fish Lake, which lies to the north-west of Rainy Lake. Its width is 135 feet and its contact with the country rock is well exposed as a sharp line. From a macroscopic examination, the gneiss does not appear to have been altered perceptibly towards the contact. Specimens for microscopic examination were taken from different parts of the dyke, viz., at sixty feet, twenty feet, and six feet from the contact, and at the contact. At sixty feet from the contact, the rock is a coarse-grained, mottled grey rock, in which dirty white felspar and black pyroxene are the prominent constituents. Under the microscope it presents the characters of a coarse-grained, comparatively fresh diabase. Augite of a pale mauve tinted grey color is abundant, and often occurs in masses that fill the field of the microscope when low powers are used. Sometimes these plates of augite are individual crystals. For the most part, however, they are not single individuals. When examined between crossed nicols the plate of augite is seen at once to be resolved into an intimately interlocking mosaic of irregularly shaped grains of diverse optical orientation. In ordinary light the boundaries between the different members of these "polysomatic"† masses of augite are traceable only with difficulty and uncertainty. There is no interstitial

Rock at 60' from contact.

"Polysomatic" augite.

* Proceedings Canadian Institute, 1887.

† Adapted from Tschermak's use of this word as applied to a similar structure in the olivine of certain meteorites.—v. Die Mikr. Beschaff. der Meteor. Stuttgart, 1885.

matter whatever, the different grains being as intimately associated as in the case of interpenetration twins of felspar. That they are not twins is shown by the fact that there are often as many as half a dozen grains all of different orientation thus combined in the same mass. The cleavage, by its lack of continuity over the field, of course, indicates a difference of orientation in different parts of it, but the cleavage traces are not strongly marked, and attention is only directed to the discordance of the cleavage after the polysomatic character of the mass has been rendered prominent by the analyser of the microscope. This polysomatic structure of augite does not appear to be common. Rosenbusch does not mention it in his last comprehensive summary of the present state of petrographical knowledge.* The nearest approach to this structure that is at all well known is the polysomatic character of some chondri of olivine in certain meteorites such as are figured by Tschermak† and Wadsworth.‡ Olivine in a similar condition in terrestrial rocks has recently been described and figured by Renard in specimens from Kerguelen Island in the Indian Ocean.§ The polysomatic structure in augite is not so well known. Renard notes that the augites of the felspathic basalt of Heard Island, Indian Ocean, are grouped together at certain points,‖ and again in the same rocks at Marion Island that the augite is characterised by a tendency to form groups of individuals having their vertical axes parallel.** Teall mentions "Granular Aggregates" of augite in the Hett and the High Green dykes in the north of England.†† Some of these appear from the figures given to be aggregates of grains of augite not in close juxtaposition with an interstitial base, although that figured in Plate xii, Fig 5, would seem to be a polysomatic augite, and if so is the only strictly parallel instance that I can find of this structure so common in this dyke and in others of the region. Analogies.

The augite is generally altered to hornblende at its periphery and occasionally the latter mineral entirely replaces the former. The process of alteration does not appear to proceed along the almost or quite imperceptible lines of demarkation between the different individuals of the polysomatic augite, but extends from the periphery of the mass as a whole in towards its centre. Alteration of augite.

* Mikr. Phys. der Mineralien und Gesteine Stuttgart, 1886.

† Die Mikr. Beschaff. der Meteor. Stuttgart, 1885, Taf. xv. Fig. 1 and 2.

‡ Lithological Studies, Mem. Mus. Comp. Zool. Harvard, Vol. x., pl. 1.

§ Notice sur la geologie de l'ile de Kerguelen, Bul. Mus. Roy. Hist. Nat. Belgique, Tome IV. No. 4., p. 233, fig. 1, pl. v.

‖ Notice sur les roches de l'ile Heard. Bull. Mus. Roy. Hist. Nat. Belgique, 1883, 8 p. 26.

** Notice sur les roches de l'ile Marion. Ibid. p. 250.

†† Petrographical Notes on some north of England Dykes, Q. J. G. S., 1884, 158. p. 209 and 242.

Plagioclase. The plagioclase appears in two general forms: a rather stout or tabular form, which is the larger and usually the more cloudy with decomposition products, and a small long lath-shaped felspar which appears quite fresh, and in which the polysynthetic lamellæ are much more distinct than in the former.

Accessory minerals. Magnetite occurs in irregularly bounded masses or is disseminated, often quite thickly, through the augite as inclusions of dusty or finely granular aspect. Pyrite also occurs and is discernable macroscopically. Apatite is seen in occasionally colorless hexagonal sections and in slender prisms with rounded terminations. Water-clear quartz, with inclusions of apatite microlites and liquid inclusions with dancing bubbles, forms a considerable proportion of the mineral constituents of the rock and is characterized by having a common orientation for isolated sections over a wide area of the microscopic field, as in the micropegmatite structure. A few colorless garnets are also present. The rock, such being its characters, may be classed as a uralitic quartz-diabase.

Rock at 20′ from contact. At twenty feet from the contact the rock is very similar to that at sixty feet, but is much less coarse in texture. It differs from the latter in mineralogical composition in the fact that there is present a number of white or colorless garnets, all perfectly isotropic. They have a well defined border, indicative of a high index of refraction and perceptibly rough surface. Their shape is for the most part rounded, or, when rectilinear outlines are observable, they are hexagonal sections of the rhombic dodechedron. The larger grains have a curved parting which may be demarkation lines between different individuals. The treatment of the slide with hydrochloric acid, cold or hot, leaves them unaffected. The occurrence of garnets in basic dykes is by no means

Garnets in dykes. unique. They are, however, regarded as a product of contact metamorphism within the dyke. Speaking of the "Iron District of Lake Superior," Wadsworth says: "Most of the 'diorites' (uralitic diabases) here (at Republic Mt) contain garnets, this mineral being found principally along the edge of the intrusion while the centre was nearly if not entirely free from it. The schist in like manner near the 'diorite' frequently contains garnets, both rocks appearing to have mutually reacted upon each other."* The garnets in the Jack-fish Lake dyke do not appear to be a product of contact metamorphism, since they are found in the middle of the dyke and very much more abundantly at twenty feet from the contact than at six feet from it, or immediately at the contact, where their presence has not been detected. Beyond the abundance of garnets, the dyke at twenty feet has the same characters as at sixty feet. The polysomatic structure of the augite is pronounced.

* Notes on the Geol. of the Iron and Copper Districts of Lake Superior. Bull. Mus. Comp. Zool. Harvard, 1880, pp. 45, 46, 47.

At six feet from the contact the rock is fine-grained and the ophitic structure of typical diabase is much more characteristically developed than in the coarser grained parts of the dyke. In this part of the dyke there is first observed a differentiation of the rock into constituents of different periods of crystallization, the order being first plagioclase in more or less idiomorphic,* lath-shaped individuals lying in all positions, then augite generally allotriomorphic,* sometimes hypidiomorphic,* and finally a base or matrix of both these minerals in a very much more finely crystalline state, together with magnetite. The structure of the base is rather obscure, the chloritic substance usually present in diabase rocks being more prominent here than in the coarser grained part of the dyke where it is almost, or perhaps entirely, wanting. Quartz is present but in smaller quantities than in the coarser grained portions of the dyke. The augite occurs both in simple individuals and in polysomatic masses. The uralitization of the augite, which is generally observable, is much more pronounced in the irregularly bounded polysomatic masses than in the simple allotriomorphic development of the same mineral. A few garnets are present as inclusions in the felspar, but were not identified with certainty. In this respect this portion of the dyke differs markedly from the more central portions examined. The most interesting constituent of this portion of the dyke remains, however, to be mentioned. It is the non-pleochroic, colorless, rhombic pyroxene, enstatite; it occurs in idiomorphic development showing the characteristic obtuse domes in some of the sections. It shows regular cleavage parallel to ∞ P (110), upon which the angle of extinction is zero, and characteristic cross parting, along which partial alteration of the mineral to bastite or serpentine is apparent. This enstatite is not abundant, and plays the rôle of an accessory mineral. Its occurrence in a rock of well marked diabase structure is interesting. Rosenbusch remarks that it is present in only a few diabases which have a gabbro-like structure,† and Teall has recorded the occurrence of the allied rhombic pyroxene bronzite in the Whin-Sill of the north of England as an accessory.‡ Enstatite also occurs in a variety of the allied rock, diabase porphyrite, from Schaumberge, which has been described by Laspeyres and Streng under the name of Palatinite. This enstatite was not observed in the coarser parts of the dyke but occurs, as will be noted, in the still finer grained diabase at the contact.

Rock at 6′ from contact.

Enstatite.

At the immediate contact the dyke assumes macroscopically the characters of a very compact, greyish-black, aphanitic rock in which

Rock at contact.

* Terms introduced by Rosenbusch. Cf. op. cit. p. 11.

† Mik. Phys. der Massigen Gestine, 2nd Ed., 1886, p. 188.

‡ Q. J. G. S., 1884, p. 652.

can be occasionally detected minute glistening facets of porphyritic crystals. With low powers of the microscope the matrix is not resolvable, but appears as a uniformly yellowish to greenish-grey ground thickly dotted with grains of magnetite. Under the higher powers this is seen to be made up, in addition to magnetite, of a fine felt-work of lath-shaped crystals of plagioclase imbedded in hazy, somewhat yellowish green flocculent chloritic substance derived presumably from the alteration of the augite, since that mineral cannot, with certainty, be identified in the base. The porphyritic character of this part of the dyke is well marked, though the imbedded crystals are small. These are augite in small irregular polysomatic masses, with a hazy margin or fringe of greenish decomposition products, long lath-shaped plagioclase and occasionally stouter broken fragments. Besides these are porphyritic crystals of enstatite much more altered and less plentiful than at six feet from the contact. Neither quartz nor garnet are observable in the contact rock.

Porphyritic character.

Considering then the dyke with reference to its variation in structure and mineral composition, the points of interest to be noted are: the passage of the coarse grained central portions of the dyke to the compact aphanitic rock at the contact; the absence of porphyritic structure in the middle of the dyke as contrasted with the well marked development of the same as the rock becomes finer grained towards the dyke walls; the absence of the characteristic chloritic substance of diabase in the centre of the dyke, and its abundance towards the contact; the presence of quartz in greater quantity in the coarse grained middle portions than at the sides; the presence of garnets in the coarsest parts of the dyke, their abundance in the medium grained parts, and their rarity or total absence in the neighborhood of the contact; the presence of the rhombic pyroxene enstatite in typical idiomorphic porphyritic crystals in the fine grained parts near the contact, and its absence in the coarser central parts; the diminution in size of the porphyritic crystals near the contact in co-extension with the increasing fineness of the ground mass; and finally the "polysomatic" structure common to the augite throughout the dyke.

Points of interest.

Three-quarters of a mile from where the specimens whose characters have just been given were collected, there occurs, on the opposite side of the bay in the line of the strike of the dyke, another exposure of the same dyke. On the islands of the bay which lie intermediate between these two localities, the outcrop of the dyke is observable, so that there is no doubt of their both being exposures of the same dyke. The rock here was not studied in so great detail as at the last exposure. The specimens taken were of the same grade of coarseness as those taken at twenty feet from the contact on the north side of the

Continuation of dyke.

bay. The felspars are more decomposed, and the twinning lamellæ often obscure, and the small quantity of quartz which is associated with them appears to be of secondary origin; whereas the origin of the quartz noted in the same dyke on the north side of the bay seemed much more problematic. In the latter case the common micropegmatic character of the quartz and the occurrence in it of needles of apatite, which in no way differ from those in the felspar, together with the not infrequent occurrence of one individual of apatite partially included in quartz and partially in an adjacent felspar, would argue for the primary character of the quartz. The augite in the dyke on the south side of the bay resembles that already described, occurring both in simple individuals and in polysomatic masses. It is largely altered to uralite. Titanic iron with its alteration product leucoxene shows characteristic barred structure of the cleavage traces parallel to the planes of the rhombohedron. The leucoxene is frequently accompanied by a margin more or less extensive, of secondary brown mica. Apatite is present in comparative abundance. Chlorite occurs in vaguely defined masses and the garnets which, as before, are present, are associated with it.

Characters of other specimens.

On the south-east shore of Pipestone Lake, about a mile west of Stone-dam Portage, there is another of these dykes cutting transversely schists which have a strike of N.E. to E.N.E. The specimen taken

Pipestone Lake dyke.

Fig. 12. Section of diabase, from Pipestone Lake dyke, showing large poly somatic grain of augite in three granules of diverse orientation *a b c*; *d*, uralitic-hornblende; *e*, magnetite. × 28.

from the middle of the dyke has the characters of an uralitic quartz diabase. The felspar, as a rule, is remarkably fresh, and occurs in the usual lath-shaped twinned crystals of plagioclase. The crystals are commonly observed to be cracked transversely and the cracks filled with a brownish-yellow material which shows aggregate polarization. The augite occurs more commonly in polysomatic masses than in simple individuals. The magnetite is often surrounded by rims of secondary

brown mica. The quartz is apparently original and has numerous inclusions of an opaque granular character, together with fluid inclusions with dancing bubbles, gas pores with black borders and glass (?) inclusions oval and circular.

Dyke on S. shore of North-west Bay.

On the south shore of the North-west Bay of Rainy Lake, a similar dyke cuts both the biotite gneiss of the region and the red granite which is intrusive through it. It is an uralitic quartz diabase. The felspar is in rather stout crystals in the coarser grained part of the dyke, though usually lath-shaped. It is much decomposed and is partially replaced by quartz and chlorite. The polysomatic character of the augite is not prominent, but this may be due to the fact that it is about half altered to hornblende and to chlorite. The augite individuals are often twinned and the cleavage traces are usually well defined. The magnetite shows a tendency to peripheral arrangement around the altered augite indicative of its secondary origin. Quartz is present which is probably original besides that which is clearly secondary. Apatite in long slender needles and leucoxene in irregular masses, are the accessory constituents.

In the same dyke, nearer the contact where the texture is fine-grained, the rock is much more uralitized, traces of augite being observable only in the cores of the green compact hornblende, which has almost entirely replaced it. Apatite appears more abundant, as do also the secondary quartz and chlorite. Garnet of a pale yellowish color occurs sparingly.

Fig. 13. Plagioclase from diabase dyke, North-west Bay, Rainy Lake, showing effect of pressure of one crystal against another.

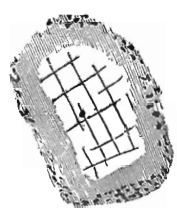


Fig. 14. Augite from diabase dyke, North-west Bay, Rainy Lake, showing marginal alteration to green compact hornblende with an encircling wreath of secondary magnetite.

At the contact the dyke rock is a compact aphanitic base in which can be detected minute porphyritic crystals. Under the microscope the base is seen to be made up of minute lath-shaped crystals of fresh plagioclase, augite grains, magnetite and chloritic substance. The porphyritic crystals are lath-shaped felspars occasionally broken and showing the lamellæ in some instances bent, as the result of pressure of

one individual against an angular part of another, and augite generally surrounded with an irregular border of secondary hornblende, which, in turn, has an outer girdle or wreath of granules of magnetite that have separated out in the process of uralitization as in Fig. 14.

On the lake, near the extremity of Gash Point, one of these dykes cuts the schists with a strike of N.W. and S.E. across the whole breadth of the point and traverses the islands on both sides of it. Here it is traceable on the point and on the islands for the distance of a mile. Three miles to the south-east in the line of the strike of the dyke, a dyke occurs cutting the schists on the islands off the south shore of the lake which is probably a continuation of that of Gash Point. From this point it is traceable for two miles across the islands to the main shore on the south side of Grassy Narrows. Thus, this dyke has a length of at least six miles and has an extension to the north-west and south-east of the points observed, for a distance that is probably very much greater. A specimen from the central part of this dyke, proved, on examination, to have the characters of a uralitic quartz-diabase. The plagioclase occurs in long, rather stout, lath-shaped crystals, which are generally so cloudy as to obliterate the twinning in most cases. The augite occurs both in simple individuals and in polysomatic masses. It exhibits the usual marginal alteration to hornblende, and there is besides a certain amount of chlorite. Original magnetite is frequently surrounded by a margin of secondary biotite. Micro-pegmatitic quartz is abundant. It is often intimately intergrown with the felspar, and, as the latter is much decomposed, would seem to replace it as a partial pseudomorph, but apatite needles of the same aspect as those which occur as inclusions in felspar, augite, and quartz, are often seen to be inclosed

Gash Point dyke

Grassy Narrows dyke.

Fig. 15. Polysomatic grain of augite—Grassy Narrows Dyke, Rainy Lake, *a* and *b* are twins—the other granules are of diverse optical orientation. × 28.

partly in a felspar and partly in quartz grain. The primary origin of the quartz, in spite of its micro-pegmatic character, is however, not beyond doubt. It is to be noted that were the quartz original we would hardly expect to find it in such close association with the felspar. The plagioclase of these rocks affords unmistakable evidence

Origin of quartz

in its idiomorphic character of its having first crystallized from the magma. The augite crystallized next, enclosing the lath-shaped plagioclase; and the quartz, which would be last to crystallize, we would expect to find separated from the plagioclase by the augite, *i.e.*, to fill in the interstices between the augite. Again, although single apatites are often found extending from a quartz grain to a felspar grain, a condition of things favoring the notion of a common primary origin of both the latter minerals, yet such a phenomenon is not incompatible with a secondary origin for the quartz, since the replacement of felspar by quartz must necessarily be a slow operation and proceed particle by particle. Further, if the quartz were original we should hardly expect to find in it inclusions of crystals of the first generation like apatite, which would be liable to be enclosed, for the most part, in the earlier secretions like felspar and augite, rather than in the residual silica of the magma. The non-existence, however, of quartz in some diabases which are very much decomposed and its presence in fresh ones, militates against the theory of the secondary origin of the quartz in these rocks, so that the question of how much of the quartz is primary and how much secondary in an old diabase is a question that as yet does not appear to be susceptible of definite settlement.

Rat-root Bay dyke.

About a mile to the west of this dyke where it crosses Grassy Island is another nearly parallel dyke converging on the former at a small angle towards the south. The rock is an uralitic quartz diabase and in its coarser portion, near the middle, the texture is more granular than that of typical diabase. The plagioclase is cloudy with decomposition products, and quartz is abundant. The augite is entirely replaced by compact green hornblende the only indication of the augite that remains being the light colored character of the central portion of the hornblende and the abundance of magnetite granules that have separated out in the process of alteration. Apatite occurs in slender hexagonal needles, mostly in the quartz, but also in the felspar and hornblende; and a number were observed which were common to both felspar and quartz. A few zircons showing parallel extinction, deep black border and brilliant polarization colors, also occur. A few colorless, rounded, isotropic grains, probably garnets, were observed. Nearer the contact where the rock is much finer grained the typical diabase structure is much better developed, the felspar having its usual lath-shaped character, with augite in allotriomorphic structure around it, although the character of the latter is obscured by its extensive alteration into hornblende. The augite so far as revealed in the cores of the hornblende occurs both in simple individuals and in polysomatic masses, and it is interesting to note that the hornblende derived from a polysomatic aggregate of augite is of

Microscopic characters.

uniform orientation throughout. Magnetite or titanic iron with associated leucoxene is generally distributed. The quartz is in small grains proportioned to the finer grained texture of the rock. In the central part of the dyke the quartz is in large grains commensurate with the increased size of the felspar and augite. In neither case does it occur in the mosaics which are so characteristic of the secondary or vein quartz. In addition to the minerals enumerated in this part of the dyke, there is in prominent porphyritic development an altered rhombic pyroxene. The alteration has proceeded very far and the mineral is now represented only a mass of yellowish green serpentine with perhaps some of the intermediate alteration product bastite. The cleavage is, however, well defined and the extinction in the several cases noted is sharply parallel to it. These characters together with the traces of the obtuse dome so characteristic of sections of enstatite are sufficient to identify it as that mineral in an altered state. The occurrence of the enstatite in this dyke in its finer grained parts towards the contact is analogous to, and an interesting confirmation of, the similar occurrence of the mineral noted in the Jack-fish Lake dyke also in the vicinity of contact. Rhombic pyroxene.

To summarise, the main points of interest are, briefly: 1. Post Archæan age of dykes. 2. Their problematic relationship to traps of Animikie and Keweenawan. 3. Their uniform strike and arrangement in lines indicative of great lines of fissure. 4. Sharp contact. 5. Passage from coarse texture at centre to aphanitic at sides. 6. Granular character towards centre, porphyritic at sides. 7. Prevalence of quartz and garnets towards centre and absence near contact. 8. Presence of enstatite at sides, absence towards centre. 9. "Chloritic substance" abundant at sides, absent towards centre. 10. Polysomatic character of augite thoughout. 11. Uralitization of augite. 12. Very marked contrast of texture of two different parts of a rock which solidified under practically the *same pressure* but at *different rates of cooling*. Summary.

Glacial Phenomena.

What was said of the glaciation of the Lake of the Woods in my report of 1885 is generally true of the Rainy Lake region. The whole country has been swept, grooved and polished by glacier ice. Towards the south, the surface has been covered by a great sheet of post-glacial fresh-water deposits, but north of the area over which these are distributed, wherever the glaciated rocks are exposed, the surface is hummocky, being made up of *roches moutonnées* and long rounded ridges Aspect of rock surfaces.

which follow the strike of the rocks of the country. In spite of this hummocky character, the surface of the country is essentially that of a flat plateau with a gentle slope to the south-west. The most prominent features resulting from the glaciation are the grooves and striæ which so constantly mark the surface of the *roches moutonnées*, and the heaps of boulders which are so abundantly strewn upon portions of their slopes. These boulders are all of Archæan and northern origin, and are all that remains of the glacial drift. All the finer kinds of drift, such as till, sand, pebbles, &c., appear with the exception of occasional remnants to have been swept down into glacial or post-glacial lakes and spread out into strata by the action of their waters. As on Lake of the Woods, those slopes which have been in the lee of the glacial current or flow have a greater accumulation of these boulders resting upon them than have those slopes exposed to its impact. Subjoined is a list of the observed direction of the ice grooving and striation at various localities. The list may seem somewhat lengthy, but it only represents an average of one observation to about every 16 square miles of the area mapped on the Rainy Lake sheet. The direction of the glacial grooves and striæ is very constantly south-westerly. The direction of the ridges and valleys of the country is quite independent of the direction of the ice flow as indicated by the grooving, and is dependent almost entirely upon the strike of the rocks as above stated. Where the strike of the rocks and the consequent trend of the ridge has been transverse to the general flow of the glacier there appears to have been little or no deflection from its mean course; but where the ridges have made a small angle with the mean course of the glacier movement, the lower portion of the glacier seems in some instances to have suffered deflection to the extent of this angle, and to have flowed in the direction of the ridges and their accompanying valleys till a change in the strike permitted its falling into line with the general flow. The average direction of the glacier movement over the Rainy Lake region as indicated by the grooving is about 40°, as compared with 45° on the Lake of the Woods, a deflection towards the meridian as we pass south-eastwardly which is probably associated with the more easterly trend of the height of land to the eastward of Lake of the Woods.

Grooves and striæ.

Distribution of boulders.

Direction of ridges and valleys independent of glaciation.

Average direction of glacier movement.

LIST OF DIRECTIONS OF GLACIAL GROOVES AND STRIÆ.

Kishkutena Route.

Kahtimi-agamak Lake	S. shore,	1 m.	E. S. E. of outlet	53°
"	"	1½ m.	E.	58°
"	W. "	½ m.	N.	46°

Clear-water Lake, 1 m. S. W. of north end	33°	Bearings of glacial grooves and striæ.
" S. E. shore opposite Hazy Point	53°	
Minomin River, ½ m. W. of entrance to Lake Despair	33°	
Hope Lake, N. side, ¾ m. W. N. W. of North-west Bay Portage	36°	

Pipestone Route.

Crow Lake, 1 m. N. W. of Crow Portage	39°
" 1¾ m. N. E. of "	44°
" 1¾ m. S. E. of Chase Point	36°
" west side of Shanty Point	42°
" north side of "	49°
Schist Lake, 1 m. N. W. of outlet	23°
Yoke Lake, north end	48°
Pipestone Lake, ½ m. N. W. of Unde Rapids	20°
" ¼ m. W. N. W. of Fisher Island	29°
" ¾ m. west of "	20°
" bottom of James Bay	37°
" Gates-ajar Narrows	27°
" ¾ m. E. of north end of Corner Island	44°
" N. W. side of Line Bay	41°
" 1 m. N. E. of Stone-dam Portage	44°
" 1 m. S. W. of " "	44°
Loon Lake, mouth of Whistle Bay	44°
Jack-fish Lake, ½ m. S. of Two Lake Narrows	24°
Foot-print Lake, 1 m. N. W. of outlet	25°

Kaiarskons Route.

Bluff Lake, 1¼ m. S. S. W. of north end	28°
Strawberry Lake, S. side ¾ m. from E. end	38°
" " 1¼ m. " E. "	48°
" at outlet	39°
Strawberry Creek	53°
Sucker Lake, E. side, ¼ m. S. of outlet	33°

Manitou Route

Grant Lake, N. E. end	38°
Missus Lake, S. shore, 1 m. E. N. E. of west end	48°
" " ¼ m. " "	43°
Manitou Lake, W. side, 1¾ m. N. E. of Paddle Portage	48°
" " 1½ m. S. S. W. "	28°
" S. E. side, 1½ m. N. E. of Snare Portage	53°
" " 2¼ m. E. of Pickerel Rapids	44°
" S. W. end	44°
Pickerel Lake, entrance to Mirror Bay	34°
" ½ m. N. N. E. of entrance to Mirror Bay	36°
Manitou River, ¼ m. S. W. of Porcupine Rapids	33°
Famine Point, Sphene Lake	33°

Little Canoe River Route.

Bearings of glacial grooves and striæ.

Bat Lake, 1¾ m. S. E. of portage to Three Island Lake	26°
Respite Lake, S. end	28°
" W. side	31°
Vane Lake, E. side, ¼ m. N. N. E. of outlet	33°
Little Canoe River, 1 m. N. of mouth	40°

Big Canoe River Route.

Dog-fly Portage	43°
Vista Lake, N. end, W. side	30°
Pickwick Lake, ¾ m. from N. end	23°
Sam Weller Lake, 1½ m. N. E. of outlet	38°
Obikoba Lake	33°

North-west Bay of Rainy Lake.

Two miles S. of Gusty Point	50°
Rocky islet, ¾ m. E. of Indian Falls	33°
S. shore, 1 m. E. of Gusty Point	37°
N. shore, 1¾ m. N. E. "	48°
S. shore, ½ m. W. of Camp Narrows	48°
" ¼ m. N. of Cliff Narrows	38 & 48°
" ¾ m. N. E. "	45°
" entrance to Brown Inlet, E. side	38°
Brown Inlet, E. side	44°
N. shore, opposite Brown Inlet	50°
Hanging-stone Point	46°

North Arm of Rainy Lake.

Island, 1¼ m. N. E. of Hanging-stone Point	53°
West side, 1¾ m. W. N. W. of Standing-stone Point	28°
Alfred Point	23°
West side, 1 m. W. N. W. of Standing-stone Point	38°
" 1 m. " Hook Island	28°
" 1¼ m. S. W. of Alfred Point	28°
" 1 m. " "	28°
Island, ½ m. N. N. W. of Hook Island	25°
Entrance to Grassy Narrows Bay	36 & 45°
East end of Hook Island	23°
Shoe Bay, north side	38°
Island, opposite Shoe Bay	38°
West shore, ¾ m. N. of entrance to Stanji-koming Bay	30°
East shore, Ami Point	43°
Macdonald Inlet, north side, E. of Big Canoe River	33°
" " 1½ m. E. "	38°
Blaze Point	40°

Bearings of glacial grooves and striæ.

Hopkins Bay, 1 m. E. of Blaze Point	46°
" 1½ m. " "	35°
" 2 m. E. "	48°
" 3 m. E. "	32°
" bottom of bay	45°
" S. E. shore at 3 diff. points	44°
Reef Point	28°
Point, 1 m. E. S. E. of Reef Point	38°
Shore, 1½ m. S. E. of Reef Point	36°
Entrance to Stanji-koming Bay, north side	40°
" " " south side	28°
Stanji-koming Bay, E. shore	31°
" " W. shore, 2¼ m. from S. end	30°
" " " 1¼ m. " N. "	18°
" " island, 1½ m. from N. end	35°
Hay-marsh Bay, N. side	48°
Island, ½ m. E. of Squall Point	31°
Squall Point	43°
Sand Bay, small island	36 & 43°
" 1½ m. N. of Pither's Point	43°

Turtle River Route.

Turtle River, 1¾ m. N. N. W. of Jones Lake	44°
Big Turtle Lake, N. E. end of large island	35°
Robinson Lake, W. side, near N. end	42°
" " ¾ m. N. N. W. of outlet	43°
Heron River, half-way from mouth to Heron Lake	46°
Heron Lake, W. side, 1¼ m. N. N. W. of outlet	53°
Little Turtle Lake, at mouth of Little Turtle River	53°
Little Turtle Lake, S. shore, ¾ m. E. of Portage to Bad Vermilion Lake	63°
" " " 3 m. from S. W. end	63°
" " " 1 m. "	61°
Sand Island River, Otter Falls	33°
Redgut Bay, 2½ m. S. W. of mouth of Otukamamoan River	48°
" 3¼ m. " " " "	42°
" Porter Inlet, 2¼ m. N. E. of entrance	23°
" " 2½ m. E. N. E. "	43°
" W. shore, ½ m. N. of Pine Narrows	33°
" west side Pine Narrows	43°
Black Sturgeon Lake, S. side	23°
Redgut Bay, 3 m. N. of Bear's Passage	28°
Bear's Passage	50°

Seine River Route.

Seine River 1 m E. of Partridge-crop Lake	56°
Wild Potatoe Lake E. end	36°
" " " S. shore 1¼ m from E. end	48°
" " " S. shore at narrows	50°
" " " N. shore at "	40°
" " " S. " 1¼ m W.S.W. of narrows	48°
" " " S. " at outlet	58°

Bearings of glacial grooves and striæ.

Shoal Lake N. side 1 m from E. end	45°
" " S. side 1½ m " W. "	53°
" " N. " near outlet	53 & 63°
Seine River opp. Kettle Pt.	46 & 60°
" " ¾ m from mouth	53°
Bad Vermilion Lake, Island Bay	40°
" " " N. shore 3 m from S. W. end	48°
" " " S. " 2 m " " "	53°

East Arm of Rainy Lake—Pither's Point to Seine River.

South shore 1 m E. of Pither's Point	48°
" " 2 " " "	48°
Island 3 " " "	33°
Island ¾ m N. of Medouganak Point	33°
Medouganak Point	46°
Entrance to Black Bay W. side	48°
Lobstick Island	53 & 28°
Island S. of Gash Point	38°
Main shore N. of Lobstick Island	41°
Cross Island	43°
Main shore W. of Lichen Island	48°
Rocky Islet Bay, W. side 1½ m N. of entrance	36°
Rice Bay, at entrance S. E. side	53°
" " N. W. side 1 m. S.W. of narrows	48°
" " near bottom	48°
" " 1 m. E.S.E. of narrows	57°
Grassy Portage Bay, 1¾ m W. of Grassy Portage	53°
Island 1¼ m. E. of Last Island	40°
" 1 m. E.N.E. of Last Island	43°
Pukamo Island E. end	53°
Island ½ m E. of Cross Island	41°
Nowhere Island N. side	43°
Island 1 m. N. of Red Sucker Island	38°
Red Pine Island S. side	48°
Sand Point Island S.W. end	43°
Dryweed Island E. end	48°
Sand Point Island at Open-water Narrows	48°
Goose Island S.E. point	48°
Rest Island S. end	38°
Goose Island W. end	48°
Berry Island S. side	43°
Little Rocky Narrows	43°
Swell Bay S. side 1½ m N.W. of Little Rocky Narrows	48°
Swell Bay E. end	51°
Island 3 m W. Halleluiah Point	48°
South shore, 2½ m W. of Brûlé Narrows	53°
Bleak Bay, E. end	56°
Seine Bay, N. side opposite mouth of Seine River	53°
Seine Bay, bottom of bay	58°
Halleluiah Point	61°

Rainy Lake—Brûlé Narrows to Kettle Falls.

Island ½ m S.W. of Point Observe	73°	Bearings of glacial grooves and striæ.
" 2½ m S.W. of " "	63°	
" at bottom of Saginaw Bay	63°	
Shore ½ m S.W. of Pine Islands	60°	
Lobstick Point	33°	
W. shore opposite Oak Point Island	28°	
Kettle Falls	38°	
S. shore 1 m W. of Soldiers' Portage	33°	
Soldiers' Portage	33°	
W. shore opposite Oak Point Island	33°	
W. shore ½ m N.E. of Oak Point Island	36°	
Stokes Bay, south side	58°	
Mouth of Pipestone River	33°	
Pipestone River, 5 miles up stream	53°	
" " 6 " " "	43°	
N. shore 2 m N.N.W. of entrance to Stokes Bay	43°	
Breezy Island	40°	
N. shore 1 m N. of Breezy Island	43°	
Vague Point	48°	
Shore, ¾ m N.W. of Vague Point	55°	
Mouth of Rat River	58°	
Shore 1 m W. of mouth of Rat River	59°	
Shore 3 m N.W. of Deer's Horn Point	60°	
Brûlé Narrows E. side 1 m N.E. of Pt. Observe	53°	

Rainy River.

Island 4 m above Manitou Rapid	38°
S. side 1 m below Longue Sault Rapids	24°
Pine River, first rapid	24°
" " second rapid	24°
South side ½ m above mouth of Rapid River	38°

Post-Glacial Formations.

Rainy River, from its source at Rainy Lake to its mouth on the Lake of the Woods, flows through a country which is thickly covered by post-glacial formations. The earliest notice of scientific value, which I have been able to find of these post-glacial deposits, is that by J. J. Bigsby, M.D.,* who remarks that "throughout the whole length of the river La Pluie, its banks expose a grey clayey and loamy soil, full of small angular fragments of the yellow limestone of the Lake of the Woods, intermixed occasionally with round lumps of gneiss from the size of the fist to that of the head. I saw no marks of stratification, nor any marine or fresh water shells." J. E. Norwood, M. D.,† in run-

Previous notices.

Bigsby.

Norwood.

* Geol. Jour., Vol. VIII., 1851, p. 217.

† Report of Geol. Survey, Wisconsin, Iowa and Minnesota, by D. D. Owen, 1852, p. 319.

ning down the river from Rainy Lake to the Big Fork, noted that "while descending Rainy River, a bed of blue clay was observed similar to that seen and described on St. Louis and Embarras rivers. It is full of gravel and overlaid by a bed of yellow sand." S. J. Dawson* also has noted that "the land immediately bordering on Rainy River, on the British side, is of an alluvial description, and almost as uniformly level as the prairie at Red River."

Dawson.

Bell.

Dr. Bell † states that "the banks of the Rainy River, except in approaching the Lake of the Woods, are generally from fifteen to twenty feet high, and are composed of clay and drift materials in which pebbles and boulders of a yellowish grey limestone are plentiful."

These brief notes by earlier observers of the formations through which Rainy River cuts its way, do not give a sufficiently clear or comprehensive account of their character, their distribution or their geological history. I shall, therefore, attempt to supplement them by observations I have been enabled to make in the field myself, as well as to point out the connection of the facts adduced with those that have been observed by others in the study of post-glacial phenomena in adjoining regions. I am at a loss to understand Dr. Bigsby's statement that he saw no marks of stratification in the banks of the river. There are abundant and distinct evidences of the deposition of the greater part of the formations in stratiform layers or beds. They are first observed on Rainy Lake on the west shore of Sand Bay, as bedded clays. Between Rainy Lake and Fort Frances, the banks of the river are composed of light colored, more or less, sandy and calcareous clays with numerous pebbles of yellow or cream-colored limestone. The banks rise about ten or twelve feet above the surface of the river at its mean height, and the country back from the river is flat. Below the Falls of Fort Frances the river sinks in level, between 22′ and 25′. And as the surface of the country remains flat, the height of the river banks below the falls is increased by this amount. The banks here present a more or less steeply scarped aspect, a character which they retain almost continuously to the mouth of the river, although there are occasionally short stretches of sloping banks or low shores which are wet or dry, according to the height of the water in the river. For a long distance down the river from the falls, evidences of stratification are not very prominent in the banks. The clay is very calcareous or marly, and crumbles readily when dry, forming a steep talus. The bedding can, however, be seen occasionally in the short scarp which rises above this talus quite distinctly. In these cases, thicker beds of a calcareous

Evidence of stratification.

Character of beds.

Steeply scarped banks.

* Report on the exploration of the country between Lake Superior and the Red River settlement. Appendix to Vol. XVII. of the Journals of the Legislative Assembly. Session 1859.

† Report on the country between Red River and the South Saskatchewan, with Notes on the Geology of the Region between Lake Superior and Red River, 1873.

or sandy clay, with numerous small pebbles, are generally separated by thin partings of purer unctuous clay. The thicker beds usually vary from 2″ to 6″ in thickness, and are often much more sandy than clayey. For the first three miles below the falls, the underlying glaciated rocks upon which the formation rests crop out occasionally on both sides of the river. From these exposures I should judge that the mean level of the rocky surface of the country along this part of the river would be but little below the surface of the river, and that we have in the height of the banks a vertical section nearly equal to the mean thickness of the formation which would, therefore, be between 30′ and 40′. Thickness of formation. After turning the bend three miles below Fort Frances, no rocks crop out along the river for over twelve miles. Throughout this distance, the character of the banks varies but little and presents only a few points of special interest. On the Indian Reserve opposite the mouth of Little American or Little Fork River there is a peculiar terrace-like ridge running parallel with the river a few hundred feet from the water's edge. Terrace-like ridge. It is observable only for a short distance where the Indians have cleared away the bush. Between the Little and Big American Rivers on the Canadian side there can be seen an extensive, apparently unstratified mass of clean, unctuous, blue clay underlying the bedded marly clays and sands of the upper portion of the bank. Blue clay. Below the Big American River the bedded clays, sandy and marly clays and sands prevail, and the lower unstratified blue clay was not again observed for a considerable distance. On Mr. George Singleton's farm, (Sec. 9, Tp. 5 S. R., XXVIII,) the glaciated surfaces of the old rocks outcrop from beneath these post-glacial deposits, not only on the river banks, but over a considerable area in the rear of his farm, the rock being a hornblende-syenite gneiss. Rock exposures are more common from this point on to the bottom of the Longue Sault than anywhere else along the river, and some of the more prominent points appear to have been islands in the fresh water lake, in which the post-glacial formations were deposited. Rock exposures. The latter cannot be on the average much more than 25′ or 30′ thick along this part of the river. The surface of the country rises gently, however, on the north side of the river, and at the back of Mr. Latterel's farm, Sec. 22, Tp. 5, S. R. XXVIII, a low flat gravel ridge was observed which probably lies on top of the beds exposed at the river bank. Gravel ridge. Between this point and Manitou Rapid many more boulders of Archæan rocks were observed imbedded in the strata of the river banks than had been noticed higher up the stream, although they are not prominent near the rapid itself, the formation, as observed by Dr. Bigsby,* being unusually clayey there. Unbedded clay. Near the eastern limit of the Indian

*Loc. cit.

Reserve at Manitou Rapid there may be seen on the north side of the river a mass of unbedded clay with pebbles to a thickness of 10′ to 15′ above the surface of the river, and resting upon this 4′ of evenly bedded sandy clay in which the pebbles are mostly yellow colored limestone. Down near the rapid these upper beds are wanting just at the water's edge and the lower clay only is seen. This lower clay is probably the same formation as that noted between the Big and Little American rivers.

Beds below Longue Sault.

Below the Longue Sault Rapids for some miles the banks of the river on either side, wherever the scarped faces permit of close observation, shew only bedded marly clays, and clayey sands with pebbles. If the unstratified lower clay underlies these beds, as appears quite probable, it is concealed by the soft talus that has fallen from the scarp.

Well.

Mr. Cameron informed me that he had sunk a well four miles back from the river on a logging road, Sec. 21, Tp. 4, S. R. XXV., for 22′, and had bored a further 40′ through formations similar to those on the bank of the river before he struck solid rock. He obtained water at this depth of 62′, but found it extremely hard, a fact due to the abundance of calcareous matter in the loose strata through which water must percolate before reaching the comparatively impermeable surface of the underlying hard rocks.

Pine River.

The formations up the Pine River, as far as the second rapid, are, as on Rainy River, bedded marly clays and clayey sands together with gravel made up very largely of limestone debris. At the first rapid on Pine River a gravel ridge which lies on the glaciated surface of the rock has been cut into by workmen engaged in the construction of a dam across the rapid. The gravel is rather fine, mostly calcareous, and much mixed with clayey matter.

Remains of Buffalo.

In it were found large numbers of fresh water-shells together with some fragments of bones of the buffalo (*Bos Americanus*, Gmelin.) Fresh-water shells were also found in the beds on Rainy River, at the confluence of Pine River, and at various points below this, particularly, however, in the bedded sands and clays at the mouth of Beaudette River. Although the shells at these points are numerous, the species are few.

Freshwater shells.

Tho following have been identified by Mr. Whiteaves, *Sphærium sulcatum*, Lamark; *Sphærium striatinum?* Lamark; *Planorbis* (*Helisoma*) *bicarinatus*, Say; *Limnœa* (*Limnophysa*) *desidiosa?* Say (one, broken). Near the confluence of Beaudette River and from that point on to the mouth of Rainy River, the banks still retain their abruptly scarped aspect rising from 10′ to 20′ above the river, but the formations composing them gradually change in character, and the clay gives place to a fine light-yellow muddy sand, bedded often with very thin partings of clay. A third of the way from Beaudette River to the mouth of Rainy River, this yellow sand is

observed to rest upon a pebble conglomerate made up of limestone and Archæan pebbles imbedded in a partially hardened mud matrix. Conglomerate.

At the south-east corner of the Lake of the Woods these post-glacial deposits of sand have been much modified and altogether re-arranged by the currents incident to the discharge of a large river, by the waves of a large open expanse of water exposed to the full force of the west wind, and by the wind itself wherever they are exposed above the surface of the water and unprotected by vegetation. About three miles west of Rainy River there runs out from the south shore of the lake, in a direction 65°, a sand spit three miles and a-half in length. The sand on this spit has been blown by the wind into dunes and ridges which are now partially protected by vegetation. At the extremity of this spit, on Oak Point, the main current from the river discharges into the open lake. On the other side of this gap of half a mile, through which the current sweeps, the sand spit is continued in a long barrier running parallel with the shore, or in a direction 40°, as far as Burton's Island, a distance of six miles and a-half from the gap above mentioned. Portions of this barrier are only revealed above the surface of the lake in seasons of low water, and its breadth varies according to the height of the water. It is, however, very narrow compared with its length, and is for the most part a prominent ridge standing out boldly against the sky in a series of wind-blown dunes which rise from 10′ to 40′ above the level of the lake. The sand is of a light yellowish color, and of varying degrees of coarseness. It is composed chiefly of quartz and felspar grains. In the dunes may sometimes be detected a bedding due to the action of the wind, and the process of sorting out the different sands in layers according to their coarseness and the strength of the wind, may be observed in actual operation. The channel or open lagoon, which lies between the shore and this barrier, varies in width from half a mile to a mile and is silting up on the shore side, there being, apparently, a weak side current from the river along the inside of the barrier which keeps it free of the grassy vegetation which prevails closer to shore, and which catches the fine silt in seasons of high water.

Sand-spit.

Sand-barrier.

Dunes.

Bedding due to wind.

The shore of the lake from Burton's Island north-eastward to the Indian Reserve north of the mouth of Little Grassy River is mostly sand of the same character as that of the barrier, and has been much modified by wave action. Windy Point is a long sand-spit and the island to the north-east of it partakes of the nature of a delta. The water for considerable distances off shore along this stretch of coast is very shallow. On the Indian Reserve 35 E., bedded clays similar to those on Rainy River are again observed in low scarped banks. The shore of the bay on the north side of this reserve was the most northerly point along this coast at which these deposits were observed.

S.E. shore of lake.

Bedded clays on Indian Reserve 35 E.

Here they consist of clayey limestone gravel and marly clay in beds.

Further distribution of bedded clays.

The same formations occur together with much sand on Bigsby Island, and in places on the south and west side of Big Island. Their occurrence on Cornfield Island was noted in my report of 1885. West of Cornfield Island, the northern limit of the distribution of these post-glacial beds bends more to the north, for they are found on the shores of the North-west Angle Inlet, and probably underlie the extensive flat country to the south-west of the inlet and west of the Lake of the Woods. At the south end of Shoal Lake great sandy stretches occur and at the north-west corner of Shoal Lake, in the neighborhood of Indian Bay, the bedded clays are again observable. The northern limit of the flat country underlaid by these post-glacial deposits appears, from such information as I can gather from those familiar with the country, to cross the C. P. railway in the neighborhood of Whitemouth, and such deposits appear thereafter to be in direct continuity with the prairie country of Manitoba.

Country north of Rainy River.

In the country north of Rainy River it appears, from information supplied by the reports of Mr. S. J. Dawson,* Mr. T. O. Bolger,† and from the plots of the township surveys as well as from my own observations, that these post-glacial formations, through which the river cuts its way, extend back to an average distance of about twenty miles, or to a line connecting the N.W. corner of Sand Bay on Rainy Lake with the northern limit of Indian Reserve 35 E. on the Lake of the Woods.

Northern limit of post glacial formations.

Thus it appears to be possible to trace approximately the northern limit of a great sheet of post-glacial deposits from Rainy Lake to Whitemouth, a distance of 150 miles. The line defining this limit is more or less sinuous, so far as can be made out, but its general direction is remarkably straight and *has a course which is approximately at right angles to the direction of the glacial grooving* in the exposed rocky region immediately to the north of the line. This sheet of post-glacial deposits appears to extend indefinitely to the south, and from various sources of information‡ the flat country underlaid by them appears to be in direct continuity with the prairie country of western Minnesota, Dakota and Manitoba. The body of water in which these formations were deposited appears to be the same, as stated in my report of 1885 with Mr. Upham's Lake Agassiz.§ According to

Lake Agassiz.

* Exploration of country between Lake Superior and Red River Settlement, 1859.

† Report of Commissioner of Crown Lands of the Province of Ontario, 1886, p. 48 et seq.

‡ Reports of Progress together with a Preliminary and General Report on the Assiniboine and Saskatchewan Exploring Expedition, by H. Y. Hind, M.A., 1859. Report VII.

Geol. and Resources of 49th Parallel, G. M. Dawson, 1875, p. 212.

Information received from Mr. Thompson, who was engaged upon a preliminary survey of a railway from the mouth of Rainy River to Red River across northern Minnesota.

§ Eighth Annual Report, Geol. and Nat. Hist. Survey of Minn. 1879, p. 84, et seq.; Eleventh Report 1882, p. 137-153; also Bulletin 39, U.S. Geol. Survey.

Mr. Upham's determination of a northerly upward slope of the surface of Lake Agassiz as it approached its northern ice barrier* there would be by his estimate 150 feet of water above the present level of Rainy Lake and much more above the present level of the Lake of the Woods. This being the case, the waters of Lake Agassiz ought to have extended far to the north of Rainy Lake and Lake of the Woods, and the fresh water deposits, which I have sketched as stretching to the south of a line drawn from Rainy Lake to Whitemouth, should also extend far to the north of that line, since there is no sufficient rise of the land along the line against which the waters of Lake Agassiz could form a shore. As a matter of fact, no old beaches have been observed along the northern limit of the fresh-water formations. Hence, if Lake Agassiz stood at this elevation, the only explanation that will account for the non-continuance of the lake deposits to the north, is the supposition that the line which defines the northern limit of those formations is approximately also *the line of the ice-barrier which dammed back the waters.* Against the base of such a barrier there would be no beaches formed, since it would be in deep water, but a gradual overlapping of strata in flat layers as the ice receded. There are, however, some facts which have yet to be reconciled with this hypothesis. These are the occurrence of areas of post-glacial deposits in the country to the north, and numerous gravel ridges and other deposits which are known to exist, but have not yet been studied. In valleys tributary to Rainy Lake, such as the basin of the Seine River and that of the Turtle River, there are local deposits similar to those on Rainy River which may perhaps be regarded as having been formed in arms or bays of Lake Agassiz. These deposits appear to lack a feature which is very characteristic of the deposits along Rainy River, viz., the presence of pebbles of cream colored or yellow Silurian limestones. The northern limit of the distribution of this limestone drift has been noted by Bigsby, Dawson and myself, and it appears to be coincident with the line that has been sketched as limiting the northern extension of the post-glacial formations. The limestone pebbles and boulders, while doubtless derived in the first instance from the Silurian rocks of the Red River basin, appear on the Lake of the Woods to come immediately from the post-glacial strata in which they are imbedded. Their glacial origin is attested by the very common and distinct striation observable upon them; which fact also attests that they have been very little water-worn since their escape from the foot of the glacier, the inference being that the clayey strata in which they are imbedded were derived largely from the same glaciers. With regard to other isolated patches of post-glacial formations, it is to be noted

Northern barrier of Lake Agassiz.

Other local deposits.

Source of limestone pebbles.

* Bulletin cit. p. 15.

that those of any considerable extent that are known, such as that near Lake Wabigoon, appear to lie on the north side of the height of land, and may have been formed at a somewhat later stage of the recession of the ice barrier, after Lake Agassiz had shrunken to a fraction of its maximum size. On this assumption the lake in which the deposits around Wabigoon were deposited would have had the height of land for its southern barrier and probably the ice for its northern. There are few facts, however, as yet to support such speculations, and they are only suggested by the analogies which the results of Mr. Upham's work naturally lead us to look for.

Economic Geology.

Prospective development.

The country mapped on the Rainy Lake and Rainy River sheets, accompanying this report, presents, in the geological features which have been described, conditions which are favorable to its development both as an agricultural and mining district of considerable importance. The lumbering industry is already fairly well established there, the greater part of the timber which is sawn at the numerous mills near Rat Portage and Keewatin being brought down the Rainy River. The fur-trade, also is an active industry, trapping being the chief occupation during the winter months of the numerous bands of Indians who inhabit the country, while in the summer they support themselves by fishing, shooting and rice-making.

Agriculture.

Agriculture is perhaps the most promising of the economic prospects of the region. Rainy River, from its source at Coutchiching to Hungry Hall, flows for eighty miles through a rich alluvial plain, which, so far as can be judged from the banks of the river, is eminently adapted to support a large agricultural population. Travellers and explorers vie with one another in praising the beauties of the river and its capabilities for settlement. Mr. S. J. Dawson in his "Report on the Exploration of the Country between Lake Superior and the Red River settlement" says of it, "The distance from Rainy Lake to the Lake of the Woods, following the windings of the stream, is about eighty miles, and throughout the whole of this extent the land fronting on the river is fit for settlement without, I may say, a single break; indeed, I have never seen anything to equal it in my experience, except at Swan River and on the Assiniboine. Farther inland, although the ground becomes in many places swampy and broken, there must be a fair proportion also fit for settlement, but to ascertain anything like the precise area that is so, would require a closer examination than we have as yet been able to bestow." Prof. H. Y. Hind in his account of the country examined by the same expedition says of the land along

Mr. S. J. Dawson's opinion.

Rainy River: "The average breadth of superior land for a distance of seventy miles might perhaps, with propriety, be assumed to be not less than six miles, giving an area of available soil of high fertility, exceeding two hundred and sixty thousand acres; and there can be little doubt, that with the progress of clearing, much that is now included in the area occupied by swamp, would, without difficulty or expense, be reclaimed." In another paragraph the same authority says: "No part of the country through which we have passed from Lake Superior northwards can bear comparison with the rich banks of the Rainy River thus far. The river has preserved a very uniform breadth, varying only from about 200 to 300 yards. The soil is a sandy loam at the surface, much mixed with vegetable matter. Occasionally, where the bank has recently fallen away, the clay is seen stratified in layers of about two inches in thickness, following in all respects the contour of what seems to be unstratified drift clay below. Basswood is not uncommon, and sturdy oaks, whose trunks are from eighteen inches to two feet in diameter, are seen in open groves, with luxuriant grasses and climbing plants growing beneath them." Prof. Hind's opinion.

A more recent authority is Mr. T. O. Bolger, P.L.S., who explored the region in the summer of 1886, for the Department of Crown Lands of Ontario, with the special object of ascertaining its fitness for settlement. His description and opinions are more valuable than the preceding, and they are even more optimistic. He says: "I first encountered good land at the point where the forty-ninth parallel or the first base strikes the Lake of the Woods, and following up Little Grassy River, which empties into the lake, a couple of miles south of this point, I found, from travelling in every direction, that the block of four townships composed of townships one and two south, ranges twenty-three and twenty-four east, contains a large percentage of the finest land I have ever seen, and the same description applies to the block of land lying westward between these townships and the Lake of the Woods. Little Grassy River is navigable for canoes for a distance of about eight miles from its mouth, and the land on the shore is all good, being composed of a rich calcareous drift formation, equal to any soil in the best agricultural districts of Ontario. Mr. Bolger's description of soil of Rainy River country. Little Grassy River.

"The timber along the river is chiefly large thrifty poplar, mixed with some scattering oak and swamp elm, and some evergreens such as balsam and spruce; inland, the timber changes in character somewhat from that along the river shore, as large balm of Gilead, spruce, balsam and tamarac are met with more frequently, and the nice open bush which prevails along the river banks is changed for a tangled brushy undergrowth; but the character of the soil remains the same. Tamarac and spruce swamps occur frequently in this section of the country, as Timber on Little Grassy River.

Swamps drainable.

is the case all throug is large level area of good land which lies along the banks of Rainy River. These swamps were all perfectly dry this summer, and are nearly all capable of being made into excellent land by drainage, as they lie nearly as high as the surrounding dry lands, and only require proper ditching to take the surface water off in wet seasons. The extreme levelness of the country causes the presence of so much swamp land here, as the surface water has no means of escaping from the low-lying portions, and consequently the growth of moss and swamp timber is engendered. I noticed that in most cases the beds of the little streams are deep enough to form outlets for ditches and drains, and these creek beds are usually so numerous that to drain any swamp no very long ditches would be required; in nearly all the swamps through which I passed I observed the soil to be a black vegetable mould, varying in depth from one to three feet, and always underlaid by the same calcareous clay above alluded to. I seldom met the muskeg proper, that is to say, the wet shaky bog in which water is present at all seasons of the year, and which grows nothing but dwarf spruce and moss. I then paddled up Rainy River, and on both shores I found the same kind of country as I have described as being in the vicinity of Grassy River, and as there are a good number of settlers along the river on the Canadian side, I had an opportunity to observe the soil while under cultivation, and to see the kind of crops it is capable of raising.

Soil.

"The soil I found to be most excellent in character, calcareous clay overlaid by a thin streak of whitish fine earth about six inches in thickness, and this again covered with a coating of vegetable mould, and these three mixed up together in the working of the land form a soil which cannot be excelled in any part of the Dominion. I saw

Crops.

along the river crops of potatoes, turnips, hay, oats, wheat, corn, tomatoes and cabbage, all grown to perfection this season, which shows that the climate, as well as the soil, is suitable to successful farming, especially when tomatoes ripen as they certainly did this year as well as I ever saw them ripen in the vicinity of Lake Ontario.

"As I went up the river I frequently travelled inland several miles, and at the easterly side of township three, range twenty-four, I penetrated northward to the section I had explored from Grassy River, and found that the calcareous clay formation extends at this point clear from the Lake of the Woods to Rainy River, a distance of over twenty miles in a straight line; I found a tremendous bush fire raging along the first correction line south, which was destroying everything before it; in fact bush fires were very frequent in this part of the country this season, owing to the extremely dry weather. There is an area of

Pine.

pine land in here a little north of the first correction line south, where

the soil is inclined to be sandy, but the extent of this tract is not very large.

"Along the line dividing ranges twenty-six and twenty-seven the good land extends back some twelve miles from the river, but towards the north-east corner of township three the rough regions begin to appear, and away to the northward the country is broken and rocky, and the good land disappears. Broken country.

"Township three and the north part of township four, range twenty-seven, have been burnt over some years ago, and are now grown up with small second growth of poplar.

"Townships four in ranges twenty-eight, twenty-nine and thirty, are mostly all good land; while townships three in the same ranges are generally broken with rocky ridges, but contain some excellent land in the valleys among the hills; townships two, ranges twenty-seven and twenty-eight, also contain some good land, although broken by rocky hills.

"A straight line drawn from the south-west corner of the large Indian Reserve on Big Grassy River to Fort Frances would approximately form the north boundary of the good belt of land, while almost all the country lying between this line and Rainy River and the Lake of the Woods is good agricultural land. This tract of country is over sixty miles long, and averages over fifteen miles wide, and contains over nine hundred square miles, or something like six hundred thousand acres, and has a water frontage on the Lake of the Woods and Rainy River of over one hundred miles. Of this area, perhaps thirty per cent. is swamp, most of which can be drained and made tillable land, rocky ridges occur very rarely, and the soil is all a limestone clay such as I have described. No limestone rock in place has been observed, but loose limestones containing fossils are frequently to be met along the rivers, and the settlers along Rainy River pick them up and burn them into excellent lime; in fact this whole district is a glacial drift. Extent of good agricultural land.

"The timber is chiefly poplar which grows to a great size; I have seen trees over eighteen inches across the stump and sixty feet long clear of the limbs. Balm of Gilead, too, prevails in some sections, while spruce, tamarac and balsam of thrifty growth are everywhere met with. In some places magnificent cedar abounds large enough for telegraph poles, shingle bolts, or any other use to which cedar is applied; there are some groves of pine through this section, but it cannot be called a pine country, that is, on this drift formation." Timber on Rainy River.

Such testimony as to the character and value of the land through which Rainy River flows leaves little for me to say beyond expressing my entire concurrence in the opinions quoted as to the great suitability of the country for settlement and agriculture. Settlers are

Settlement.

going in gradually, and there are some excellent farms along the river front, the chief market for produce being the town of Rat Portage and the milling population between it and Keewatin. With the settlement of the question of civil jurisdiction, and the prospect of the railway which is projected to run through the valley, a more decided influx of settlers may be expected, and all the lots along the river front will doubtless soon be occupied and cleared. The river affords an easy means of access, and the levelness of the country renders roads easy to build.

Other patches of good land.

Other small isolated patches of flat-lying land, probably old post-glacial lake bottoms, which would be suitable for agricultural purposes occur to the north and east of Rainy Lake. One of these is on Big Turtle River, and another smaller one, now occupied by Indians, is on Seine River.

Mineral resources.

The economic value of the Rainy Lake region, as regards its mineral resources, is entirely prospective. There are no mines in the region, and extremely little search has been as yet made for mineral deposits. It is, however, quite probable that when such search is made, the various minerals will be found which are more or less common elsewhere under the same conditions as those which obtain here. The Keewatin rocks of the Rainy Lake region are the same as those in which the gold of the Lake of the Woods occurs. In them deposits of iron may confidently be looked for. Indeed on Seine River, good indications of iron ore have already been discovered, and farther up the river, beyond the limits of the region mapped, valuable deposits have been found on the Atic-okan. Iron pyrites, copper pyrites and arsenical pyrites are very common in small quantities in the Keewatin rocks and will doubtless some day be found in valuable deposits in some portion of the belt. Lead and zinc ores may also possibly be discovered. The occurrence of bosses of serpentine suggests the possibility of diamonds, and some enterprising prospector may yet be rewarded for a close examination of the vicinity of the serpentine rocks indicated on the map, or of others that may be discovered, particularly if they be found near the carbonaceous schists that sometimes occur in the Keewatin. Asbestus should also be carefully searched for in these serpentine rocks. Poor varieties were observed in veins in the serpentine of Clear-water Lake. Closer examination may reveal the finer and more valuable varieties. Good soapstone is not uncommon in the Keewatin rocks and will some day be of value. Limestone in small quantities has been observed on Manitou Lake, associated with the green schists. Good roofing-slate has not been observed, but occurs in the Keewatin series on the Lake of the Woods. Some of the more siliceous schists would make good whetstones, and the finer-textured

felsite schists good hones. The development of these various resources will, however, only come with the gradual settlement of the country, as it is only the discovery of the more valuable metals in large quantities that will create a sudden influx of prospectors and mining population.

In the dykes and irregular masses of pegmatite which break through the rocks of the Coutchiching series on the south-east arm of Rainy Lake and on Nemeukan Lake, white mica occurs abundantly, but unfortunately not often in sheets over two inches in diameter. If these pegmatites were carefully prospected, local developments of large and valuable sheets of white mica would very probably be found in paying quantities. Mica.

The Laurentian rocks of the region are, so far as they are known, perfectly destitute of metalliferous deposits, except in one instance, where, at the immediate contact of these rocks with the schists of the Coutchiching at the Bear's Passage, a quartz vein occurs in which flakes of molybdenite are common. Even in this instance it is difficult to say whether the vein is not as much in the Coutchiching as in the Laurentian, the contact of the two being a brecciated one. This remarkable barrenness of the Laurentian rocks, as contrasted with those of the upper Archæan, is a fact of great interest as well as of practical importance to the prospector. On the map accompanying this report, the distribution of the Keewatin rocks is mapped distinctly, so that prospectors for gold, or iron, or any other of the metalliferous ores, need not waste time examining the Laurentian country. Barrenness of Laurentian rocks.

The reason why the Keewatin series should be metalliferous and the Laurentian barren of metals is a theoretical question which need not be gone into at all fully here. It may, however, be briefly indicated that the fact is quite in harmony with the interpretation of the geology of the region which has been given in the earlier pages of this report. It has there been shewn that the Keewatin series is largely made up of volcanic rocks, while neither the rocks of the Coutchiching nor of the Laurentian are volcanic. From this it is inferred, as has been established in many parts of the world, that the presence of metalliferous deposits is intimately associated with the volcanic rocks. It has also been shewn that the Laurentian or lower Archæan rocks have very probably resulted from the plutonic fusion and recrystallization of the floor upon which the upper Archæan was deposited, and that such fusion has included portions of the upper Archæan formations. Such fusion would effect the dissemination throughout the magma of whatever metalliferous deposits existed, so that on recrystallization, the ores would only be found in the minutest traces, while the existence of an extensive magma underlying the unfused rocks of the upper Archæan may have Theoretical considerations.

been an important factor in the production of the numerous veins found in them.

Value of post-glacial formations.

In the post-glacial formations of Rainy River, the clays, sands, and limestone boulders are all of economic value. Some of the lower blue clay seen on the banks of the river appeared to be very pure and capable of being worked for pottery. Other clays would make good bricks. Much of the sand intercalated with the clays would be serviceable for building purposes, and some of that at the mouth of Rainy River would be good for glass making. The limestone boulders are occasionally burned for lime by the settlers.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

ANNUAL REPORT

(NEW SERIES)

VOLUME III.

PART II.

REPORTS H, J, K, M, N, R, S, T.

1887-88.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
WILLIAM FOSTER BROWN & CO.
1889.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON

MINES AND MINING

ON

LAKE SUPERIOR.

PART I.

A. HISTORY AND GENERAL CONDITIONS OF THE REGION.
B. SILVER MINING.

BY

ELFRIC DREW INGALL, M.E.,

Associate of "The Royal School of Mines" Mining
Geologist to the Geological Survey of Canada.

PUBLISHED BY AUTOHRITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

NOTE.

It was intended that this Report should have been published as Part H. of the Annual Report, Vol. II, 1886; but the illustrations not being ready, it was postponed and will now constitute part H. of the Annual Report, Vol. III, 1887. Additional developments on some of the mines to which it refers are noticed in Part S. same Vol.

Unless otherwise noted, the bearings throughout this Report are referred to the magnetic meridian.

To A. R. C. SELWYN, ESQ, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I send you herewith Part I of my report on Mines and Mining on Lake Superior, prepared in compliance with your instructions.

This part, whilst referring to the history of the whole region for the past forty years, and the economic and other conditions which have affected its development during that period, treats more particularly of the Silver Mining there, the subjects dealt with constituting the great bulk of the matter to be considered. In view of the fresh importance which the subject of Silver Mining in this region has assumed, owing to recent discoveries, it was deemed advisable to complete this part for publication at once rather than to delay it until the rest was ready.

Part II will treat of the mineral substances, other than Silver, found or mined in the region. These are receiving little or no attention at present, and, in comparison with what has been done in exploring and developing the Silver district, the history of the mining of these other substances constitutes a comparatively small part of the subject under consideration. This part is in an advanced state of preparation, but some important information is yet wanting to complete it, which I hope soon to be able to obtain when it will be at once put in shape for publication.

The field work of this investigation was only completed late in the fall of 1886, and the elaboration of the material thus obtained, together with the collection and preparation of the other information incorporated with it, has been, in the nature of the work, a very tedious and lengthy undertaking. The same applies also to the preparation of the illustrations, the data for which had often to be obtained from very various sources, and from people who had long since left the region; and all this, together with the natural difficulties encountered in compiling such data to form plans, etc., which should be as complete and reliable as possible, has caused the unavoidably slow progress of the work.

This work was further delayed owing to the fact that during the two winters following my appointment in July, 1885, to a position in connection with the work of the collection of Mineral Statistics, the greater part of my time was taken up in making, in conjunction with

Mr. Coste, the necessary preparatory arrangements for carrying out that undertaking; and in the compilation and writing of part of the report on that subject for 1887.

In conclusion, I beg to express my thanks to all those from whom I have received assistance during the progress of the field work, and to Messrs. S. J. Dawson, M. P., A. L. Russell, W. H. Furlonge, T. A. Keefer, P. McKellar, W. M. Courtis and H. K Wicksteed, who have supplied me by correspondence with much valuable information since leaving the district, and also to the many others who have kindly supplied information, maps, specimens, etc.

During the progress of this work I was assisted in the field by Messrs. A. W. Hopkins and J. H. Moore, in the summer of 1885, and by Messrs. H. P. Brumell and J. H. Moore, in the summer of 1886. In the preparation of the maps and illustrations for the report I was assisted in the office for a short time in the spring of 1886, and during part of the winter of 1886-7 by Mr. H. P. Brumell, and afterwards by Mr. J. White, who succeeded him in the spring of the latter year, and who did much towards the completion for publication of the accompanying map of the Silver Mountain district, and of the Sketch Map of the Thunder Bay mining region.

I have the honor to be,

Sir,

Your obedient servant,

7th July, 1888. ELFRIC DREW INGALL.

PREFACE.

The objects chiefly kept in view in the prosecution of this work have been: 1st. To make as complete a history as possible of the mining developments of the whole region. 2. To ascertain either personally or from the most reliable sources the results of such developments. 3. To examine as many examples as possible of the veins and mineral deposits with a view to the collection of information which might lead to their classification and a better understanding of their nature and relationships, and of the conditions under which they are found. Objects of investigation.

Regarding the attainment of the first two objects much difficulty has of course been encountered. The greater number of the mineral locations prospected have been worked upon by small gangs of men for periods varying from a few weeks to a few months, and that mostly years ago, so that those from whom detailed information might be obtained are now spread far and wide. Even where this is not so, those interested in the matter could hardly be expected to judge of results quite dispassionately, and again, where personal inspections of old mines were made, these being of course full of water, it was found necessary to supplement these observations, which were necessarily confined to the surface, by information obtained from others regarding the underground workings. In these cases however, a careful examination of the surface indications has resulted in useful and necessary additions to the information gleaned from such sources. Concerning the third object mentioned, I hope that the details and facts recorded in this Report may be considered desirable additions to our knowledge in this respect. Where advisable, I have also incorporated information gathered and published by other observers both amongst and outside of the officers of the Survey, with a view to making as complete a summary as possible of the evidence on the subject. Since the commencement of this investigation, after tedious enquiry, communication has been established with various people formerly connected officially with some of the important mining efforts of the past, and the information so obtained has been very valuable and will add materially to our stock of experience of the district.

Various questions naturally present themselves to capitalists, engi-

neers and others purposing to interest themselves in this region, such as the following:—

To what extent has this region been examined and prospected, and what have been the results of such search for minerals?

What is the state of the mining industry there at present, and what has been done in the past?

What have been the results of all these trials, and what experience has thus been gained of the nature and habits of the mineral deposits of the region?

How does the experience so gained apply to the recently discovered mining sections to which attention is at present directed?

In attempting to answer these questions, I have in the first part of the Report given the particulars of the work done, nature of the deposit and of its geological environment, etc., for each property which has been worked or prospected to any extent, and have thus summarised the evidence upon which are founded the general conclusions contained in the latter part.

Wherever it has been possible to secure the information for their compilation, plans, etc., illustrating the individual properties have been given, it being believed that a map or plan, even if somewhat diagrammatic, will produce a clearer idea in the mind of the reader than many pages of letter-press. A Sketch Map of the Thunder Bay region accompanies the Report which having been compiled from various sources does not pretend to represent the topography with absolute accuracy, but is as correct as the material at present available will permit, and is sufficiently so for the purposes for which it is intended, viz.: To show the various districts, their position, communications, etc., as well as the grouping and relationships of the veins as far as at present known. The rest of the illustrations being explained in their proper connection need no comment here.

Sketch map.

Every possible means has been taken to fill up gaps in our information on the subject in hand from reliable sources and doubtless a continuance of the effort would from time to time bring to light much that would serve to render this record still more complete, but the collection of such items being a very tedious process, it would be obviously unwise to further delay publication on that account. With the original matter then of this Report much extraneous and scattered information has been incorporated and rendered available, and it is hoped that in this way the Report here presented will be found to be as complete and systematic a record as it is now possible to obtain of Mines and Mining on the Canadian shores of Lake Superior, and the connected districts from the commencement of mining there in 1846 to the present day.

REPORT

ON

MINES AND MINING

ON

LAKE SUPERIOR.

PART I.

A. HISTORY AND GENERAL CONDITIONS OF THE REGION.

Extent of area dealt with.

The area which may be said to naturally come under study in the consideration of the above subject is very great, extending as it does through a tract comprised within 10 degrees of longitude and 3 degrees of latitude. To those unacquainted with the region and unaccustomed to deal with the great distances of a new country, it may convey a better idea of the size of this tract when it is pointed out that its area nearly equals that of England.

I have placed this rather extended meaning on the term "Mining Region of Lake Superior" as I feel assured that in course of time, as the country back from the Lake shore gets opened up, new mining districts will be discovered which will naturally connect themselves with this region. I have also included a large section of country to the North of Lake Huron which geologically, geographically, historically and otherwise, seems to be naturally connected with the East end of Lake Superior, and in which the mining developments will be a guide for the future in the whole region. Thus considered then, the area dealt with may be described as a belt of country extending along the north shores of Lakes Huron and Superior to an indefinite distance back from them, commencing about at longitude 81 degrees on the east, and continuing west to where the International boundary is intersected by longitude 91 degrees, thus including the silver bearing area extending south-west from and tributary to the town of Port Arthur.

This great region, until a comparatively recent period, was a *terra incognita* to the great proportion of even the inhabitants of the Canadian Provinces themselves, and to the present date, large sections of the area spoken of are only known to the trapper, the Indian and the timber hunter, and have not even come under much notice from the mineral explorer.

Speaking generally of the whole region, it consists for the greater

part of a great rocky area covered with bush, which is mostly very dense, whilst extensive swampy areas are frequent. In places, considerable stretches are covered with useful timber such as maple and pine, but for the greater part the bush is useless, except for local demand such as would arise from mining operations. Districts of considerable extent of good farming land exist at places, but a large proportion of this region is little blessed with soil, and seems only fitted to be the happy hunting ground of the trapper and mineral explorer. For these it has many advantages, as it is a land of rocky hills and mountains, of numerous lakes and rivers where the large extent of rock exposed gives a chance to find valuable mineral deposits, and where the water stretches, whilst being seldom navigable for larger craft, yet furnish canoe routes whereby the interior of the country may be reached.

Surface features of region.

Geological features of region:

As might be expected in so extensive a tract of country, the geological features present considerable diversity, although, apart from the superficial deposits, the rocks are all referable to the Palæozoic and Archean. It may be said to consist of a large area of Laurentian gneissic and granitic rocks, etc., within which are found numerous and considerable areas of plutonic and volcanic rocks, and of metamorphic slates, etc., which are considered to be of Huronian age, whilst overlying these, chiefly round Thunder Bay and Lake Neepigon, occur the sedimentary and volcanic rocks of the Animikie, Neepigon and Keweenian groups, whose approximately horizontal position and low angles of dip contrast markedly with the steeply inclined or almost vertical older rocks. The lithological and other details concerning these different groups of rocks are best left for description in connection with the various mining districts dealt with hereafter, and full descriptions of these particulars will be found in the various publications of our Survey.

Mineral resources of region.

Within these rocks are found veins and deposits carrying ores of iron, chiefly as magnetite and hematite; of copper, which occurs both in the sulphuretted and native state; of silver, in the argentiferous galena and some of the copper ores and also native and as sulphide; of gold, both free and in the baser form contained in pyritous and arsenical ores. Besides these there have been found deposits of zinc-blende, veins carrying molybdenite and minerals of nickel, the latter found in connection with native copper ores, not to mention other useful but less generally important minerals which have been occasionally found. Amongst the other useful products of the region, other than ores proper, may be mentioned quartz-amethysts, and agates amongst the ornamental stones; various structural materials, especially a fine

variety of red sandstone; amongst the mineral pigments, barytes which has been obtained from the native silver veins constituting part of their gangue. Plumbago has also been found.

Thus we have the following useful elements represented in the mineral deposits of this region: gold, silver, copper, iron, lead, zinc, molybdenum, nickel, arsenic and sulphur. Reports were spread recently of the finding of ores of mercury, but these lack confirmation.

History of the Region.

Commencement of mining.

The history of the Canadian shores of Lakes Superior and Huron as a mining region may be said to have commenced about forty years ago, in 1846, when the first mineral locations were taken up. It is divisible into three periods separated by periods of inactivity, the first commencing as mentioned in 1846, the second in 1863, and the third in 1882, with the discovery of rich ore at Rabbit Mountain.

Attention first directed to search for copper.

Attention was first directed to this region by the discoveries which were being made and had been made for some years previously in the copper bearing rocks of the south shore of Lake Superior. Reference was made to this by Mr. Logan (afterwards Sir William) in his "Report of Progress of the Geological Survey for 1843," as follows:—

"It is at the summit of the rocks under description" (the inferior rocks) "in the peninsula lying between Lake Superior and Lake Michigan, in a great range of trap interposed between the transition series and a metamorphic group which rests on the granite, that Mr Douglas Houghton, the State geologist of Michigan, has made the discovery of an important collection of copper ore veins which are likely to become of considerable economic value, and it remains to be ascertained whether an analogous condition of circumstances may not extend to Canada."

Following this we have a Report addressed by Mr. Logan to the "Committee of the Honorable the Executive Council" dated the 24th March, 1846, in which, in answer to enquiries made by them respecting the mineral region of Lake Superior, he deals with "the data upon which it would be judicious to proceed in ascertaining the value of the mineral district in question; and the principles which should be taken into consideration in dividing it into lots for the purpose of mining locations."

Mr. Logan's exploration of the Canadian shore of Lake Superior in 1846.

The Government having decided to act upon these suggestions gave Mr. Logan instructions to investigate this region, which work he started in May, 1846, and spent the whole of that summer voyaging round the Canadian shores of Lake Superior.

In this voyage he was accompanied by a properly authorized land

surveyor who determined the position and limits of numerous tracts of mineral land which were required by sundry capitalists who had applied for them. These grants of land, to the number of 27, comprised about ten square miles each, having a width of about two miles, and running back from the coast about five, and were granted by the Government evidently upon the supposition that *bona fide* work on them was intended, and that the country would thus get the benefit of the tests there made of the value of the mineral deposits of the region.

First mineral locations granted.

Mr. Logan, in his Report, urged that in order "to secure a *bona fide* intention of working the minerals and to avoid the encouragement of mere stock-jobbing speculation,—there should be some stipulation on the part of the Government, that a certain number of miners should be employed on each location" He further on points out that "In such sales of locations, it must be recollected, that all control over the working and proving of the mines would be relinquished by the Government, and the private interests of parties might in some cases carry them no farther than the establishment of a company for the purpose of traffic in shares; whilst in others, persons of a less sanguine temperament than their neighbours, might patiently wait to observe the success or failure of the more adventurous."

Precautions suggested in granting mineral lands.

It will thus be seen that even at this early date the Geological Survey had pointed out the precautionary policy necessary to be observed by the Government in order to ensure the proper development of the mineral resources of the country, and it is curious and instructive to observe that notwithstanding the clearness with which this time-honored experience of the development of mining districts was pointed out, the opposite policy of losing all control over the development of this most important part of the resources of the country has been followed ever since with the consequent effect of seriously retarding the opening up of the region.

Effect of neglect of precautions.

But to proceed with its history. In this same year the *Bruce Mines* copper ore veins were discovered on the north shore of Lake Huron, east of Sault Ste. Marie, besides some other discoveries in that section of less importance of similar veins.

Continuation of history.

The development of the *Bruce Mines* veins was carried on by the *Montreal Mining Company* from this date until they were taken in hand by the *West Canada Mining Company* of London, England, which had commenced working similar veins in its immediate vicinity in 1855 under the name of the *Wellington Copper Mine Company*. From this time on, this Company continued to operate all this group of mines until about 1875, when work was discontinued, chiefly owing to the price of copper having for some years previously been so low as to

Discovery, &c., of copper ore veins of Lake Huron.

leave no margin of profit on the working of the mines. The operation of these mines has been the most extensive, and successful mining venture of the whole region here dealt with, continuing as they did over a period of more than thirty years, and for the greater part of that period yielding handsome profits. They employed directly and indirectly a large number of people, and were the cause of directing considerable attention to the district, and of forming quite a settlement around, and to this day a large proportion of the present inhabitants now engaged in farming, etc., are old *Bruce Mines* employees, or their descendants. So much then for the indirect benefits accruing to a district from the development of its mineral resources.

Period of stagnation in western district of L. Superior.

For sixteen years following Mr. Logan's visit to the region and the acquirement of the before mentioned mineral locations, little attention was paid to the mineral resources of the western end of the Lake, beyond a few spasmodic efforts at exploration and testing of some of the silver properties of the Thunder Bay district, for a year or two after their acquirement in 1845-6.

Spasmodic exploration of eastern district.

From time to time, however, the more easterly portion of the region received a little attention. The search for copper seems to have first occupied attention, and discoveries were made at intervals, of veins carrying sulphuretted copper ores, more especially in the Huronian rocks of the Lake Huron district, and a few in connection with Huronian and Laurentian rocks on Lake Superior. Amongst these were the *Wallace* and *Emerald Mines*, and some other places on Lake Huron and the discoveries at the *Begley*, *Palmer*, and *Point aux Mines* properties on Lake Superior, at which latter place work was carried on in 1856.

Exploration and testing of native copper formation.

The continued success attending the exploration of the native copper-bearing rocks of the south shore, now called Keweenian series, directed attention to similar areas on the north shore, and from time to time, during the period under consideration, slight efforts were made to discover the native copper deposits of this formation. The exploration of the St. Ignace Island properties in 1846 came first, but a great deal does not seem to have been done there. Following this, in 1853 came the commencement of work on the east end of Michipicoten Island by the *Quebec and Lake Superior Mining Association* on the native copper-bearing beds there, and later, a little testing work was done on similar beds on the north shore of the same Island at a place known as the *Bonner Mine*, where some interesting nickel and silver minerals were associated with the copper. At Mamainse Point also, about this time, some work was done on native copper-bearing fissure veins in this formation on a location known as the Meredith location belonging to the *Montreal Mining Company*. At none of these places, however, were the developments very extensive.

Second period of activity.

This brings us to the second period in the history of the region which began about 1863, when an era of much greater activity was inaugurated. This was more especially the case in the silver district of the western portion about Thunder Bay.

Further operations in the native copper formation from 1863 to the present.

The eastern end of the Lake did not benefit so much by this increase of interest in mining matters. Another effort was made in 1863, to place the *Quebec Mine* on Michipicoten Island on a working footing, and it was operated for about a year, after which this mine received no attention until 1881, when an English Co. acquired the property, and did considerable work, and with an interval of idleness during a change of ownership, this has been continued, and mining was still progressing at this spot in February, 1887. Another English company, the *Lake Superior Native Copper Co.*, in 1881 acquired the old McDonnell location at Mamainse from the *Quebec & Lake Superior Mining Association*, and expended some $400,000 in testing various veins which had been discovered there in 1880, and in erecting machinery, &c. The *Silver Islet Company* also about this time had a force at work, and did a considerable amount of exploring and testing, both on the old Meredith location, which is adjacent to the last mentioned, and had been worked as previously mentioned, and on the adjoining one to the south. Work was suspended, however, at all these places and, excepting at Michipicoten Island, nothing was being done in 1886.

Discoveries of iron ores.

Evidences of the possible future of the region in the direction of iron production first came to hand about 1863, in the discovery of hæmatite and magnetite deposits at various places along the shore of the Lake between Port Arthur and Sault Ste-Marie, but beyond an insignificant amount of testing work there is nothing to record, so that the possibilities of the region in this respect still remain an unsolved problem. This subject is, however, now beginning to occupy a good deal of attention, and fresh zest has been given to the search for ores of this metal in the Thunder Bay district by the great success attending the opening up of the deposits at Vermilion Lake in Minnesota, just across the International boundary in a W. S. W. direction from Port Arthur. It is argued, that as these are within a measurable distance of Canadian territory, and there is good reason to believe that the areas of similar rocks found a little way across the line in Canada are the continuation of the Vermilion Lake rocks, that there is therefore very good reason to predict the discovery of equally good and extensive iron ore deposits in our own territory. In fact, the veteran explorers of the district, the Messrs. McKellar Brothers have recently announced such a discovery in the Lake Shebandowan section.

The year 1870 saw the first discovery of gold-bearing ores at what is

now known as the *Huronian Mine* at Jacktish Lake, near Lake Shebandowan, about 70 miles in a direction a little N of W. from Port Arthur, where the precious metal occurs in the native state as well as combined in sylvanite and pyritous ores. From that day to the present, a few more gold-bearing veins have been discovered from time to time at various places both in the above mentioned district and on the shores of Lake Superior between Port Arthur and Sault Ste-Marie. The metal in all these is mostly carried by the sulphurets. The work done on these gold-bearing veins has not been great, considering the lapse of time since their discovery, and what has been accomplished in this way has been almost altogether on two of them, viz.: At the *Huronian Mine* which has been worked at intervals since its discovery with more or less vigour, but is now closed, and at the *Heron Bay Mine* which was discovered in 1872, and then worked for a short time, and also about two years later for a short period. Discovery and testing of gold veins.

In the Black Bay section of the Thunder Bay district, several lodes carrying galena were found in 1863 and 1865, which seems to have been the first time anybody turned their attention to this mineral. Amongst these are the *Cariboo* and *Enterprise* veins, at which latter place some test work was done in 1872, and in the same section similar work was in progress at the *Arctic Mine* in 1884. The only other localities of this mineral of any importance are at McKellar's Harbor on the north shore of Lake Superior near Middleton on the C. P. R., where an 80 feet shaft was sunk in 1878; and at the *Victoria* and *Cascade Mines* at Garden River near Sault Ste. Marie, at both of which latter places considerable underground work has been done and stamp mills have been erected. The work at the latter mine was prosecuted during the years 1880 to 1885, whilst the former worked during the greater part of this period, but had ceased operations in 1884. None of these galena veins were being worked at the end of 1886. Galena veins.

The history of the mineral development of the eastern end of the Lake would be incomplete without a reference to the *Zenith Mine*, about eight miles north of the mouth of Steel River on the north shore of Lake Superior about six miles east from Rossport on the C. P. R., where a deposit of zinc blende was found in 1884, and some test pits sunk on it. Zinc-blende discovered.

To complete this chronological review of the chief mining events of this region a few words must be said on the subject of the discovery of the silver veins proper of the Animikie rocks of the Thunder Bay division. History of discovery of silver veins.

Although a number of these veins had been located along the coast and islands S.W. from Fort William during the before-mentioned trip

First discoveries regarded rather as copper and lead veins.

of Mr. Logan in 1846, and although some pockets of rich silver ore were found in them, the only ones on which much test work was done, viz., those of *Spar Island* and the *Prince Mines*—seem to have been regarded more as copper than as silver veins, and it was not until 1866 that the first silver vein, or rather the first one properly recognized as such, was found. Veins had been located in 1863, in this formation at the *Wallbridge Mine* and at *Lot* 11 in Paipoongo township, and the former had had a shaft sunk upon it, but they also seem to have been looked upon as bearers of copper sulphurets and galena ores rather than as silver veins proper.

Subsequent discoveries of recognised silver veins.

Thus the discovery of the *Thunder Bay* vein in 1866 by Mr. Peter McKellar inaugurated the era of mining of the higher grade silver ores which has been continued with varying success up to the present. The next year, the *Shuniah* or *Duncan* vein was located, and in the summer of 1868 a Mr. Morgan, who was employed on the exploring party which, in charge of Mr. Thomas Macfarlane was examining the locations held by the *Montreal Mining Co.*, found rich silver ore in the now famous *Silver Islet* vein, which resulted in sixteen years of successful development of a mine which has been the great mining feature of this end of the Lake.

For the seven following years, exploration and development work was actively prosecuted in the district surrounding the *Thunder Bay Mine*, chiefly on the veins already mentioned, and at the *Beck* or *Silver Harbor*, 3 *A*, and *Cornish Mines*. Some discoveries were also made of veins along the W. coast of Thunder Bay, and on the Islands in that vicinity, and work done to test them, notably at *Pie*, *Jarvis'*, *Thompson's*, *McKellar's* and *Mink Islands*, and at *Stewart's Location* near Pigeon River, *Sturgeon Bay*, &c.

Intervening period of quiet in silver district.

By the year 1875, most of these enterprises had ceased working, and a period of quiet intervened, for though the *Shuniah Mine* did not finally cease operations until 1881, and the *Silver Islet* until the spring of 1884, the former had little success and the latter had passed the zenith of its prosperity.

Renewal of activity.

Following this period of quiescence came a renewal of activity which, commencing with the discovery of remarkably rich ores of silver at *Rabbit Mountain* in 1882, has been continued with increasing vigour until the present. Discoveries at numerous other places around this point have quickly followed, notably of the *Beaver*, *Porcupine*, *Silver Creek*, *Little Pig*, *Big Bear*, etc., veins, the first of which has of late become especially famous by reason of the recent find of large quantities of rich ore.

To this third period also belong the discoveries near Whitefish Lake,

to which district attention was first directed by the discovery of the *Silver Mountain* vein carrying rich silver ores. This discovery has been followed by the location of numerous veins in this formation both in its immediate vicinity and for some distance westward around Whitefish Lake.

Natural and Economic Conditions.

To fully judge of the results attained in this great region from the standpoint of the miner, attention must also be paid to the natural and economic conditions under which its development has taken place, and when it is remembered that the history of mining there dates back forty years or more, it must be admitted that when the matter is viewed superficially the results attained seem very small in view of the apparently numerous and widespread discoveries of minerals. A closer inspection however of the conditions existent during this period will go far to explain this seeming anamoly.

Lack of communications throughout region.

The communications of the region with the outer world have until recently been very poor. Until the opening of the Canadian Pacific Railway from Winnipeg to Port Arthur in 1883 and throughout in 1886, the only means of communication with other parts of the continent was by steamboat, and this necessarily during the summer only. Furthermore, it was only the two ends of the Lake that benefitted by this, Fort William and Port Arthur at one end, and Sault Ste. Marie at the other. A certain amount of communication was of course kept up between these points and isolated fishing stations around the coast by tug, but this only partially and occasionally met the requirements of prospectors. The coast line naturally formed the base of operations from which the exploration of the interior of the tract was undertaken, and this stretch of some 400 to 500 miles had to be reached from the two previously mentioned centres by very imperfect means of transit, exploratory parties generally having to make long expeditions in sail boats carrying with them all their material, camps and provisions for the whole season's work. Even when the desired section was reached, other difficulties would have to be confronted, owing to the absence of any roads, so that the interior could only be reached by canoe routes or by starting through the bush on foot when every thing needful had to be carried on men's backs. The limited amount it is thus possible to transport, and the slowness of such means of travel over a rugged country covered with dense bush naturally forced the explorers, who could not of course have a large gang of men packing

Communications by water at first.

in material after them from the centre of supplies, to limit themselves to the examination of the country in the immediate vicinity of the shores of the Lake. Those who are not acquainted with new countries may perhaps better realise these conditions by supposing all England covered with dense bush and uninhabitated and its exploration undertaken with the coast line as a base of operations by comparatively a handful of explorers, who would have to start either from London or Newcastle in canoes or small boats.

Water travel unavailable during winter.

Even this means of travel was prohibited during the six months winter, for the end of November sees the stoppage of all water communication on the Lakes, and apart from this, the advent of snow, of course, puts an end to exploring.

Early difficulties and expenses due to isolation of region.

Incidents which occurred during the working of the *West Canada Mining Company* at the *Bruce Mines* on Lake Huron well illustrate some of the difficulties consequent upon this state of things. Owing to the state of siege existent in the region from the absence of winter communications, a stock of all necessary material for the whole winter had to be taken in every fall. One fall, the steamer bringing in the horse feed was wrecked, and the management had to resort to the expedient of substituting flour, of which they had a good stock, and having built a baker's oven, fed the horses on bread all the winter. At another time, the general supply steamer having broken her propeller shaft, a message was with some difficulty sent to the merchants supplying the goods, who duplicated the order for the winter's supply and chartered another steamer, only to find that it was too late, and that it could not get through on account of ice, so that the supplies had to be collected from all over the district, and teamed from long distances at great expense.

Before the opening of the ship canal at Sault Ste. Marie, Michigan, between Lakes Huron and Superior in the spring of 1855, things were even worse, for there was then no means of passing the falls at this place, and everything had to be trans-shipped and portaged overland for about two miles, and taken up Lake Superior in large canoes or sail boats. It is said that when the *Montreal Mining Co.* started work at *Point aux Mines*, that bricks which they took up for their smelting furnace cost 25 cents a piece at the mine, and everything else in proportion.

All this of course rendered access to the region both difficult and expensive, and largely deterred people from efforts to make or develope discoveries.

Another source of difficulty and expense, especially in the earlier part of its history, has been the difficulty of procuring supplies in the

region itself, for owing to the absence of agricultural settlers until a comparatively recent period, everything had to be brought in from distant places thus incurring heavy freight charges.

Deterrent effect of dense bush.

The effect of the dense bush also, covering as it does so large a proportion of the country, has been very potent in retarding discovery, as every one who has ever travelled through it realises how effectually it limits the vision, so that one may travel quite close to indications of a mineral deposit and never see them. This same retarding effect is felt in trying to work out the extent of deposits found, and the relationships of various exposures of either rock or vein, and when it is remembered how even when actual soil is absent and the rock is near the surface, it is yet concealed by moss, fallen trees and the general debris of defunct vegetation, the difficulties due to these causes may be better realised. Once the veins or deposits have been located, however, and traced up, this same covering of bush is found very useful in supplying material for building and fuel.

Comparison of conditions of development of region with those of other mineral countries.

Some points of difference between the development of this region and that of others on the continent is worthy of notice. In the case of the famous California and Rocky Mountain districts of the United States, the discovery of placer gold caused a tremendous rush of explorers to these districts in the first place, from the fact that this class of deposit enabled individuals, or small parties of individuals, without much capital to work claims in their own interests, with the chance, if lucky, of making large sums of money in a short time. This influx was largely assisted by the system adopted of staking out and recording the claims, whereby a discoverer or locator could acquire his property with the least possible delay, in the simplest manner and at the smallest expense. Thus these districts suddenly received a large mining community, which led to the opening up of the country in every way so that when the placer diggings began to get worked out, the explorers, being already on the ground, were naturally led to turn their attention to the discovery of veins and other mineral deposits, whilst all the necessary communications being already in working order, the conditions were very favorable to the opening up of mines at once, when found, and the eyes of capitalists being already turned in that direction by the original gold excitement, it was found easier to interest them in the proposed enterprises.

The Lake Superior region has, however, had none of these benefits. There has been no preliminary inrush of thousands of explorers and the opening up of the region has been consequently, as mentioned, very gradual, whilst the process by which discoverers can secure their claims has not been very satisfactory.

Retarding effects of mining laws.

The present system offers every facility to the man of means to acquire and to hold for an indefinite period, large tracts of land around discoveries, but retards and renders it difficult for the explorer himself to acquire his discovery. The process acts somewhat in the following manner. An explorer makes a discovery and possibly secures it but within a few months or even weeks, all the land for several miles around will have been surveyed and tied up by parties whose means allow them to hold for an indefinite period whilst they have not the funds or do not care to meet the much larger expenditures required to develop their properties. The interest of this class is to hold with a view to re-selling at much enhanced figures when the developments on the first good finds cause a demand for mining locations in the section. This does not always come about according to the expectation of the investors, so that at present large tracts of land in the mineral regions are tied up and held thus, the amount of taxes * on them being a comparative trifle to such as have spare funds enough to go into this kind of speculation whilst it is quite a considerable item to the prospector whose means, already slight, are all required to outfit him for the search.

Large areas tied up for speculative purposes.

The extent to which this state of things exists in one part of the region will be rendered plain by looking at the appended Sketch Map of Thunder Bay region, where the areas of patented land are shown, of which one may safely take four-fifths to three-quarters to represent mineral lands ties up. The worst effect of this system is that it disheartens the actual explorer and keeps him out of the district, for instead of a promising discovery causing as it should a rush of actual explorers to the section and a consequent multiplication of discoveries, the land around the very spot where other finds might be expected, is speedily bought up and discoveries made on property belonging to others are not very profitable.

This subject is of course a complicated one, but after studying the matter in the district and making enquiries amongst actual explorers, one cannot help coming to the conclusion that the effect of the mining laws is to encourage a wholesale speculative acquirement of mineral lands on the slightest provocation, rather than to ensure actual working and to foster discovery by rendering it as easy as possible for the explorer to get the full benefit of his toilsome and dangerous efforts.

Attention drawn to this in the past by Geological Survey.

Attention was drawn to this matter from time to time by the Geological Survey, for beside the already quoted suggestion of Sir William Logan in 1846 and other places, Mr. Macfarlane refers to it in his Re-

* A tax of 2 cents per acre on all patented lands in Algoma was imposed in 1868.

port on Lake Superior published in the Report of Progress of the Survey for 1866, page 147, where he says. "Although important results might reasonably be anticipated to flow from a search for rocks having the lithological character of the cupriferous beds or with the compass in the manner above indicated, probably the best method would be to make such arrangements as would induce the experienced miners and explorers of the south shore to undertake the search. So far as I can judge, numbers of them would be very willing to do so were they only certain that after having made a discovery they could reap the advantages. At present the impression prevails amongst them (how far it is justified I am unable to say) that in the event of their discovering valuable minerals and applying for the land containing them, it would, before it would be surveyed and secured, find its way into the hands of some more favored individual. In order to prevent this, it would be necessary, after ascertaining the limits of the copper bearing rocks or of the 'mineral range,' as it is called, on the south shore, to have those parts of it which are still unsold, surveyed, laid out in not too large lots; establishing a price for them such as that at present fixed, and making arrangements by which the public would at once know what lots were unsold, and by which any applicant for one of those could at once secure it."

Change of laws necessary to encourage exploration.

Were a system adopted based on the general principle of the discoverer or other person, holding his claim by doing a certain yearly amount of development work on it, coupled with arrangements whereby he would be allowed to make a preliminary definition of its position and area on the ground at the time of discovery, and were steps taken to make this widely known, it would undoubtedly greatly assist in inducing more explorers to make this region the scene of their operations. This is an end very necessary to attain, for although many efficient explorers have given attention to the region, still in proportion to its extent, their number has been ridiculously small, and it speaks well for the general prevalence of mineral that they have found so much as they have.

These proposed ameliorations of the conditions under which the prospector has to work are rendered the more necessary just now in view of the extensive new sections of country recently thrown open for exploration by the completion of the C. P. Ry. and its branches within the region in which the tying up of the land has not yet taken place.

Even when work has been commenced with a view to test deposits found, failure has often been courted, owing to the limited ideas held, of the extent of the expenditure and work necessary to convert an un-

Bad effects of erroneous ideas of mining requirements.

proved prospect into a proved mine, which misconception has caused premature abandonment of the effort, or a start to be made with insufficient capital, so that the end of the funds at disposal has been reached before the question is satisfactorily answered as to whether or not the mineral existed in paying quantities. Added to all this, a failure on the part of operators to realise to what extent a mine should be tested before erecting large stamp mills and making other surface expenditures not immediately called for, has often caused a waste of much capital, which used on actual underground work, might have seen the venture through barren stretches of vein to a successful demonstration of its value.

These failures, when from such causes, give the region an undeservedly bad name, and render it difficult to interest capitalists who living far distant from the section and unacquainted with the facts, must necessarily judge from superficial appearances.

Of the multitudinous erroneous ideas which find currency amongst explorers and others working in such a region, and of the large loss of energy, etc., in ill-directed effort consequent thereon, one need hardly say more, other than that when they have found common acceptance, they have materially affected the direction of the developmental energy in the district. One case, however, may be given as an illustration where an explorer acting on a belief widely accepted by the prospectors that "true fissures always run straight", had run a picket line of about a mile in length through the bush from a short outcropping of a vein, and then with perfect faith had sunk a shaft close to a creek bed and at a place where the thickness of the clay covering was evidently at least fifty feet, and probably much more, so that his chance of finding solid rock, even at a reasonable depth was small enough, not to mention the other absurdities of such a proceeding.

In pursuing the consideration of the subject of this Report viz.—Mines & Mining in the Lake Superior Region—the matter presented will be considered under the headings of the various mineral substances there found.

B. SILVER MINING.

Under this head will be considered the Silver mining proper, as distinguished from the operation of those veins carrying argentiferous lead or copper ores, and its history is practically that of the western end of the region, i.e., of the Thunder Bay mining district, for whilst veins and deposits have been there found and operated to a slight extent carrying other ores than the silver ores proper of the district, yet they have been so far comparatively few in proportion to the others, and will be considered under their proper heading in Part. II.

Extent of silver district.

This district, which is comprised within the area covered by the appended Sketch Map, has been more actively prospected than any other section of the region herein dealt with. Its history has already been given in a general way. The name of Mr. John McIntyre, the officer who was in charge of the Hudson's Bay Co.'s post during the earlier part of the history of the region, is prominently connected with the mining efforts of that time in association with the Messrs. McKellar Brothers whose active explorations extending over many years have done so much to prove the widespread existence of mineral deposits in the district.

Early conditions

The old Hudson's Bay Co's distributing and trading post of Fort William at the mouth of the Kaministiquia river naturally became the headquarters of the first mineral explorers, and remained so till the commencement of the operations for the construction of the Dawson route to the North-West. This road came out at a point on the shores of the Bay some three miles from the old Fort causing the village of Prince Arthur's Landing to grow up which has subsequently developed into the present town of Port Arthur, so that the two places with their wharves, &c., form the head of navigation of the great Lakes for the Dominion, and have become the headquarters of much mining activity at present.

Recent improvements in accessibility of district.

The means of communication of this district have been much improved of late, and are now very good. The completion of the C. P. Ry. affords connections with the rest of the continent, whilst still cheaper freight rates will be obtainable in summer from the numerous steamboat lines, by which the products of the mines can be shipped direct to other ports in Canada, or to American ports on the lakes. Starting from Port Arthur as a centre, the shore portions of the district can be easily reached by small craft or tug, whilst the C. P. Ry., Dawson road and numerous canoe routes over the lakes and rivers give means of communication with the inland portion.

Geological features.

The rocks of the district are comprised within several areas which are marked as Huronian, Laurentian and Lower Cambrian on the published maps of the Survey, and also include several granitic masses.

The veins carrying the ores of silver occur with one or two exceptions, which are pointed out later on, in the lower division of these lower Cambrian rocks which is known as the Animikie series, and whose distribution and extent are shown upon the appended Sketch Map. The chief area is that extending S. W. from Port Arthur which is roughly triangular in shape, with sides of about 40 miles extending along the west shore of Thunder Bay, 60 miles along the International boundary at Pigeon River, and 80 miles along the northern side, where the formation abuts against the Archæan rocks, which gives an area of approximately 1,200 sq. miles. Besides this, there are other areas of these rocks as shown on the map, on the N. E. side of Thunder Bay and extending down its eastern coast to Silver Islet. With the exception however, of this latter mine, all the discoveries of importance are confined to the first mentioned area, the general features of which it would be well to describe before going on to the detailed description of its mining phenomena.

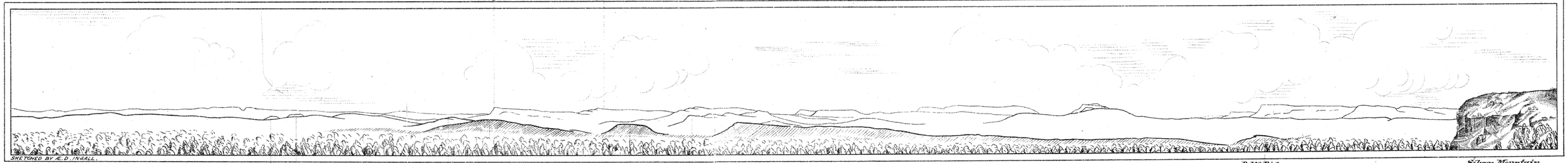
Extent and distribution of silver formation.

Surface characteristics of silver area.

The surface of the region presents a number of flat-topped hills and ridges, the former frequently roughly circular in shape, separated by valleys about two or three hundred feet deep. From the tops of the hills down, the rock is shown in cliffs varying in height from 30 to 150 feet, below which the debris fallen from above slopes off at an angle of about 45° for probably another 50 feet, when it merges into the gentler slope of the clay and soil filling the valleys. The peculiarities of the landscape due to these table-topped hills is shown on the accompanying panoramic Hill Sketch, which also shows the very different profile of the surface of the Archean rocks to the N. as contrasted with the Animikie hills to the S., the division between the two being about in the position of the letter " A ". The little flat-topped hills, " B. and C ", in the distance are most probably outliers of the Animikie formation lying on the Archean rocks. The mineral discoveries are so far mostly confined to a belt of country running along the northern fringe of the formation between Arrow lake and Port Arthur, and to the coast and islands of the N. and W. sides and in the mouth of Thunder Bay, the country in the interior of the triangle being comparatively little known. A few discoveries of similar veins have been made in the eastern areas of these Animikie rocks, but besides the notable one of Silver Islet, little or no work has been done upon them.

Distribution of mineral discoveries.

The valley bottoms in this area have usually a considerable depth of soil, consisting often of a compact white or yellow clay with varying



HILL SKETCH LOOKING EASTWARDS FROM CROWN POINT MINE
SILVER MOUNTAIN

thicknesses of alluvium on top. The bush which covers the whole district consists mostly of poplar and birch, in the lower lands with some intermixed pine, etc., whilst balsam, spruce and tamarac preponderate in the swampy parts. The trappean capping of the tops of the hills is usually scantily covered with soil, and generally supports a growth of jack pine, the dark foliage of which causes them to stand out prominently against the lighter shades of bush in the valleys. These valleys, forming as they do a considerable proportion of the area of the country and containing good soil, for the most part, render this section important from an agricultural as well as from a mineral standpoint.

Character of bush.

Agricultural possibilities.

In connection with the subject of the surface it will be interesting to note the frequent occurrence of smooth surfaces of rock which have been polished and grooved by ice, these show chiefly on the shores of Lake Superior and the inland lakes and rivers.

Glaciation.

It may be well here to give a short description of the general features of the Animikie rocks, leaving the details for consideration later on in connection with the description of the Silver Mountain and Coast groups where they were most carefully studied. Their relationships to the other formations of the district are to be seen on reference to the Sketch Map on which the boundary lines of each are given. These lines were put on from information gleaned from various sources, those west of Port Arthur being located from work done by myself, and from information kindly given by Dr. A. C. Lawson, whilst east of the same point, their position has been defined by the investigations of Dr. R. Bell and from data supplied by Mr. Peter McKellar of Fort William.

Geological character and relationships of Animikie series

The formation lies nearly horizontal, and rests in this position on the denudation surfaces of the older rocks which shew to the north whilst in their southerly and easterly extension near Black Bay, and in Thunder Cape peninsula, they are covered up by the rocks of the Neepigon formation, and S. of this, at the island in the mouth of Grand Portage Bay, are seen to pass under the Keweenian series, which consists of interstratified beds of conglomerate, sandstone and various trappean rocks. The rocks comprising this silver bearing formation consist of basic traps, black and grey argillites, cherts and jaspers, with some ferruginous dolomites, the mineralogical composition and structure of all of which will be understood by reference to the Appendix which contains the notes of Mr. W. S. Bayley of Johns Hopkins University, Baltimore, on his microscopic examination of typical specimens of these rocks collected by myself.

This Animikie formation is divisible into an upper and lower portion which while being quite distinct are not separated from each other

Sub-divisions of the Animikie.

Lower division.

by any very definable line, the rocks of each division at places taking on somewhat of the nature of those belonging to the other. Thus the chief character of the lower division consists in the almost entire preponderance of siliceous rocks, such as chert and jasper, which are often accompanied by ferruginous dolomites, and themselves all contain more or less iron in the oxidised state, at some places carrying so much magnetite as to constitute almost an iron ore. An analysis of such a piece, by Mr. Hoffmann, gave 53 per cent of iron, titanic acid being absent.* Occasional developments of the black argillites are found interstratified with the silicious beds but they are only local and do not seem to be ever of any extent.

Upper division.

In contrast with these, the upper division is formed for the most part of the black, soft, carbonaceous argillites. These are occasionally dolomitic, and at some places are quite ferruginous, whilst at others they hold such a large percentage of silica as to approach very nearly in character to the rocks of the lower division.

Distribution of lower division beds.

The cherty and jaspery rocks coming in at the bottom of the formation show chiefly in a strip forming its northern fringe where it abuts on the Archean. They constitute all the lower lying land north of the range of hills which extends along the southern boundary of the valleys of the Whitefish and lower part of the Kaministiquia rivers, commencing at McKay's Mountain on the east, and passing through Rabbit and Silver Mountains, and westward from this. These cherty rocks would seem also to constitute the greater part of the extension of the main area east from Port Arthur, and of the fringe of this formation along the North shore of Thunder Bay as far as the Mackenzie river, this section containing most of the Port Arthur group of veins.

Outliers of lower division beds.

Outliers of these rocks are to be seen as detached flat-topped hills out on the Archean area, some distance removed from the northern edge of the Animikie. The Outpost Hills shown on the Sketch Map constitute a group of these† which, when visited, were found to consist of high bosses of granitic and gneissic rocks, on the top of which rest thin sheets measuring from 20 to 30 feet thick of the typical cherty rocks of the lower division, with a capping of about 100 feet of the usual dark, vertically columnar basic trap. The opposite view entitled, owing to a printer's error, "Outline instead of Outliers of the Animikie on the Archean" shows the distinctive shape of these hills, their peculiar contour enabling one to recognise several other evidently similar outliers which show to the east of those shewn.

In passing south across the strike of the formation, one comes to the

* Report of Geol. Surv. 1886. Part I, Analysis of Iron Ores No. 4. Idem, 1887, Analysis No 10.

† By mistake the Archean ruled tinting on the Sketch Map has been run right over these outliers, which should, of course, have been left blank.

E. D. INGALL, PHOTO., 1886. IVES-PROCESS; G. E. DESBARATS & SON, MONTREAL.

OUTLINE OF THE ANIMIKIE SERIES, NORTH OF WHITEFISH RIVER, ONTARIO.

E. D. INGALL, PHOTO., 1886. IVES-PROCESS; G. E. DESBARATS & SON, MONTREAL.

TRAP FLOW ON ARGILLITES, ANIMIKIE SERIES. SILVER MOUNTAIN DISTRICT.

beds of the upper argillaceous division in the higher levels and forming the range of hills just mentioned, where they show in the cliffs which usually form their boundaries, and are seen to underlie the trap-sheet usually constituting the capping or top of these hills and ridges about which it is noticeable that they very frequently have a distinct southerly dip, their north facing aspect usually constituting steep bluffs and cliffs. These upper division beds would seem to form the surface rocks in all the area lying south of this fringe of hills, as far as can be judged from the reports of persons who have traversed it, and from the study of the cross section of the formation presented by the coast line from Port Arthur to Pigeon River.

Position and distribution of upper division beds.

The traps are not only visible as mentioned as vertically columnar beds capping the hills, but also exist at various lower levels. Whilst some of the highest might possibly be portions of a crowning overflow separated from each other by denudation and brought to different levels by faulting, the evidence seems to leave no doubt of the existence also of numerous other sheets at very various horizons in the formation, and the intrusive nature of some of these appears from a close study of them on the ground to be quite assured. The observed instances of this are mentioned later on in this Report in describing the different districts in which they occur. In view of all the evidence, it would seem then that the trap-sheets are not confined either to the lower or the upper division of the formation, although they seem to occur more frequently in the latter.

Trap sheets.

As has been already mentioned, the formation lies nearly flat, and it is very difficult to decide whether it really has any general dip or not. The dip measurements obtained both in the examination of the new silver districts west of Port Arthur and along the coast section south of that place, whilst ranging usually from 5° to 10°, were so conflicting in direction, and were evidently so often rendered unreliable by the proximity of disturbing influences such as dykes, veins, intrusions of trap, etc., as to leave it in doubt whether the rocks have any general dip, and if so, what its amount and direction is, or whether they are bent into a series of flat anticlinal and synclinal ridges, troughs and basins such as were commonly seen to exist along the coast section. This question will have to stand in abeyance for satisfactory settlement until the whole district comes to be thoroughly worked out, but meanwhile it would seem that the balance of evidence is in favor of the existence of a general flat southerly and south-easterly dip of the whole formation, probably averaging from 5 to 8 degrees.

Dip of formation.

If we assume the average dip to be 5° in a S.S.E. direction, and measure the width of the outcrop of the formation from Grand Portage

Probable thickness of Animikie formation.

Island, where it passes under the overlying Keweenian rocks, N.N.W. to near Woodside's vein, in the Silver Mountain area, where the Archean appears from below them, which we find to be some 25 miles, we get a thickness for these rocks of over 12,000 feet.

Contents of veins

The silver ore of the district consists of the native metal and sulphide or argentite generally associated with blende, galena pyrites, etc., in a gangue of calcite, barite, quartz and fluorite in a series of fissure veins the details of whose characteristics are dealt with later.

Vein groupings.

Such, then, are the general features of the Animikie or silver-bearing formation of Lake Superior. In considering the details of the various mining discoveries and experiments the veins historically, and naturally fall into the following groups, and will be hereafter considered in that way, viz.:—

1. The Coast Group.
2. The Port Arthur Group.
3. The Rabbit Mountain Group.
4. The Silver Mountain Group.
5. The Whitefish Lake Group.

The Coast Group.

Distribution.

This group comprises a series of veins located on the coast of Lake Superior between Port Arthur and the International boundary at Pigeon River, and on the group of islands in the mouth of Thunder Bay.

"Country rocks."

The greater number of these intersect what was formerly known in the district as the "Macfarlane Band," a belt of trap dykes and associated intrusive sheets, with argillaceous beds filling out their interspaces, constituting the string of islands between Silver Islet and McKellar's Point and considered to be the continuation of the Silver Islet dyke. The chief mine of this group is *Silver Islet*, and the great success attending the opening up of this vein caused great excitement in the district and directed the attention of explorers to the series of veins already mentioned, upon the supposition that whereas the Silver Islet vein had only been productive where it intersected the dyke, that therefore the presence of silver was due to its influence, and that all other similar veins intersecting its supposed extension would be found equally rich. The rocks enclosing the veins along the coast line consist of argillaceous beds which, in places, are so siliceous as to constitute argillaceous sandstones and flagstones, whilst they often merge on the other hand into dolomitic argillites. With these are associated also numerous trap-sheets which are seen to occur both capping the bluffs overlooking the shore, and also at lower horizons in the formation. Trap dykes are also very numerous, constituting, as they do, nearly all the capes and points of the coast. They nearly all strike N. E. & S.W., or at right

Trap sheets.

Trap dykes.

angles to the system of vein fissures. Further details regarding these rocks are given later on.

The gangue of this group of veins consists mostly of quartz, fluorite, calcite and barite, and they carry native silver, and silver glance associated with much zinc blende and galena and sometimes some copper sulphurets. Vein contents.

Apart from the work which was going on at *Jarvis Island* and *McKellar's Island* (the latter for barite) none of the mines of this group were working at the end of 1886.

Silver Islet Mine.

This having been the most extensive and most successful venture of the region, I have gone into its history and nature somewhat at length. It is situate on a vein crossing a small rocky islet about a mile out in the lake off Thunder Cape.

The vein strikes N. 35 W. and dips to the S. E. at an angle of about 70° to 80°, whilst in thickness it would average about 8 to 10 feet. In some places, however, it has shown from 20 to 30 feet of solid vein-stuff. At the time of my visit the mine had been closed for some time, and was full of water, so that beyond making an examination of the surface I have had to depend for further information on various published accounts of the mine, chiefly by Messrs. Thomas Macfarlane W. M. Courtis, and F. A. Lowe, all of whom were connected officially with the mine at various times. From these sources and from information supplied by Mr. Richard Trethewey, the manager, who was in charge of the underground department since December, 1871, and took charge of the whole work from 1876 to its close, as well as from my own observations, I have been able to compose the following history and description of the mine. Vein characteristics.

The gangue of the vein consists of calcite, quartz and dolomite, the latter varying in color from cream to pink, according to the varying amounts of manganese it carries. Mr. Courtis also mentions having found rhodochrosite in the ore shipped to the Wyandotte smelting works. The metallic minerals are native silver, argentite, galena, blende, copper and iron pyrites with marcasite. Mr. Macfarlane also mentions tetrahedrite, domeykite and niccolite and cobalt bloom, the two latter, probably, oxidation products of a peculiar mineral called Macfarlanite, containing arsenic, cobalt, niekel and silver. Two new minerals are also said to have been found in the ore, by Dr. Wurtz, called by him Huntelite and Animikite. The three latter, according to Mr. Lowe, " are now" (October, 1881) "the principal producing silver ores of the mine " (E). Besides the above, Mr. Courtis found in the Vein contents. Metallic minerals.

ore shipped to the Wyandotte smelting works, annabergite, antimonial silver and cerargyrite, the latter " where the rock has been decomposed " (L). Graphite also occurs in considerable quantity and seems to be connected in some way with the occurrence of the silver. On enquiring of Mr. R. Trethewey as to what connection he had noticed between the existence of this graphite and the occurrence of the silver, with a view to ascertain its value as an indication, he told me that although they never had silver without graphite, they sometimes had graphite without silver. " The native silver is generally disseminated through the ore in more or less dendritic masses, the points of native silver forming nuclei for the deposit of niccolite and sulphurets " (A). In a specimen of the ore collected by myself are to be seen pieces of trap and graphite enclosed in pink spar, whilst from the graphite start out dendrites of silver. " Particles of silver were also found in some of the small feeders which intersect the country rock (or perhaps *horse*) lying between the two veins " (C). The vein splits in crossing the islet going south but according to Mr. Lowe, comes together again both in length and in depth at the fourth level, after which they continue both in length and depth as one vein, with an average width of 8 feet. " The southern part of the latter " (the western) " branch carried the richest ore, the eastern branch being less rich, and the whole of the vein to the northward being almost entirely barren and consisting of a huge mass of calc-spar with quartz and occasional cubes of galena which carry only a minute quantity of silver " (C). Mr. Hoffmann recently examined some large crystals of galena given me by Mr. R. Trethewey which the latter said came from a vug at the 560 feet level, and found only a trace of silver. " The blende, galena and pyrites are generally very poor in silver, seldom exceeding 2 oz., per ton when taken from the barren parts of the vein, but in and about the rich silver deposits, they become highly enriched both chemically and mechanically.... by particles of and streaks of native silver " (E). " The relative quantity of calcareous and siliceous matter varies, however, in different parts of the vein, and in some places, streaks of quartz have preponderated to such an extent as to make some of the ore highly siliceous." (C). A curious feature of the vein is the combustible gas which has been met with in large quantities in the workings. This gas, according to Mr. Lowe, is accompanied by water containing calcium chloride in solution. He says : " Two gallons of this water furnished, roughly measured, nearly a pint of very acrid and deliquescent salt, chloride of calcium." (D.) He further states " the gas and water are principally confined in large vugs or cavities in the vein under great pressure.....it " (the gas) " is met with in the deepest

Graphite.

Native silver.

Gas and mineral water.

workings.....above the 8th level all water infiltrating into the mine is pure lake water, whilst below that level is a zone of highly mineralised water.....the gas is unequally distributed through the lower workings, occupying independent cracks, fissures and vugs....the water annoyed the men very much; on touching their skin it would almost blister it.....it" (the gas) "was also previously met with in the 3rd and 6th levels." (D.) Mr. Macfarlane also mentions the occurrence of this gas on the 8th level in a vug.

Analysis of mine water.

Mr. G. C. Hoffmann, chemist to the Survey, having analysed a sample of this water which was collected by Mr. Richard Trethewey at the instance of Dr. Selwyn in the summer of 1882, reports as follows. * After giving the details of the analysis, he says: "Total dissolved solid matter by direct experiment dried at 180 C. 35·9566" in 1,000 parts by weight. "The foregoing acids and bases are most probably combined in the water as follows (Carbonates calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Chloride of Potassium	.4582
" Sodium	16.8098
" Calcium	17.0867
" Magnesium	1.2937
Sulphate of Lime	.0672
Carbonate of Lime	.2936
Silica	.0540

"Country rocks."

"The rock on the Islet intersected by the silver vein is a chloritic diorite, evidently forming a dike.† It differs somewhat from the rocks of the other dikes of this location among which may be mentioned corsyte and anorthite porphyry.....gray flags fill out all the

* Geological and Natural History Survey of Canada. Report of progress. 1885, sec. M, page 17.

† Prof. Roland D. Irving describes these rocks as follows:

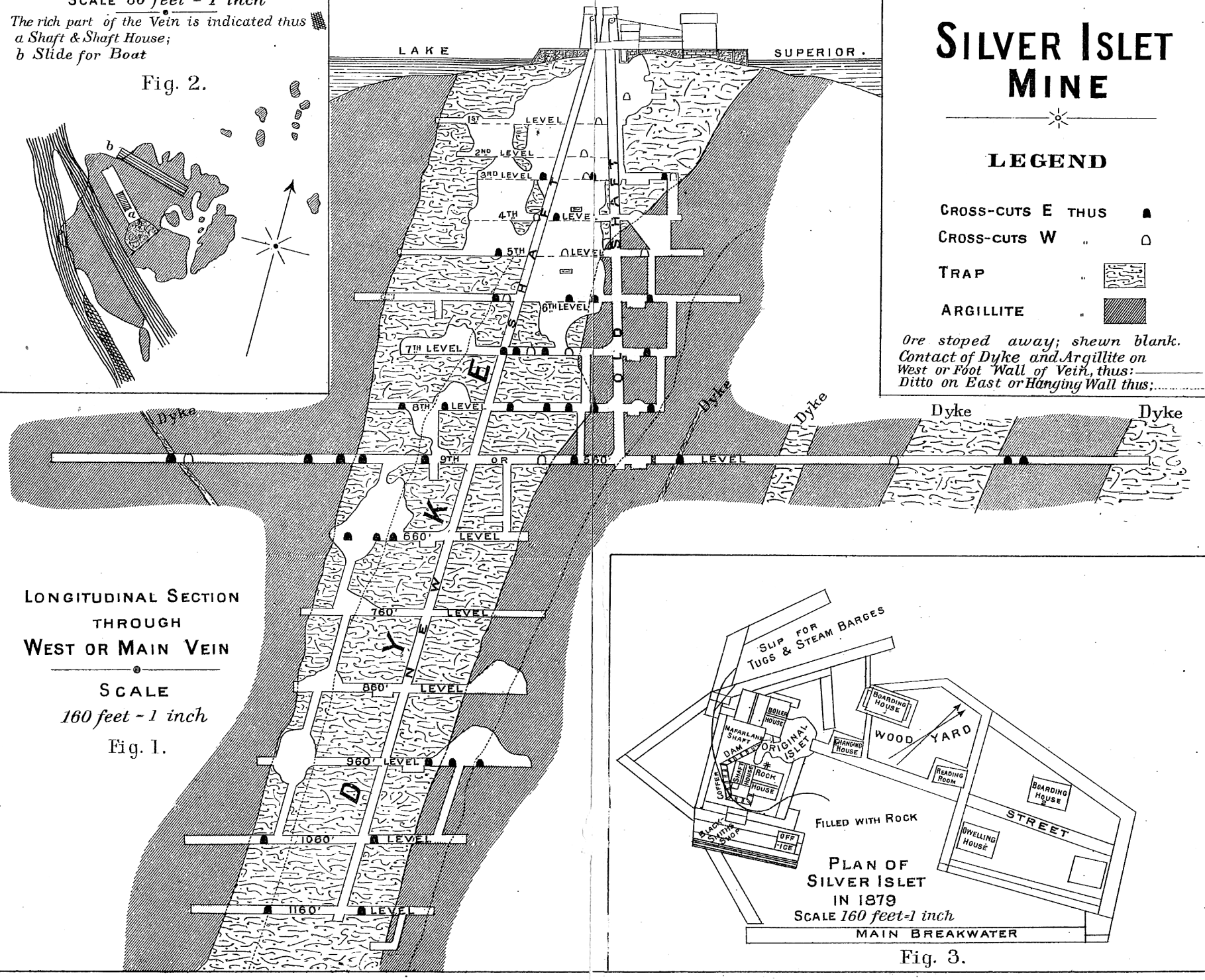
"Between Thunder Cape and Silver Islet a large number of dikes are seen cutting the slates. Only one of these dike rocks, which appear for the most part to be the same as those which form the numerous dikes of the South West shore of Thunder Bay, already described, was examined. This is the rock which forms the dike at Silver Islet. It is a nearly black, rather fine grained rock, distinctly composed of a greenish black and a white mineral, the latter being of course felspar. According to Macfarlane its specific gravity is 2.7 and its silica content 53.34 per cent. It contains 5.02 per cent of water, an amount indicating a considerable alteration; and this indication is fully borne out by a microscopic study of the thin section. This shows tabular plagioclases with some orthoclases as predominating ingredients. These felspars are all much dulled by alteration and are often penetrated by secondary quartz. In many places the larger felspars have between them a mass of smaller, much crushed and always highly altered felspars. The augitic ingredient is only partly fresh, being commonly much altered to ochre, and uralite with which alteration is connected the formation of some magnetite, Rather abundant titanic iron for the most part altered to its characteristic gray decomposition product and sparse apatite complete the resemblance between this rock and the finer orthoclase-gabbros of the Keweenawan." See monographs of the United States Geological Survey, Vol. V. "The Copper Bearing Rocks of Lake Superior" by Roland D. Irving, p. 378.

SILVER ISLET
IN 1869.
SCALE *80 feet = 1 inch*

The rich part of the Vein is indicated thus
a Shaft & Shaft House;
b Slide for Boat

Fig. 2.

S.E. N.W.



SILVER ISLET MINE

LEGEND

CROSS-CUTS E THUS
CROSS-CUTS W "
TRAP "
ARGILLITE "

Ore stoped away; shewn blank.
Contact of Dyke and Argillite on West or Foot Wall of Vein, thus:
Ditto on East or Hanging Wall thus:

LONGITUDINAL SECTION THROUGH WEST OR MAIN VEIN

SCALE
160 feet = 1 inch

Fig. 1.

PLAN OF SILVER ISLET IN 1879
SCALE *160 feet=1 inch*

Fig. 3.

Figs. 2 & 3 are reproductions of drawings accompanying a paper on Silver Islet, by Mr. THOMAS MACFARLANE, in the Trans. American Institute of Mining Engineers for 1879-80. The Longitudinal Section is from tracings supplied by Mr. C. A. TROWBRIDGE.

spaces between the various dikes." (C). The vein "has been exposed at several points where it crosses the sedimentary beds, but there it is split up into numerous thin veins of quartz, and shows nothing of the great width which it carries on Silver Islet, nor have any of the rich silver minerals of that locality yet been found upon the mainland or upon Burnt Island" (C). This diorite dyke dips S. E. at an angle of from 60° to 75° from the horizontal, and is faulted some 80 feet by the vein. "The workings have never been productive outside of it, indeed there are large areas of the vein enclosed by diorite walls on both sides which have yielded no ore." (C). "The long" (diamond drill) "holes E. and W. on the 1st level proved that the dyke was saturated with graphite which is also noticed in its outcroppings known as Pyritic and Ship islands, one and five miles from the mine. Out of the whole series of twenty-one dykes cut by the vein,.....the Silver Islet dyke is the only one impregnated strongly with graphite and pyrites" (D). "The influence of the country rock upon this vein is very apparent from the development on the 6th level N. and on the 9th both N. and S. In both levels on entering the schists" (? slates) "the vein gradually thinned out to mere stringers, but recovered its width on entering two other dykes N....and the vein in them was highly mineralised..... In drifting south, a small dyke of a few feet in width was met with" (D). Regarding the connection supposed to exist between the *floors* which cross the vein at intervals and the occurrence of the silver ore. Mr. R. Trethewey told me that they were not necessarily to be regarded as an indication, as has often been alleged, for although there seems to be some little connection in the upper and richer part of the mine, they had the same floors below that in the poorer part, but they were unaccompanied by silver. However, in a general way, if on coming on to a *floor* it was found to be covered with patches of argentite, it was mostly a sign that the rock down to the next *floor* would be rich, though sometimes the silver would not be found for some little depth below such a floor.

Dykes impregnated with graphite.

Influence of *floors* in vein.

History of mine

Discovery.

History of the Mine.—The *Silver Islet* vein was discovered in the summer of 1868, during the exploration of the lands of the *Montreal Mining Co.* by a party under the direction of Mr. T. Macfarlane which, on leaving in the fall, after the summer's exploration of this and other properties, the party brought away with them specimens valued at $1,200 taken from the outcrop of the *Silver Islet* lode. During the summer of 1869, Mr. Macfarlane continued his work of surveying and exploring Woods' location, of which the Islet forms a part, and notwithstanding a stormy summer, rendering work on the Islet difficult, some 9,455 lbs. of ore were produced and shipped to Mont-

real, valued by assay at $6,751.67. In August of 1869, the same party began to sink a shaft on the Islet on the east branch of the vein, intending to cross-cut to the western or richer branch, and a party of twelve men with a horse were left to continue this work during the winter of 1869-70. They were instructed to take advantage of the formation of ice around the Islet to continue the extraction of the ore from the outcrop of the western or main vein which was under water alongside the Islet. The winter was favorable, the ice having formed quietly and remained for two months, so that the efforts of the party were successful, and by the spring they had, by sub-aqueous blasting, and fishing up the product with tongs, etc., enough rock to yield by sorting 17,669 lbs. of ore, whose total value by assay was $18,291.39. This ore was shipped to Montreal in the spring of 1870. The shaft, however, had to be discontinued on account of water. "That ten men had been able to produce $16,000 worth of ore, and that the actual time employed by them in so doing had not exceeded fourteen days, was again insufficient to induce the *Montreal Mining Co.* to proceed to work the Silver Islet vein" (C). Work commenced.

After some negotiations, the whole of this Company's property passed into the hands of New York and Detroit capitalists in September, 1870, and on the 31st August, Captain Frue arrived and commenced work with a party of about 30 men and two horses accompanied by the necessary provisions, etc. "In spite of severe weather extensive breakwaters were built, part of the vein enclosed by a cofferdam, the area within the latter pumped dry, a considerable amount of mining done, and about 77 tons of ore shipped before the close of navigation. The time devoted to mining was about four weeks ..... About $80,000 were expended in the above operations, and in making provision for wintering" (C). The total value of the ore in this parcel was $92,153.23. The winter of 1870-1 was taken up by Mr. Frue and his party in enclosing the Islet with cribbing, so as to establish a permanent mine there. The difficulties experienced from the storminess of the season and trouble with ice were very great, both in placing the cribbing and in keeping it in place, and gales took away most of it, which had to be replaced. Change of ownership.

"By the 1st May, 1871, an excavation had been made on the rich part of the vein inclosed by the cofferdam having a length of 65 feet, depth of 32 feet and an average width of 8 feet. By the close of navigation in November, this working had attained a depth of 90 feet, and had produced from the same time in 1870 about 485 tons of ore" (C)., and had thus in the year, Nov. 1870 to Nov. 1871, produced ore carrying silver, worth by assay $642,932.01, and also one lot of five tons,

Continuation of history of mine

worth $5,200, which was lost in transit on the propeller Coburn.

"Mining was continued with varying success after the close of navigation in 1871. The vein was found to be subject to frequent and sudden changes, both as regards size and richness. In the fall of 1871, it narrowed down to 6 inches in width at some points, with scarcely any first quality ore in sight. During the winter, it gradually widened and became very productive. In Mr. Frue's reports many such alternations are recorded. He says that in the summer of 1872, 'the lode became broken up, being thoroughly mixed with diorite and wedges of plumbago, and in the fall, the mine assumed anything but a flattering appearance.' Mr. Frue further writes on this subject as follows: 'In the following winter it suddenly changed in character and produced, up to May 1st, 1873, 250 tons of rich packing ore worth about $1,500 to the ton. During May, and the early summer, the vein disappeared almost entirely, being broken up into strings and feeders. Later, however, there was a decided improvement which was again overshadowed by a passing cloud, and although in extending the drift north on the 40, a very promising show of silver had been opened, I had often seen the mine clothed in richer apparel than it appeared at the close of navigation.' (1873)." (C).

During the winter of 1873-4, severe storms did considerable damage to the cribwork protecting the Islet, amounting to over $11,000, besides carrying away the upper portion of the main breakwater and doing other damage. The unfavorable changes which occurred in the fall of 1873, continued up to the close of 1876." The new levels which had been opened up, the 8th and 9th, proved wholly unproductive, although no difficulty was experienced in following and working on the vein. A vast amount of exploratory work by means of the diamond drill, also failed to discover any deposits of rich ore. The consequence was of course great financial embarrassment and an almost entire cessation of work during the summer of 1877. In August of that year, work was resumed, and up to December, 23,850 oz. of silver obtained by stoping in the upper part of the mine. It was even proposed to remove the rich ground lying betwixt the mine and the lake, substituting for it an artificial arch, but fortunately, in the summer of last year" (1878), "a bunch of rich ore was struck beneath the 4th level S. of the shaft which in a few months yielded 721,632 oz. of silver, a quantity amply sufficient to rescue the mine from all its embarrassments and provide a reserve or working capital of $300,000" (C).

Mr. Lowe describes this period of the mine's existence as follows. Speaking of the first bonanza, he says it "extended for a distance of 100 feet on the hanging wall of the main vein, and for nearly a like distance

upon the same wall of the east vein. It varied from 6 inches to over 2 feet in width, finally disappearing below the 6th level. The silver did not crop out in the east vein, but was found in cross-cutting through the horse of diorite on the 1st level. It extended upward within 40 feet of the outcropping. It was completely worked out by 1874, yielding over $2,000,000 .....The shape of this bonanza was that of an irregular pear and throughout its extent in both veins it was accompanied with a strong impregnation of graphite which formed the selvage of both veins. The bulk of this bonanza was arborescent silver, more or less mixed with Macfarlanite, a rich ore of silver carrying 78 per cent. of that metal along with arsenic, cobalt and nickel. Its physical structure resembles niccolite....The years from 1874-8 were devoted entirely to exploring, and but little silver was mined." (D.) During this period the new inclined shaft was started from the 9th level, diagonally across the vein, and on the pitch of the same. "Previous to the sinking of this shaft, the diamond drill was extensively used in different parts of the mine....long holes were driven N. & S. on the 1st level. In one of them, silver was struck, but it proved to be only a small pocket. On this level, 400 feet holes were driven E. and W. for parallel veins; 40 feet west a small vein was struck," (D.) but subsequent testing by cross-cut and drifting showed no silver. "On the 3rd level, S., another series of holes was driven, and one of them, which was subsequently proved, skirted along within a few inches of the second bonanza.....The small pocket of silver struck on the 1st level, S., was followed later on by a considerable streak of argentiferous pyrites, running 2,000 oz. per ton; lead with 800 oz. per ton, and native silver. This streak was cut near the junction of the two veins on the hanging wall in a cross-cut and extended down as far as the 2nd level.....The writer has since learned that another small bunch was struck S. of this point on the same level." (D). He further says in reference to the before mentioned second bonanza. "In drifting south on the 3rd level in August, 1878, strong impregnations of graphite were met on the hanging wall which were soon followed by the second bonanza. This deposit of silver was remarkable for its great width, 5 feet solid across the breast, and the occurrence in great quantity of two hitherto unknown compounds of silver, namely, Animikite and Huntilite. The shape of this bonanza was that of an inverted cone with a base of about 50 feet on the 3rd level with the apex down as far as the 5th level. This deposit was phenomenal in its structure and a winze in the middle of the deposit to the 4th level, sixty feet, was sunk literally through native silver, the metal standing out boldly from the four walls of the winze. In the breast of the drift it stood out in great arborescent masses in the

First bonanza.

Period of adversity.

Second bonanza

shape of hooks and spikes, in gnarled, drawn out and twisted bunches, followed by arborescent silver with intercalated bands of Animikite and Huntilite. This deposit was struck near the junction of the two veins and the whole extent of the bonanza was strongly saturated with graphite carrying a selvage of the same in the hanging wall three inches thick. The hanging wall was as smooth and as polished as a mirror, with horizontal striæ.... The width of the vein was over 10 feet, and the entire deposit, including the stamp rock, yielded about 800,000 oz. of silver. An interesting fact connected with this deposit was noticed in the manner in which the arborescent silver was disseminated throughout the whole width of the vein, and in the concentrated parts and the manner in which it was impregnated through a series of horizontal floors in the vein. These floors did not break or separate the deposit. This deposit paid off the bonded indebtedness, leaving a surplus of $300,000, which, however, was expended, along with six assessments, in the construction of the new shaft to the surface, and sinking of the same 500 feet below the 9th level, in driving five levels N. and S. from the same, equipping it with new pumping machinery, developments in the upper parts of the mine and two years' work on Burnt Island and the mainland." (D.)

"Floors" in vein.

Yield of mine.

Mr. Macfarlane's description continues:—"I have not found it possible to ascertain the amount of the product year by year subsequent to 1875, but according to information received from C. A. Trowbridge, Esq., Secretary of the *Silver Islet Co.*, there have been extracted since the commencement of operations in September, 1870, and up to the close of navigation in 1878, 2,174,499 ½ozs. refined silver with a value of $2,921,727.24. If to this we add the value of the ore obtained immediately after the discovery by the *Montreal Mining Co.*, we have a total yield of $2,948,019.81" (C.) He further adds that he had since learned from Mr. Trowbridge that the precise yield (up to the end of 1879) was $3,039,557.49 and continues "when visiting the mine in July, 1877, the vein appeared perfectly well defined on the 9th level, but nothing in the shape of ore was to be seen. The vein was said to possess the same character in the inclined shaft sunk 100 feet deeper than the level, and to a point about 640 feet from the surface. This shaft was filled with water at the time of my visit. The vein below this point has been tested by a drill hole 296 feet deep, in which traces of silver ore were detected. Even if we suppose this trace is the clue to another *bonanza*, the fact still remains that from the 6th level to the deepest working, a distance of 300 feet, the vein has been found to be unworthy of excavation, and this too in spite of the presence of diorite on both walls, a condition which, when the mine was first opened was supposed to ensure a remunerative vein" (C).

Barren stretch of vein.

The foregoing gives the history of this mine up to the end of the year 1879, as recorded by Mr. Macfarlane and others. Mr. Low's paper, from which I have taken the following items, brings it up to December, 1882:—

"On the 9th level a small bunch of silver was struck accompanied with graphite.....From 1878 to the present date" (December, 1882), "the mine has been passing through its second period of adversity, although in that time silver has been struck in various parts of the mine below the 9th level. The only important deposit met with was on the 13th level south. This was also accompanied with a graphite impregnation, but from its irregular and detached condition it did not augur well for a large deposit. It yielded about $30,000.....Gas and water were struck in considerable volume. The new inclined shaft is now down nearly 1,200 feet, with a strong, highly mineralised vein in the bottom, the vein being 9 feet in width" (D).

Second period of adversity.

Mr. R. Trethewey states that the mine had attained a depth of 1,230 feet before the cessation of operations. I have it on his authority that at 80 feet north on the bottom level, they had a good bunch of ore. He also tells me that the total yield of the mine from its commencement to its close in 1884, was about $3,250,000.

Total yield of mine.

Exploratory work was done on other parts of the vein which was traced inland for about a mile from the shore, making the length of the vein thus known, counting from the Islet, about 9,000 feet. In traversing this distance, it intersects many trap dykes which, however, do not seem to favorably affect it. Three shafts have been sunk to test it at various points along this inland portion, attaining the respective depths of 40 ft., 100 ft., and 60 ft., and a great deal of surface trenching has been done. This work did not, however, result in any discoveries of importance, but Capt. R. Trethewey told me that they had got some galena running 19 oz. of silver to the ton at Morgan Junction shaft (the furthest inland). He tells me they got no plumbago at any of these places. At the latter point, where the shaft is sunk at the intersection of the vein with a dyke of compact trap, I noticed in the dump a quantity of iron pyrites accompanied by a little copper pyrites in a vein stone consisting of argillite cemented together by calcite. The series of dykes crossed by the vein on the mainland differ in appearance from that on the Islet consisting as they do of dark compact trap, whilst the latter is much coarser grained and carries much iron pyrites. Besides the beforementioned shafts one was sunk on the vein where it crosses the dyke forming Burnt Island. These dykes are faulted by the vein and are, therefore, older than it. Mr. Lowe says that the diamond drill was also used extensively on Shangoinah Island and on Burnt Island.

Work done on vein on mainland.

Work on vein on islands.

Expenditure and returns

Mr. Curtis writing in February, 1877, sums up the history of the mine as follows:—"A capital of $73,000 paid a dividend of $160,000 the first year, besides paying about $200,000 towards settlement with the *Montreal Mining Co.*, and expending also a large amount of money to establish the plant. In the report for this year" (1877,) "we find that the total amount of dividends have been $622,666.66, and the total production $2,237,479.84. This great outlay was needed at the mine to establish a town on a barren rocky shore, to maintain a foothold on a little rock not 80 ft. square against the mighty storms of Lake Superior, to furnish steam-tugs, engines, pumps, and build a mill capable of concentrating over 75 tons of rock per day" (B).

Mr. Lowe states that more than $1,200,000 were expended in securing the Islet, also that the volume of water made by the Silver Islet vein per minute was about 170* gallons, its principal source being above the 9th level, and further that throughout the mine nearly 5,000 feet of holes were bored by the diamond drill.

Diamond drill holes.

Statistics.

The below given tables show the yield of the mine year by year, and are compiled from Mr. Macfarlane's paper above quoted and the other sources mentioned.

	Weight in Lbs.	Value per Ton. $ c.	Total Value. $ c.
Under Montreal Mining Co.....	27,073⅜	1,646.80	23,115.35
" New Proprietors, 1870.....	155,543	1,175.80	92,153.23
" do 1871 (Newark)....	183,453	1,507.64	138,291.88
" do 1871 (Wyandotte).	778,468½	1,296.48	504,640.13
Lost on propeller "Coburn".....	10,000	1,040.00	5,200.00
	1,154,537⅞	$1,322.44	$763,400.59
Season 1872.....	310,744.02 ozs.		
" 1873.....	289,763.77 "		
" 1874.....	250,021.75 "		
" 1875.....	145,902.50 "		
	996,432.04 "	=	$1,195,718.45
Carried forward.....			$1,959,119.04

* Mr. Richard Trethewey says 155 gallons per minute is the correct figure.

Brought forward			$1,959,119.04
Produced by stamp mill, Dec. 1875, to Nov., 1876 (concentrates)	136,529.00 ozs.		163,835.00
Produced by stoping in upper part of the mine, 1877	23,850.00 "		28,620.00
Produced from second *bonanza*, 1878	721,632.00 "		865,958.00
Produced from deposit at 960 ft. level, about 1882. (Mentioned in Mr. Lowe's paper.)			30,000.00
Total of amounts mentioned in various accounts of the mine as above			$3,047,532.04
Amount unaccounted for above			202,467.96
			3,250,000.00
Total value of silver produced from the commencement to the close of operations, according to Mr. Richard Trethewey			$3,250,000.00

This discrepancy of $202,467.96 is not necessarily due to an actual disagreement of the different authorities, but probably represents the results of the treatment of mill rock taken out from various parts of the mine which had been neglected during its palmier days, and to which attention was turned after the mill was built and the rich ore bodies were worked out.

Latest developments.

The last authentic statement regarding the mine is found in the official report of Mr. Richard Trethewey, dated January 20, 1884, to the President of the Company, where he says "The work at the mine during the past year has been devoted to the sinking of the shaft to the 1,160 feet level, drifting the same north and south of the shaft, sinking two winzes below the 1,160 feet level, and back stoping at encouraging points in some of the upper levels.....These drifts" (from the 1,160 feet level) "have been extended southward 227 feet and northward 81 feet. The vein, though well defined and carrying quantities of minerals, has not produced the expected amount of silver. A deposit of silver was opened into during the summer, near the end of the north drift, but proved to be small in extent. At this point and in this run of ground a winze is being sunk towards the 1,260 feet level, hoping that in its course other bunches may be found. A winze has also been commenced towards the 1,260 feet level, near the end of the south drift in the same run of ground in which silver has been found above. In the levels where back stoping has been carried on, the vein, although of a very encouraging nature, yielding minerals which are always found accompanying silver, has not produced silver in paying quantity; still it will be remembered that heretofore we have worked for long

periods in ground such as described and finally been rewarded by encountering rich deposits, and there is no reason why we should not expect similar results again." He continues thus: "Ere long we shall find ourselves placed in a serious dilemma owing to the non-arrival of our winter supply of coal last fall—a vessel with a cargo of nearly 1,000 tons having failed to reach here, being laid up while *en route*. The present supply of coal is sufficient to run with until about March 1st, after which we shall find it extremely difficult to carry on the work." Operations were accordingly suspended early in the spring of 1884.

Closing of mine

Description of illustrations.

Plate I shows the underground workings of the mine on the west or main vein. I have not been able to obtain a section showing the same for the eastern branch above its junction with the main vein at the fourth level, but Mr. John Trethewey tells me it was mostly stoped out from the fourth level to surface, being worked by cross-cuts from the main vein from which levels were driven on it. The tracing from which the illustration was taken was apparently not kept quite up to date, for some of the measurements given me by the manager do not quite coincide with those of the tracing; these differences, however, are trifling and do not affect the utility of the drawing as an illustration of the direction and extent of the underground development made upon this famous vein.

Stamp mill.

During the first few years whilst the very rich ore of the first deposit was being worked out which had only to be barrelled up and sent to the smelter, the poorer mill rock was neglected, and it was only when the period of adversity was experienced, that attention was paid to it, and a stamp mill erected on the mainland at a cost of about $100,000 to treat it. This work was carried out in the winter of 1873-4.

The machinery used consisted of 50 head of stamps, 24 Frue vanners (an improved form invented by Captain Frue of the old Brunton frame) and two No. 4 Blake crushers with the necessary hoisting gear, water tanks, etc., and a 250 horse-power engine to supply the necessary power. The ore as it came out of the mine was dumped by the self-dumping skip into cars and brought thence to the mainland on a scow towed by a tug. These were then hauled up an incline to the mill where the ore being dumped and fed into the Blake crushers, passed from them to the stamps. The battery slimes passed directly to the Frue vanners, which were arranged in two sets, one below the other, the upper or head tables and the lower or clean-up tables. The tailings from the former passed to the latter, and were there further concentrated, the heads or concentrates being barrelled up and sent to the smelter. The heads from the lower set were passed over to extra clean up tables to be further concentrated. The mill had a capacity of

about 60 tons per day, producing from 1 to 2 tons of wet concentrates, holding about 14 per cent. of moisture, at an average cost, according to Mr. Low, of $1.70 per ton. The concentrates varied in their value from $300 to about $10,000 per ton, but averaged between $500 and $1,500. Mr. Lowe states that the tailings averaged about $2 per ton, and that the mill saved 90½ per cent. of the silver in the ore. The rock put through ran from 6 to 37 oz. per ton.

Cost of milling.

To Mr. Richard Trethewey I am indebted for the following items regarding cost of production calculated per ton of rock milled :—*

Mining	$2.50 (to $3.00)
Sorting	50
Labour and tug expenses, transporting rock from mine to mill	50
Crushing, stamping and dressing	2.00
Total	$5.50

Smelting of ore, etc.

In the early period of the existence of the mine there seems to have been considerable difficulty in making satisfactory arrangements for the sale of the ore. The assays made of some of the first lots by different assayers varied greatly, and furthermore, the smelting charges were very high. "Both at Newark and Wyandotte, the smelters only guaranteed to return 95 per cent. of the silver contents and charged $100 per ton for smelting," says Mr. Macfarlane, and the smelters naturally refused to account for more silver than was shown by their own assay. These discrepancies no doubt arose from the natural difficulty of getting uniform samples from so very rich an ore, and one containing so much metallic silver.

Wyandotte smelting works

In consequence of this, the Company determined to erect smelting works of their own, and this was accordingly done and smelting was commenced at the Wyandotte works by July 1st, 1871. Of these works Mr. W. M. Courtis, in a paper read before the American Institute of Mining Engineers, Oct. 1873, says "The intention was to work Western ores with those from Lake Superior, since the latter contain but a small amount of lead. Hence the capacity of the works is much larger than is needed for the present yield of the mine. The planned process for treatment was, smelting with lead ores, desilverizing the lead by Balbach's process with zinc, cupelling the rich lead and refining the crude silver. Since the supply of Western ores was uncertain, and prices and freights were high, a sufficient supply could not be obtained; and hitherto the works have been in operation but a few months each year.

* For further details see Appendix B.

Yet they have produced a very large amount of silver—931,203 oz. in fine silver up to Sept. 1st, 1873. The process has been smelting for rich lead at once and cupelling and refining the bullion. In addition has come: treatment of the matte to save the nickel; refining the nickel matte; extracting the silver from the marketable nickel speiss, and treatment of the refuse too poor for smelting."

Other veins of Coast Group.

I have gone somewhat fully into the history of the Silver Islet mine, as it was the chief and typical mine of the district. In order to show how far the rest of the veins of the group under consideration have been tested as to their value, I have added below all the data obtainable, either from personal observation or otherwise, regarding the developments made on the other veins of this group and referring to their conditions of occurrence.

Angus Islands.

About ten years ago, a vertical shaft is said to have been sunk on one of the islands, and a drift run out from it to intersect the vein which could be seen outcropping under water near the shore. No success seems to have attended this effort.

McKellar's Island.

This vein was discovered in 1869 by the Messrs. McKellar Brothers, and some years afterwards the test work was done, shown in the accompanying drawing of the mine. (See Plate II, Figure 2).

Vein characteristics.

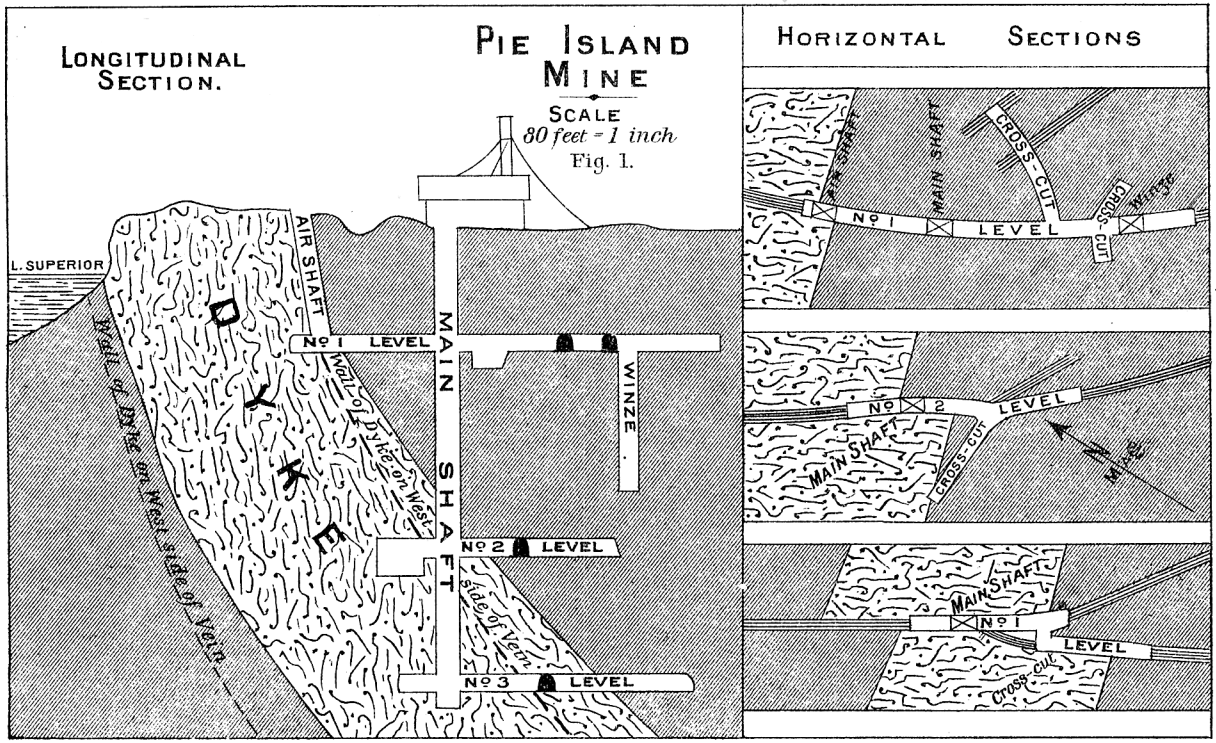
It is very large, consisting of coarsely crystallised, calcite and barite, occurring in separate ribs for the most part, although they are mixed in parts of the vein. With these preponderating minerals there is a smaller proportion of quartz, generally colourless. The metallic minerals consist of zinc-blende with a little galena and pyrites which are for the most part concentrated in dark coloured bands in the main vein, of which bands there are two on the north side and one on the south side of the island. A sample of one of these streaks assayed—

Assays.

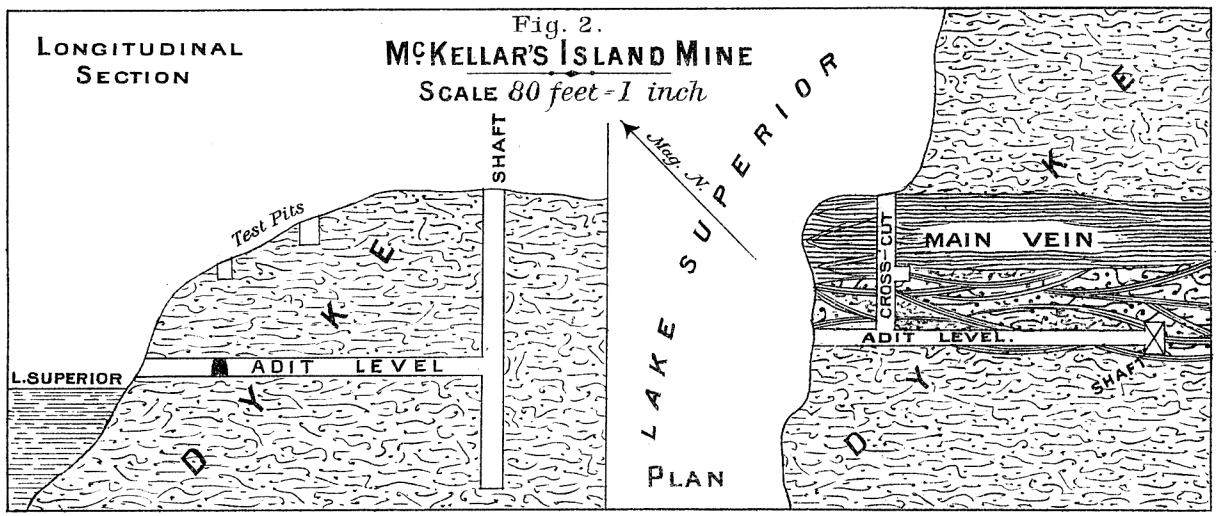
gold, none; silver, about ¼ oz. whilst another from a different place in the same gave neither gold nor silver, showing that the dark coloration was not due to finely disseminated argentite or agentiferous blende. (See Report of Progress, Geological Survey of Canada, 1886, part T, assays 33 & 34.)

Side branches.

Besides this main vein which is composed of solid spar, and is about 60 feet wide on the south side of the island there are numerous side stringers intersecting the country rock of the west wall of the vein, and on these the developments have been mostly made as shown in the accompanying illustration.



From published Reports, Maps, and data supplied by Mr. P. McKellar.



From Sketch survey made by E. D. Ingall, M. E.

Desbarats, Lith.

EXPLANATION.

Trap. Argillite. Cross-cuts.

The enclosing rock is a dark green, coarse grained trap. This composes the whole island which is only some eight or nine chains in diameter, and is evidently part of the outcrop of a dyke which appears further west in Thompson's Island. A little altered argillite appears on the south side of the island still clinging to the dyke. Enclosing rocks.

According to Mr. P. McKellar, argentiferous blende was the chief silver bearing ore of the vein. The developments done so far have evidently not opened up any very large body of ore.

During the summer of 1886, the barite rib on the east side of the vein has been worked down from surface, some thirty men being employed at this work, and the product after handpicking to extract as much of the calcite and quartz as possible, was being shipped to the United States, the buying firm giving $5 per ton *over the rail* at the island for the best quality. Worked for barite.

Thompson's Island.

This island consists for the most part of trap in the form of dykes running lengthways through it with a small development of the argillites between the two forming the two points at its western extremity. The backbone of the island is constituted by the dyke which forms its eastern extremity, and which is evidently the same as that forming McKellar's island, which it resembles in appearance, being a dark green trappean rock of rather coarse texture. Enclosing rocks.

It was located in 1853 by Mr. T. Macfarlane for the Montreal Mining Co. A small amount of exploration was done in 1873 and in the winter of 1873-4, when some development work was done to test a vein crossing the island at its eastern extremity in a north-westerly direction. It consisted, as far as I was able to see, of an adit level run in on the vein, where it shows in the face of the cliff forming the north shore of the island, for a distance of about 25 feet, from the end of which a nine feet winze has been sunk on the vein, which here consists of an aggregate of stringers and branches of various sizes, covering a width of about four feet. The gangue consists mostly of barite with some calcite and white and amethystine quartz. It carries a small amount of the usual metallic minerals, viz., blende, galena and pyrites. Other veins occur, crossing the island in a north-westerly direction of a very similar nature to the last, and where seen, are all enclosed in trap. Work done. Vein characteristics.

Spar Island.

This island is part of the old Prince location, and was one of the first worked properties on the lake, operations having been carried on there in the years 1846 and 1849.

Rocks of island

It consists, like the others, of a group of trap dykes with argillites between, which latter rocks attain their largest development at the east end of the island, where they are to be seen forming a cliff about 200 feet in height, and are capped with a thin sheet of columnar trap. They are cut at this place by several dykes running lengthways of the island. Passing along the south shore of the island the same geologic conditions are observable, except that for some distance the argillites are seen to be associated with intrusive sheets of trap. This is visible for some distance along the south shore at one place where in cliffs some 30 to 40 feet high are to be seen three such sheets. That they are intrusive sheets is shown by the fact that they are frequently lenticular and curve up the beds above them out of their plane of bedding, the under side of the trap sheet lying flat on the beds below it. At one place this was found to be the cause of a very sudden change of dip of the argillites from a flat angle to the eastwards to a dip of about 45° westwards. Again, where the covering argillite has been recently denuded away, the remarkably smooth upper surface of the trap sheet further attests to the correctness of this view, these surfaces in no way resembling those polished and grooved by ice which also occur in this region.

Intrusive trap sheets.

Enclosing rocks of vein.

A plan, etc., of the western point of the island where the developments have been made is given in Plate III. Here there are as shown two dykes of trap separated by argillaceous beds and accompanied by an intrusive sheet of trap, on which is left a slight thickness of the argillite originally covering it. The main dyke consists of a medium grained trap whose color is lightened by the presence of white feldspar occurring radiately crystallised, the interspaces being filled out with a dark green mineral, probably hornblende. The smaller dyke "B" is a dark green crystalline trap carrying a quantity of pyrites much more compact than the other, and weathering with a comparatively smooth reddish brown surface in contrast with the gray aspect of the weathered surfaces of the main dyke, which can be seen to be due to the kaolinisation of the felspar. The trap sheet in general appearance and fracture closely resembles dyke "B," and also carries pyrites.

Trap dykes and sheets.

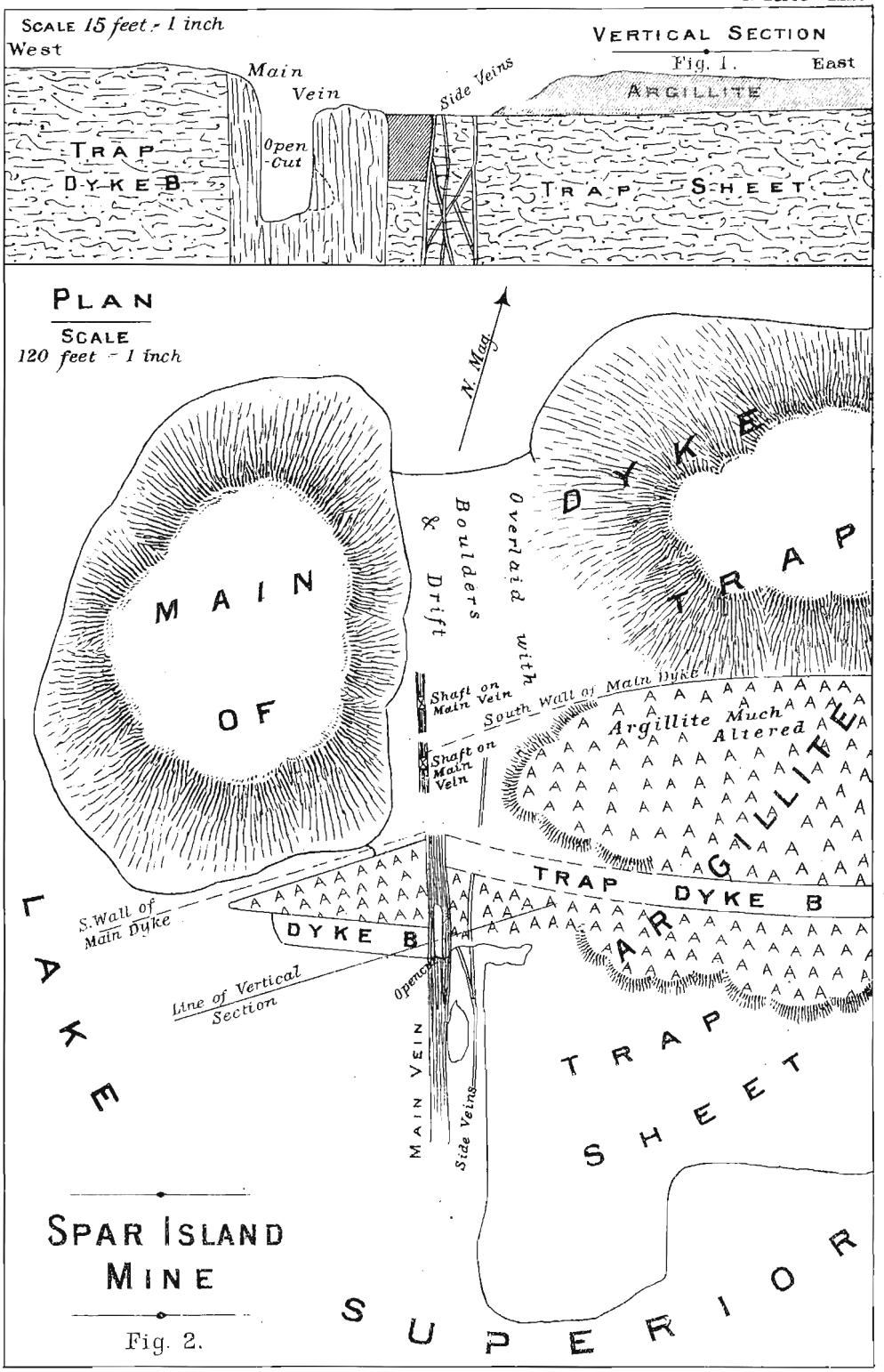
The argillites are of a dark gray color and lie nearly flat. They turn upwards as they approach the main dyke and are much altered. When within about twenty feet of it their bedding becomes obliterated and they take on a confused structure like false bedding, whilst on the fracture they resemble a fine-grained red trap. A similar altered argillite is described later as occurring at Jarvis Island.

Altered argillites.

Veins.

There are several veins visible on the shores of the island running across it in about a north-westerly direction. They show occasionally

Plate III.



From Sketch survey made by E. D. INGALL, M. E.

a little of the usual metallic minerals, blende and galena in a gangue of barite, calcite and quartz. The vein at the western end of the island shown in Plate III, is the only one on which any work has been done. The main vein with which are associated a few side branches is large and filled with a solid gangue of coarsely crystallised barite and calcite, the metallic minerals being represented by copper glance, copper pyrites, zinc blende and a little argentite, which occur for the most part disseminated through about six inches of gangue along either side of a six inch rib of pink barite occurring in the middle of the vein. This fissure has faulted the enclosing rocks about sixty-five feet horizontally. In the Geology of Canada, page 708, it is stated that the two shafts (shown on Plate III) are respectively 24 and 47 feet deep, so that the developments made have apparently not been extensive. It is said that besides the copper minerals found here some rich specimens of silver ore were obtained. Main vein.

Jarvis Island.

This vein was discovered in 1868. It runs across the island in a north-westerly direction and dips N. E. at 50° to 55°, contrasting thus with the nearly vertical dips of the veins of the other islands. In the summer of 1869 Mr. Macfarlane sunk a twelve feet shaft on the vein, "in accomplishing which work the following ore was produced:— History of developments.

79 lbs. first quality ore containing 3.45 per cent. of silver = 39.70 oz. at $1.25	$49.62
2,483 lbs. second quality ore containing 0.15 per cent. of silver=54.18 oz. at $1.25	67.72
Total	$117.34" (C).

In 1870 this shaft was sunk twenty feet deeper. In 1871 the *Ontario Mineral Lands Company* had a small party working on the lode during the months of June and July, when they sold it for $150,000 to an English company, under whose *regime* quite a considerable amount of work was prosecuted in the way of drifting, sinking winzes, &c. Three shafts were also sunk, of the respective depths of 160, 31 and 78 feet, and some stoping done. Besides this, the necessary surface work, erection of houses, etc., was accomplished, and considerable explorations made on the mainland portion of the property, which latter did not, however, lead to any results. These operations were conducted during the years 1871-2, and were suspended late in the latter year owing to unforeseen financial troubles. In the spring of 1886 the company which had prosecuted this work again commenced operations, and have been working ever since.

Their operations have been chiefly confined to sinking the main shaft and drifting from it. Mr. John Trethewey, who was in charge of the underground department at the time of my visit, was drifting south to get to the contact of the argillites and the dyke, as that was the position in which the ore had always been found at *Silver Islet*. I am now informed that, having been unsuccessful to the south, they are drifting north to get into the argillites upon the other side of the dyke, and that the superintendent, Mr. Arthur McEwan, says that the vein is looking well.

Enclosing rocks

The distribution of the enclosing rocks is shown in Plate IV. Here, as at Spar Island, the vein crosses two trap dykes with argillites in between, which lie nearly flat, but turn down and become much altered on approaching the more northerly dyke, as they do under similar conditions mentioned in speaking of Spar Island. A description of the microscopic characteristics of this rock is to be found in Appendix I., Specimen No. 127. Near the southern dyke the argillites are turned upwards, but there is little or no alteration. The most northerly dyke shows two varieties, the one a rather coarse grained rock, in which the hornblendic mineral, being mixed with white felspar, gives it a greenish-gray appearance; whilst the felspar of the other, being red, gives a redder color to the rock. A description of the microscopical characters of this rock will be found in Appendix I., Specimens Nos. 113 and 128. The vein on which this work has been done is somewhat similar to the two last described, the gangue being made up of the same minerals. It is from ten to fifteen feet thick, and the different minerals are arranged in bands more or less parallel with the strike of the vein. I notice the following succession at one point on the outcrop of the vein, in going from west to east across it:—

Vein characteristics.

1st. About four feet of largely crystallized calcite, with thin seamings of quartz throughout, occurring mostly between the crystals and along their cleavage planes.

2nd. A two foot band in which the calcite still preponderates, but with a large admixture of barite and a small per-centage of quartz seams as before.

3rd. About six feet consisting almost entirely of barite, with only a few inclusions of calcite.

The same banded structure is visible in the main shaft, where there is, however, a good deal of decomposed rock enclosed, and slickensided walls would indicate fissuring and movement subsequent to filling. Although silver ore has been found from time to time in the vein, the bodies have apparently been so far of limited extent.

The other metallic minerals, as elsewhere, occur concentrated in spots in the vein, and occasionally carry a little silver, as evidenced in the assay of a specimen which came from the lower drift whilst I was there. (See Report of Progress, 1887, Part T, Assay No. 34). It contained about 2 per cent. of blende and galena, with a little pyrrhotite, and gave: Gold, none; silver, 0·35 of an ounce to the ton of 2,000 lbs. An assay of some of the pyrites from this vein showed it to contain neither gold nor silver. (See Report of Progress, 1886, Part T, Assay No. 20). This vein is somewhat analogous to the Silver Islet vein in carrying carbonaceous matter, which shows as a black seam on the hanging wall. Assays.

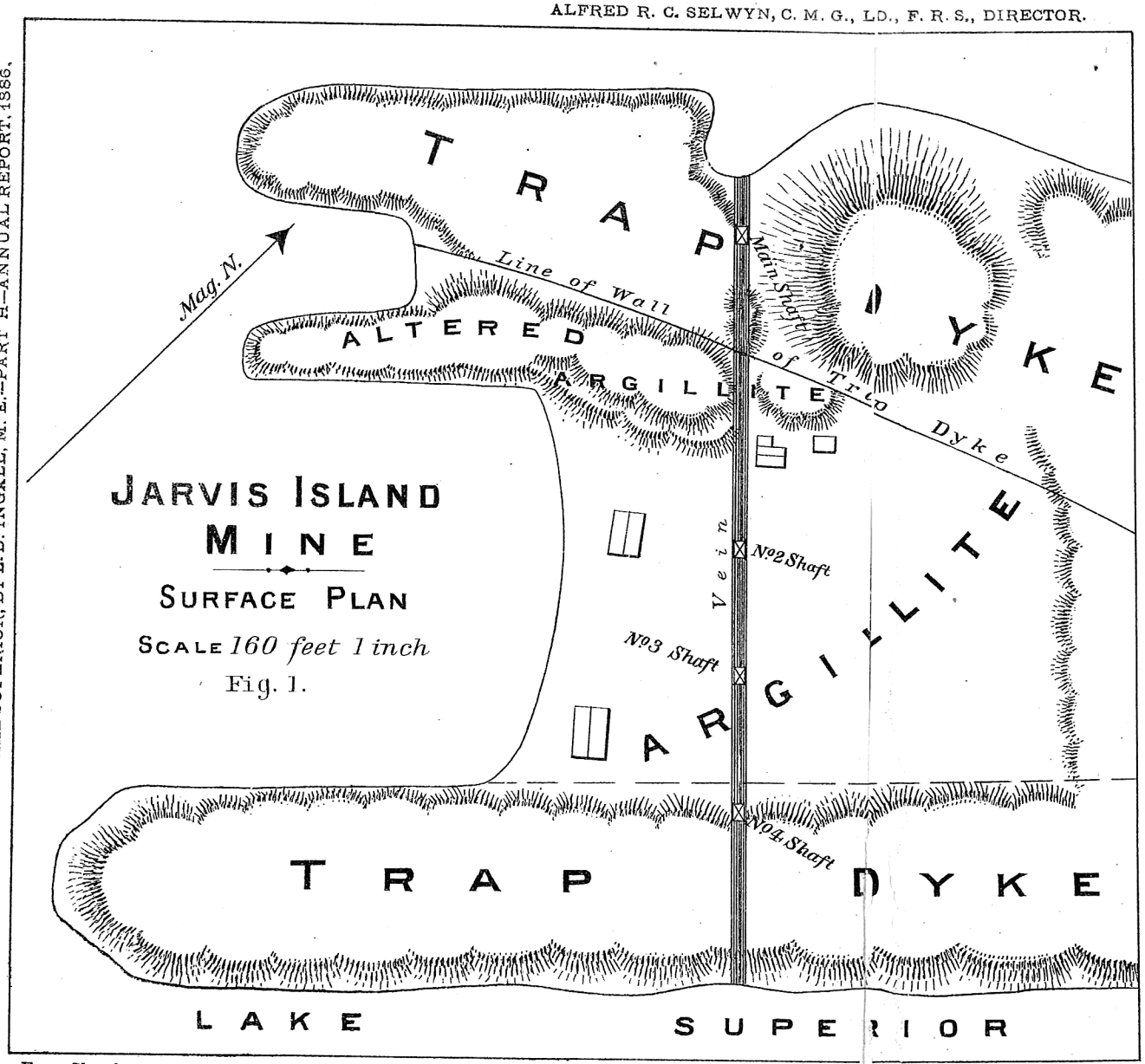
Victoria Island and McKellar's Point.

Passing westwards along the band of dykes forming the "Macfarlane Belt," we come to Victoria Island. This is similar to the rest, having several dykes of trap running through its length, with intermediate argillites, which latter however, here compose a much larger proportion of the island than is the case with those just mentioned. The developments made are situate at its western extremity, where a vein of the usual type, of barite and calcite, running in a north-westerly direction, has been tested by surface work and by two test pits to a depth of thirty feet. Some tunnelling was also done on another vein. It is said that about $5,000 were expended on this island. Geological structure. Veins.

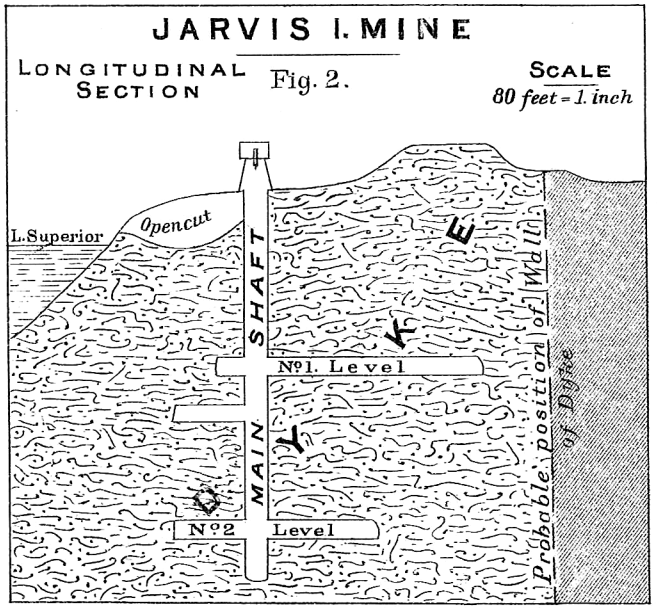
At this end of the island there is a large development of a red syenitic rock. Whether this is a product of the alteration of the argillites by the intrusive rocks of the dykes, or what is the precise nature of the causes which originated this rock, must be left in abeyance for closer study, both on the ground and with the aid of the microscope. Red syenitic rock.

On the further extension westward of this belt, at the extremity of McKellar's Point, very similar conditions are found. Here also there is a large development of the red syenitic rock in connection with trap dykes of the usual basic nature and dark appearance. The syenitic rock varies in different places from a highly crystallized, rather coarse-grained red rock, showing distinctly to the eye the red felspar associated with the green, apparently hornblendic, mineral, while in other places, whilst presenting the same general color and appearance as the typical syenite, it is much finer grained, and has more the appearance of a clastic rock which has been somewhat metamorphosed. Here also nothing can be definitely said of the origin of these rocks without further work being done.* This syenitic rock has a distinctly McKellar's Point.

* See Appendix, Specimen No. 85.



From Sketch survey made by E. D. INGALL, M. E.



From data supplied by Mr. J. TRETHEWEY, 15th Aug., 1886.

EXPLANATION.

TRAP.

ARGILLITE.

bedded appearance at this point, showing a dip to the east at about 15°. Another curious feature here presented, and which is noticeable also in the rock at the west end of Victoria Island, consists in the occurrence of inclusions, which have the appearance of bent and twisted pieces of argillite which have been metamorphosed.

These rocks only occur at the extremity of the point, the rest of which consists of a regular tangle of dykes of trap of the ordinary nature, with argillites included between them, the whole forming a prominent rocky ridge running back towards the mainland. Numerous veins of the usual nature cross the point in a more or less north-westerly direction. They carry a little of the ordinary metallic minerals of the district in a gangue of barite and calcite, with some colorless and amethystine quartz. A little work has been done on some of them, notably on one on the north side of the point, on which an 80 foot tunnel has been run in and a shaft about 30 feet deep sunk.

Veins on McKellar's Point.

Coast Section.

Red syenitic rock at Little Trout Bay.

The north shore of Little Trout Bay presents very similar phenomena to those just mentioned. Here we find quite a large development of this red rock, which at this point, however, has a much more distinctly syenitic composition and appearance, in marked contrast to the general appearance, structure and mineral nature of the other igneous rocks of this formation. It lies apparently in beds, interstratified with the usual sedimentary rocks. Several of these occur here, with varying thicknesses of argillite between, which latter in places thins out so as to leave two syenitic beds in direct contact, the plane of division between the two being, however, still quite distinct.

Examined by eye, this red rock seems to consist largely of red felspar, with which a green mineral is intermixed, probably hornblende or an alteration product of that mineral. It is for the most part moderately coarse-grained, and in places is porphyritic from the presence of large felspar crystals distributed throughout the rock and occurring occasionally in large nests or aggregates in a dark hornblendic base. Dykes of the ordinary dark-green basic traps cut these beds in places.

Intrusive trap sheets at Caldwell Pt,

On the eastern side of Caldwell Point occurs a little bay whose northern shores consist of cliffs about thirty feet high, coming down vertically into the water and which present a very good section, showing intrusive trap sheets in the flat lying argillities occurring similarly to those noticed at Spar Island. They show the same features, viz :—Flat under and arched upper surfaces closely conforming to the bedding planes of the enclosing argillities. Two distinct sheets are distinguishable,

the upper one at one place having protruded a tongue from its lower surface and lifted a part of the sedimentary rock on which it lies, which is now visible as a thin sheet of shale, projecting upwards into the mass of the trap and making an angle of about 19°, with a horizontal bedding of the rest of the beds. Passing eastwards along the section, the upper surface of this upper trap sheet is seen to curve downwards to the water level, and at its eastern end to be overlaid by the argillites resting on its remarkably flat, smooth upper surface, which here shows the end view of the columnar structure of the sheet. Another trap sheet is seen to overlie these argillaceous beds about fifty feet above this point. A vertical trap dyke about the middle of the section cuts the horizontal traps, &c., causing a displacement of a few feet, thus being evidently younger than them. Other displacements have also occurred causing a slight difference of level of different parts of the beds.

Different ages of trap dykes, sheets, etc.

At the extremity of the same point the surface of a similar trap sheet shows slightly above water, and is intersected by a small dyke of trap closely resembling it, but which, judging from its well defined walls, is evidently younger. Similar evidences of differences of age are occasionally observable with the dykes, notably at one point, on the shore about north of McKellar's Point where a larger dyke is cut by a smaller one, running on about the same course. The former consists of moderately fine grained greenish gray trap, showing distinctly the radiately arranged felspar crystals upon the weathered surface and decomposing into a loose granular mass, whilst the smaller and younger dyke has a much more compact structure, rendering the separate minerals indistinguishable, and weathers to a smooth, uniform, rusty-red surface.

Passing northwards from this point the rocks are well exposed in a series of hills, with cliff faces, running parallel to and close to the coast. These vary from 200 to 400 ft. in height, and consist of the sedimentary beds of the series capped by coarse trap, giving them the table-topped appearance so characteristic of the district. The trap shows a thickness of from 50 to 100 ft, and has a very characteristic vertically columnar structure. This rock also appears in the shape of numerous dykes, cutting the sedimentary beds, and forming nearly all the points along the coast, owing to their superior power of resisting denudation agencies. These dykes consist for the most part of dark colored compact trap, and have often, a columnar structure at right angles to their walls. They are often left standing up like walls, and although they are frequently visible running up to the sheets of traps capping the hills, it could not be positively said in any instance whether they cut through them or not, and although in several cases they appeared

Rocks of coast section N. from Caldwell Pt.

Traps.

to do so as viewed from the water, it was either found impossible to reach the spot at which this might have been proved, or when reached, the covering on the rocks prevented the necessary observations from being made. A good instance of this is observable on the north side of Turtle Point a little west of its extremity where a dyke of a very compact trap, and with a marked columnar structure, normal to its walls, rises out of the water as a perpendicular cliff, owing to the removal of all the argillite originally enclosing it on the lake side. This dyke is seen to extend as high as the top of the trap sheet capping the argillites on its inner side, and seems to retain its horizontal columnar structure to the top, even where in contact with the vertical columns of the horizontal trap.

Effects of trap dykes on sedimentary beds.

These dykes, curiously enough, have in nearly every case altered adjacent rocks very slightly or not at all, and in most instances the impress of the bedding of the argillities can be seen on the sides of the dyke where they have been stripped bare. Occasionally the argillite may be porcelanized for a distance of one or two inches away from the dyke, but this is the exception, and an instance was never encountered where a crystalline structure was induced in them. This contrasts strongly with the large amount of alteration observable near the Jarvis Island and Spar Island dykes already mentioned, and which was also observed near the dyke forming the western point at the entrance of Cloud Bay, where red felspar crystals were noticed to occur in the argillite, immediately adjacent to the dyke. This absence of alteration is also noticeable with regard to the contact of the horizontal sheets of trap where there is occasionally a slight amount of induration of the underlying sedimentary beds, a few inches below the junction, but generally there is no appreciable effect of this sort. The line of division between the two rocks, both in this district, and where studied elsewhere in the formation is generally quite distinct, and where the softer underlying shales, etc., have been removed by weathering, which is very frequently the case, the lower surface of the trap is presented as a smooth overhanging plane. Occasionally, where not assisted by this weathering effect, there is a little difficulty in locating the exact plane of the junction which is rendered more difficult sometimes by the frequently very fine grain of the trap close to the contact and its close resemblance to the colour and grain of the fracture of some of the underlying sedimentary beds. As a rule the thicker trap sheets found capping the hills get coarser in grain towards the top, but with the less extensive and thinner beds occurring at other horizons, no such effect is noticeable, and neither these latter nor the dykes show that coarser grain towards their centre which one would expect.

Effects of trap sheets on sedimentary beds.

Varying texture of traps

As a rule, the trap in both these last instances is a much finer grained, darker colored and more compact rock than the first-mentioned.

Sedimentary deposits.

The sedimentary beds of the coast section consist of what may generally be termed argillites, although, from the preponderance of silica, they merge in some places into sandstone and in others take on more the nature of dolomites or limestone, from the large development of carbonates. They vary in color from a dark to a light bluish-grey, and in structure they vary also from flags to shales, according to the extent to which the bedded structure is present. Other noticeable features are the occasional presence of a little mica along the bedding planes and a confused ropy structure of the surface of some of the beds, resembling somewhat ripple-mark in some instances, whilst in others it gives one more the impression of the surface which would result from the flow of a viscous mass or thick mud beneath a surface skin.

Jointing of same.

Wherever developed, the jointing shows two sets of planes, one bearing between east-north-east and north east and dipping from 65° to 85° southwards; the other bearing about north-north-west and dipping from 80° to 85° westwards. It is noticeable that these two strike directions closely correspond with the two main systems of fissures in this vicinity—the north-easterly dyke and the north-westerly vein systems.

Dip of formation.

These sedimentary beds all along the coast are found lying comparatively flat, and although locally they dip slightly, and these dips are at times in somewhat contradictory directions, yet they may possibly have a general dip in a southerly direction of a few degrees. The difficulty of determining the general dip of the whole formation is enhanced by the existence of numerous shallow synclinals and anticlinals and shallow basins in the beds, and by the local disturbances and contortions due to faults and dykes, although the latter only produce these effects occasionally.

Several veins have been located along this Coast Section, and a little work done at the following places:—

Stewart's Location (Near Pigeon River).

Coast group of veins continued.

This is one of the tracts of land originally taken up by the *Montreal Mining Company* in 1846, and is now owned by the *Ontario Mineral Lands Company*. In 1868 a small party of men explored there for about a month without result. Later on, the *Silver Islet Company* had a party working for about a year on several north and south veins carrying copper glance.

Pine Bay.

Coast group of veins continued.

A little has been done here on a N. N. W. vein carrying argentiferous galena, but the proportion of silver was not large.

Big Trout Bay.

Near the inner end of this bay some test work has been done on a vein running in a north-westerly direction, and dipping to the north-east at an angle of 70° to 75°. It is about twelve inches thick, and has definite walls where seen in the workings. It cuts a hill about 300 feet high of argillites, capped, as usual, with trap, and intersected by dykes of the same rock. The work done is near the top of the hill, and shows a vein which, in the usual gangue of coarsely crystallized calcite and barite with a little amethystine quartz, carries iron pyrites and shows indications of copper in the shape of occasional malachite stains. Around the workings the country rock is entirely trap, which carries a large percentage of pyrites adjacent to the vein. A piece of this was selected for assay to see whether the pyrites carried the precious metals, which proved not to be the case. (See Part T, Annual Report Geological Survey, 1886, Assay No. 17).

The work done consists of some stripping on the back of the vein, and two tunnels, each about 50 feet in length, one 30 feet below the other, run on the course of the vein. It was done in the years 1882-83, and some $1,500 were spent on these developments.

Cloud Lake.

Here argentite and native silver are said to occur in a vein with blende and galena in quartz. An adit 200 to 300 feet long was driven into the side of the hill to cross-cut the vein, but did not succeed in finding it, as it had apparently split up. The surface explorations traced the vein for about a quarter of a mile, in which a good show of silver is said to have been seen. The expenditure on this work probably amounted to about $25,000. This vein was supposed to be the continuation of the last-mentioned one, but as the distance between the two points is about five miles, this is rather a gratuitous assumption.

Caldwell Island.

This island is composed almost entirely of trap, intersected by numerous dykes of the same. A shaft was here sunk to the depth of 60 feet on a vein, without much result.

Mink Island.

A wide vein, carrying some indications of copper in a gangue of calcite and barite, crosses the dyke forming this island. In 1872-3 a slight amount of work was done here, and some little was accomplished on the mainland opposite, which showed a promising looking vein. The expenditure amounted to about $1,000. Coast group of veins continued.

Sturgeon Bay. (*K.* 13.)

Some capitalists of London, Ont., did some work here. Two large veins occurring in the argillites near a dyke were seen intersecting under water near the shore. A shaft was sunk close to the water's edge, on the north shore of the mouth of the bay, and a drift run out to cut the veins at their junction. A shaft was also sunk some 300 feet further inland.

K. 17 *Location.*

Some test work has been done on a brecciated vein consisting of the argillite country rock cemented together by quartz. It runs north 60° to 70° E. (mag), and dips to the south 80°. It is said a strong force of men worked here for nearly a year about 1878 or 1879, and that the expenditure at this time amounted to some $5,000.

Prince's Mine.

This is the oldest mine on the Canadian shores of the Lake, having been worked in 1846 or 1847, when it appears to have been regarded more in the light of a copper than of a silver-bearing vein. It strikes N. 30° to 40° W (mag)., and where it shows on the shore is split into two branches, with argillite between and trap forming the outer walls—that on the eastern side appearing to be a dyke cut transversely by the vein. Regarding the trap on the western wall, it is not very apparent whether it is a large dyke also traversed by the vein, but it shows as a forty-foot cliff rising out of the water, running south from the vein exposure mentioned for a distance of fifteen chains, whilst inland it shows as a similar wall running about parallel to the vein and dipping about 80° to the S.W., up against which almost horizontal argillites are seen to abut. About sixty yards in from the shore, at a point where the two before-mentioned branches would seem to come together, a 65 feet cross-cut tunnel has been run through the argillites in a westerly direction towards this cliff, the inner end of which tunnel intersects numerous branches for a distance of about twenty- Enclosing rocks.

Coast group of veins continued.

five feet. The vein next shows about 250 yards further inland, where it outcrops on a hill, at which place two shafts have been sunk on it and a tunnel has been driven in on it towards the shafts about fifty feet lower than the mouth of the higher shaft. The vein down to this level occurs in trap, but whether this is the bed which caps the argillites in the neighborhood, or whether it is the extension of one of the dykes that are seen on the coast further north, running in this direction, it would be impossible to ascertain without making a much closer examination than I found it possible to do with the time at my disposal. The drift being blocked up with debris, it was impossible to enter; but it is said that a winze was sunk some fifty to sixty feet below this, and whether the vein was thus followed down into the argillites, or what was the effect of this change of the "country" rock, it would be interesting to know, but it is now impossible to find out after this lapse of time. According to the Geology of Canada, 1863, this tunnel was driven for a distance of 163 feet, and one of the shafts was

Rich silver ore.

ninety feet deep, in sinking which a bunch of ore was obtained weighing several hundredweight and containing three per cent of silver, which in two assays yielded respectively one part of gold in 7,000 of silver, and eight parts to 1,000 of silver. This bunch contained "native silver disseminated in thin laminæ through the calcareous spar and blende.....Crystallised sulphuret of silver was also found in this vein, and the calcareous spar was stained with blue and green carbonates of copper and with red arseniate of cobalt."

Between these workings and the shore exposure the vein must intersect several trap dykes which are to be seen along the coast to the north, striking in such a direction as to there run athwart it.

Vein characteristics.

The two branches on the shore are respectively five and six feet thick, whilst at the inland workings, where it exists as one vein, it is much thicker. It here shows a central rib of coarsely crystallised calcite with some barite, with a large proportion of largely crystallised, mostly amethystine, quartz on either side. Judging from the loose ore on the dump, blende seems to have been the most plentiful metallic mineral in the vein at this place.

On the shore exposure the vein presents very similar characteristics, except that the metallic minerals do not seem to have been so plentiful and that some of the branches consist almost entirely of quartz, whilst in others calcite and barite mixed constitute the greater part of the vein stone.

Assays.

Assays made of specimens selected on account of the metallic minerals present in them, proved these to carry neither gold nor silver. (See Report of Progress, 1886, Part T, Assays 21 and 22.)

Pie Island.

This island consists of the usual argillaceous series of sedimentary beds traversed in a north-easterly and south-westerly direction by dykes of trap, the same rock capping the argillites in the table-topped hills. Coast group of veins continued.

The developments shown in Fig. 1, Plate II, were made on one of the north-west series of veins which occurs on the western shore of this island. The underground developments have been made in the vein where it cuts a trap dyke, which intersects the argillites of the vicinity, or immediately adjacent to it. The width of the vein is from three to four feet and is filled with a breccia of fragments of the country rock cemented together by crystallised quartz, which is mostly colourless but sometimes anethystine, and is accompanied by a little calcite, which occurs mostly crystallised in scalenohedra in the vugs. The great feature of this vein, as shown by an inspection of the dumps, consists in the large amount of metallic minerals it carries. These are blende, galena and iron pyrites, mentioned here in the order of their preponderance, and all occurring for the most part well crystallized, especially in the case of the galena, of which small but very perfect crystals of a combination of $\infty P \infty$ with O may be found. This latter also occurs sometimes as thin seams in the joints of the argillite, which, on account of their dark, lustreless appearance, might possibly be mistaken for argentite by the inexperienced, especially where the films are thin. An assay of such a piece showed it to carry neither gold nor silver. (See Report of Progress, 1885, Part T, Assay 28.) That these metallic minerals, although they are occasionally found to do so, as a rule carry either none of the precious metals or a very small proportion, is shown by the other assays given in the same place. Assay 25 of a specimen selected as carrying a good proportion of galena, free from other metallic minerals, gave: Gold, none; silver, 0.175 of an ounce to the ton. The other numbers: 26 carrying a good proportion of blende mixed with a little galena and 27 consisting nearly altogether of pyrites, gave neither gold nor silver. Developments. Vein characteristics. Assays.

The nature and extent of the developments made is shown sufficiently in the figure, and needs no further description. Operations were conducted here about the years 1875-7.

Some development work has also been done on a large vein on 13 B mining location, about a mile E. S. E. from the last mentioned. It strikes in from the shore with a course N. 75° W (mag.), and dips to the N. It is about twelve feet thick, is enclosed in the argillites of the district and intersects two trap dykes which cut through them. 13 *B*. Mining location.

13 *B* Vein. A shaft has been sunk on it, the depth of which was not ascertainable, however, as it was full of water. In mineral contents it is very similar to the first mentioned, except that the quartz is accompanied by a good proportion of pink spar, probably dolomite.

Assays. One assay made of some specimens selected as carrying some galena and a little blende, gave neither gold nor silver; whilst another sample, broken from an outcrop about half a mile from the latter point and about on the run of this vein, which carried some galena accompanied by a little pyrites, yielded on assay: Gold, none; silver, 0.467 of an ounce per 2,000 lb. ton. (See Report of Progress, 1886, Part T, Assays 29 and 30.) Little or no work has been done on the rest of this island.

The Port Arthur Group.

The Port Arthur group of veins. The members of this group of silver veins may be considered in two sub-divisons:

Div. I.—In which the veins occur in the Animikie rocks.

Div. II.—Comprising those occurring in the Archean area to the north of the former.

Division I.

General conditions. This comprises most of the veins of this group. They occur in the lower beds of the Animikie which consist for the most part of siliceous rocks, cherts, silicified argillites, etc., with a small development of the softer and carbonaceous argillites. The chief developments have been made on veins near the northern fringe of this formation, whose thickness must be here comparatively slight, owing to its practically horizontal position, and the way the old Pre-Cambrian surface dips under it. This was actually found to be the case at the Shuniah mine, where as hereafter mentioned, the vein was followed through it and into the underlying older rocks.

Thunder Bay Mine.

The discovery of this vein by Mr. Peter McKellar in the fall of 1866, may be said to have been the commencement of the second era of mining activity in the Thunder Bay region. As it was not found possible to visit this place, the following description has been compiled from various sources.

Vein characteristics. This vein strikes N. 34 E. and dips at a high angle to the north-west and consists of a series of "closely reticulated veins of white granular quartz the largest being about one inch thick and the aggregate aver-

DEPARTMENT OF THE INTERIOR,

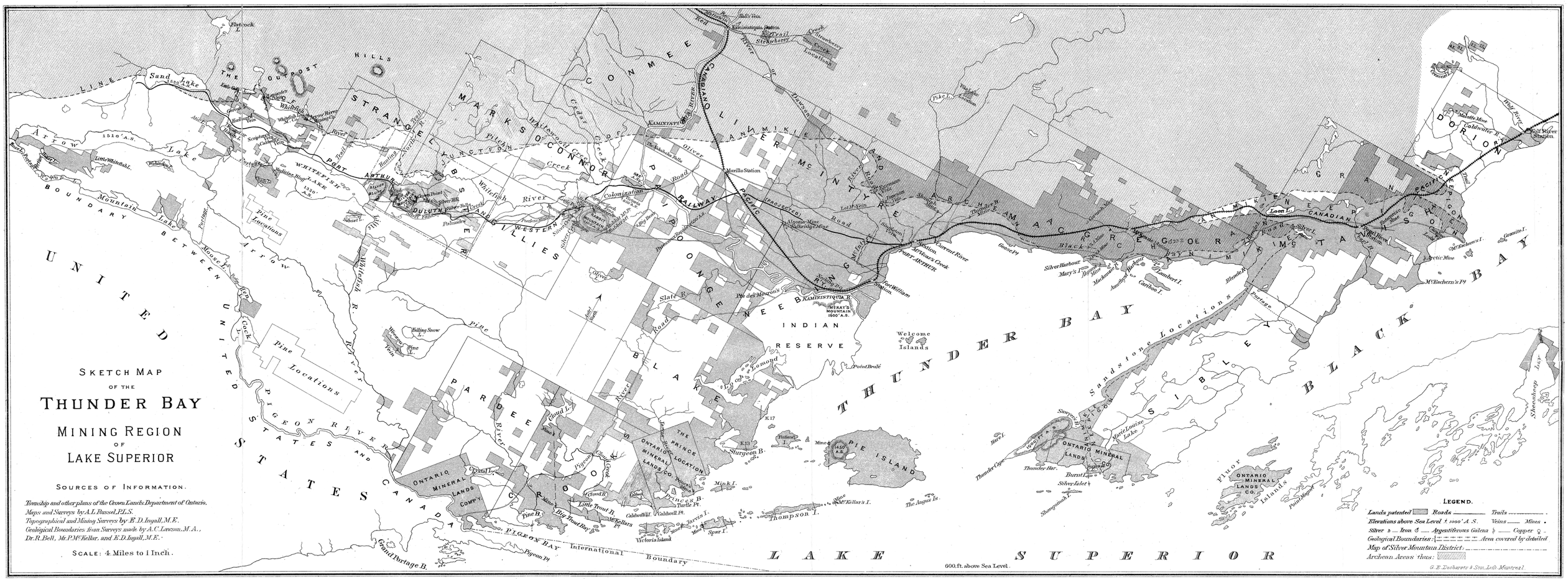
HONORABLE THOMAS WHITE, MINISTER.

Geological and Natural History Survey of Canada.

ALFRED R.C.SELWYN, C.M.G. LL.D., F.R.S. &c. DIRECTOR.

1887.

Mines and Mining on Lake Superior, by E.D. Ingall, M.E. Part II. Annual Report 1886.



aging perhaps ten feet. It carries native silver and argentite, accompanied by galena, blende and iron pyrites." According to Mr. McKellar "the ore occurs in bunches three to eighteen inches thick by six to forty feet in length, the silver being in strings, leaves, grains, etc., irregularly distributed throngh the vein-stone which constituted the greater part of the bunch. At the first opening there were two of the streaks. one next to the north or hanging wall, and one in the middle. It is not well defined, being generally in ribs with considerable slate between" (F). Mr. McKellar further states that the vein was strong and rich in the upper strata but below consisted of small stringers with galena, etc., but little silver. Port Arthur group of veins—continued.

Dr. Bell, in his description of the mine, points out that "silver often forms ten per cent. of the mass" (H). in the isolated bunches of ore occurring in the vein, and says further that the country rock consists of a thick bed of trap underlaid by from fifteen to twenty feet of "alternating beds of dark shale, impure dolomite, argillite and what appear to be diorite layers. These are followed in descending order by massive dark olive and drab-grey argillaceous slate, about fifty-five feet of which have been cut in the shafts." (H.) Enclosing rocks.

The work done consists of four shafts sunk on the vein, a cross-cut driven north-west at the ten fathom level, and some drifting, done between the two deepest shafts. No. 1 shaft is some seventy feet deep, No. 2 is the same depth and 300 feet north-east of it, whilst 150 feet further on is another shaft thirty-five feet deep, and again 150 feet to the north-east on the strike of the vein another shaft has been sunk to the depth of twenty-five feet. Ore was stoped out from the outcrop of the vein between the two extreme shafts over a distance of 600 feet. On surface the vein was traced upwards of half a mile, and besides the erection of necessary buildings, three miles of a good waggon road were constructed to the shore of Thunder Bay, where a stamp mill was erected as well as a dock 200 feet long, built of crib work filled with stone. Work was stopped in the spring of 1869. * Work done.

According to Mr. Robb (Report on the Mineral Statistics of Canada, Geo. Survey, 1871-2) the product of the mine was 3,294 lbs. of ore, worth $2,592. Expenditure and results.

The work was done by an English company having a capital of $400,000 divided into 80,000 shares of the value of $5 each, 60,000 of which were unassessable, thus leaving a working capital of $100,000.

The mine was again opened up in 1874, and Mr. Peter McKellar, in a letter to myself, recently received, says: "The *Thunder Bay Mine* was in operation on this occasion for six months or more....The mining was almost entirely done on the south spar vein with no success. The spar Mine re-opened.

* "The *Thunder Bay Silver Mine* ..... has not been worked since the winter of 1869-70." (I).

Port Arthur group of veins —continued.

vein is large, six to twelve feet wide, bearing E.N.E. & W.S.W. with a high angle of dip to the south, whilst the silver bearing vein, the one from which all the silver was taken, is a parallel vein about twenty feet to the north, one to three feet wide, principally quartz, and dipping at a high angle to the north. The south vein seems to be the main fissure occupying a line of fault, the other a dropper from it. The mining on the spar vein was carried on through a cross-cut at the ten fathom level from the foot of No. 2 or B shaft." He further states that some 200 tons of low grade ore from the first works of the mine had been hauled to the company's mill, but not treated, and that after the closing down of the mine the last time, the manager hauled it to his own mill (five head of stamps) at Port Arthur and milled it, of the results of which Mr. McKellar speaks as follows: "Having seen the work in operation I have no hesitation in stating that it yielded well, the concentrates, which were sold in the States, were unusually rich in fine native silver. The actual yield was not made known."

The Shuniah or Duncan Mine.

Vein characteristics.

The vein strikes nearly E. and W. and has a general dip to the south at a high angle from the horizontal. The total width on surface is twenty to thirty feet. According to Prof. Chapman who reported on the mine in August, 1868, "Several cross lodes intersect or run into the Champion vein. These are at present altogethe rundeveloped, but they show on the surface a gangue of quartz holding small quantities of galena, blende and pyrites.....These cross veins appear to have an average breadth of six or seven feet, and.....are well defined." Several of these were afterwards intersected in driving cross-cut "a." (See Plate V, fig. 2), and were found to dip northwards.

Mr. W. M. Courtis, who was manager of this mine for some time, gives the following description of it: "The vein consists of one main fissure, with many parallel fissures rising from the foot wall" (or south wall) "at different depths, and at some places striking into the main fissure afterwards continuing as separate fissures again. These small fissures seem to be the silver bearing part of the vein and the large fissure is silver bearing only in the neighborhood of these junctions.... The ore is in bunches with ground almost barren between.....The vein contains horses of the country rock.....The edges of the fissures are often brecciated carrying native silver or ore, as do also many of the black slate *horses* in the main vein, deposited on the surface of the slate" (B). "We find these *horses* from the size of a pin to masses weighing tons. The effect of the solution" (which filled the vein) "upon them was silicifying. The extremely fusible green slate, equally with

the black slate or felsite horses, retained its sharp edges. They all analysed much higher in silica than the adjoining country even though embedded in a mass of spar" (G). Port Arthur group of veins —continued.

"The principal gangue, almost all *the* gangue, is calc-spar. The lime sometimes is replaced by magnesia or manganese. At *Duncan*, there is no pink spar" (as at *Silver Islet*) "but it is coloured amethyst, and cavities near the surface are filled with black oxide of manganese..... Quartz is the second mineral in importance in the gangue" (B). He also says in a later publication that some of the vugs, as at *Silver Islet*, "contained hydrocarbon gas under great pressure" (G). Gas.

The accompanying cross-section (Plate VI, fig. 1) through No 3 shaft, shows the enclosing rocks of the vein at that point as worked out by Mr. Courtis from knowledge gained in the opening up of the mine, and from careful records kept by himself of the numerous diamond drill holes bored. The dislocation produced by the vein is very apparent. The trap sheet "A" shown overlies the rocks for an area of several square miles to the south. Owing to the trend of the vein bringing it nearer to the trap bluff in passing westward, and to the fact that the strata have a south-westerly dip—the trap forms the south wall of the vein almost down to the first level at No. 2 shaft, and to the half level at the west winze, being at these places opposed to the black slate of the north wall, the line of contact sloping upwards on the south side to the surface at No. 3 shaft as shown in the cross-section. Enclosing rocks

The rocks marked L, H & K in the figure may be said generally to belong to the Archean, as distinguished from the horizontal Animikie rocks lying on them, but whether they can be properly considered as the equivalent of the rocks which have been called Huronian in that district, and found to be gold-bearing, it is not possible to decide from an inspection of the eight specimens of drill cores kindly lent me by Mr. Courtis, for whilst one of the cores has all the appearance of coming from one of the green mottled dioritic beds which are very typical of the gold-bearing formation of the district, yet the rest of the cores seem to be more related to the gneissic rocks of the Laurentian. Mr. Sargent, who was in charge after Mr. Courtis, in writing to the latter gentleman seems to have noticed a great difference in these Archean rocks on either side of the vein, for in speaking of the drill cores got in boring north and south from the vein, he says, "The rocks on the south are unmistakeable diorite, whilst on the north they are felsite, hornblende and (syenite ?)"

The Animikie rocks in the section would seem to have all the characteristics of the lower beds of this series as exposed elsewhere in the district, viz., a great preponderance of dolomitic and cherty rocks with

Fig. 2.

HORIZONTAL PROJECTION

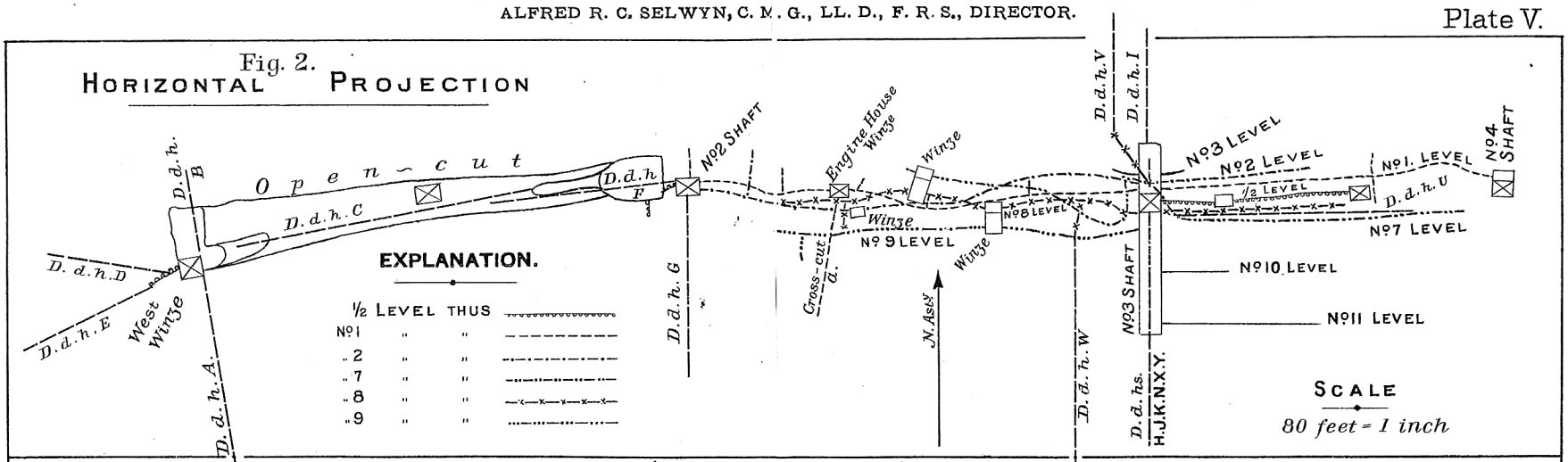
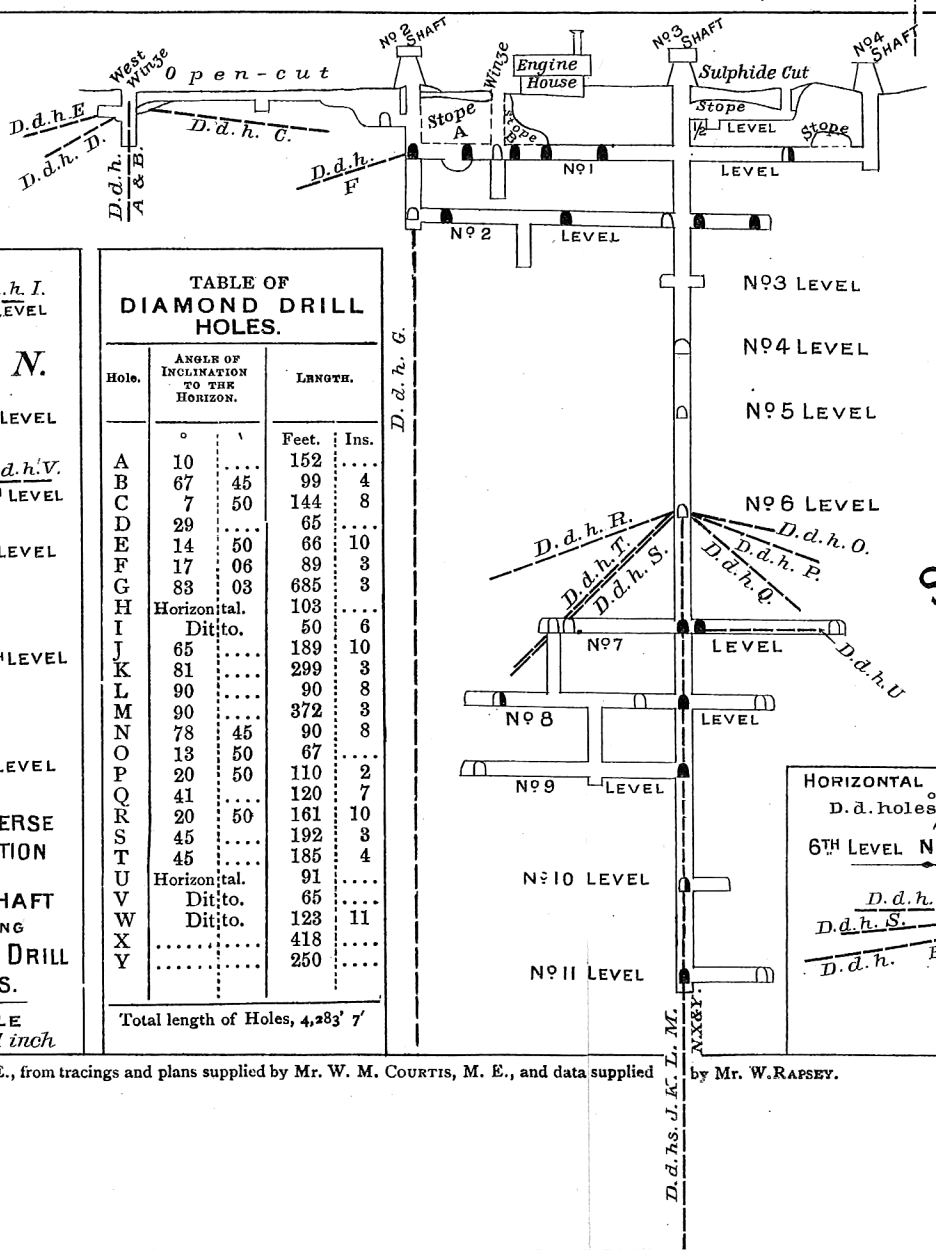


Fig. 1.

VERTICAL PROJECTION



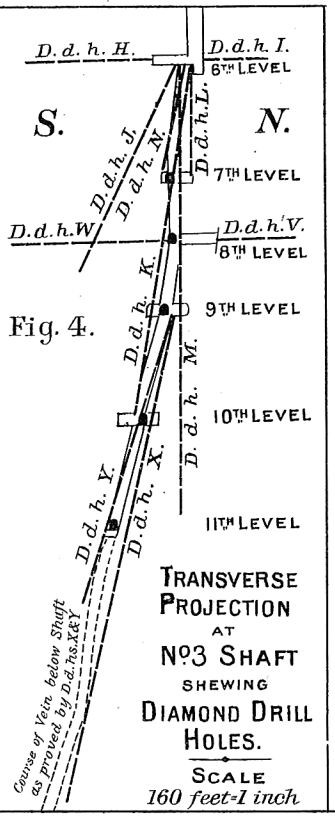
SCALE
160 feet = 1 inch

EXPLANATION.

Cross-cuts to North
Ditto " South
Diamond Drill Holes } = D.d.h.

SHUNIAH OR DUNCAN MINE

Fig. 4.



TRANSVERSE PROJECTION AT No 3 SHAFT SHEWING DIAMOND DRILL HOLES.

SCALE
160 feet=1 inch

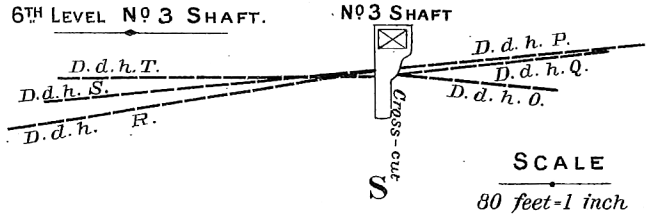
TABLE OF DIAMOND DRILL HOLES.

Hole.	Angle of Inclination to the Horizon.		Length.	
	°	′	Feet.	Ins.
A	10	....	152	....
B	67	45	99	4
C	7	50	144	8
D	29	....	65	....
E	14	50	66	10
F	17	06	89	3
G	83	03	685	3
H	Horizontal.		103	....
I	Ditto.		50	6
J	65	....	189	10
K	81	....	299	3
L	90	....	90	8
M	90	....	372	3
N	78	45	90	8
O	13	50	67	....
P	20	50	110	2
Q	41	....	120	7
R	20	50	161	10
S	45	....	192	3
T	45	....	185	4
U	Horizontal.		91	....
V	Ditto.		65	....
W	Ditto.		123	11
X	.....	....	418	....
Y	.....	....	250	....

Total length of Holes, 4,283′ 7″

Fig. 3.

HORIZONTAL PROJECTION OF D.d. holes O.P.Q.R.S.T. AT 6th Level No 3 Shaft.



SCALE
80 feet=1 inch

Compiled by E. D. Ingall, M. E., from tracings and plans supplied by Mr. W. M. Courtis, M. E., and data supplied by Mr. W. Rapsey.

Desbarats, Lith.

Port Arthur group of veins —continued.

silicified argillite and small occasional developments of the soft carbonaceous black argillites. Mr. Courtis says, "The silver seems to give out as soon as the leaders enter the dolomite." (B.)

As the cross-section given in Plate VI, fig. 1, would be incomplete without fuller descriptions of the rocks, I quote those given in Mr. Courtis' paper from which the illustration has been copied. (Transactions American Institute Mining Engineers. vol. XV, page 671).

"The microscopic determinations, made by Mr. John Caswell, of slides I had cut from some of the cores, are given below; but I should preface them with the remark that Mr. Caswell wrote me he had had very little time, and felt a great lack of confidence in describing these specimens, as the rocks were new to him. He added the names simply as suggestions, needing confirmation after more extended study."

Descriptions of the different rocks enclosing the vein are then given as follows:—

"A, on the section, is probably an olivine gabbro of Dr. Irving, but has been called diorite: sp. gr., 3.033; proportion insoluble in acid, 83.4 per cent.; silica, 54.2 per cent.; proportion attracted by magnet, 2.8 per cent.

"B, a black slate, containing less carbon than E: sp. gr., 2.640; proportion insoluble in acid, 91.5 per cent.; silica, 74 per cent.

"C, may be said to be a dolomite with chert, and G, a chert with dolomite and pyrite.

"D, is a dark-green slate, with masses of chert, red above and gray at the base of this formation. It very easily fuses to a black glass which is magnetic. Different specimens gave the following results:—

Sp. Gr.	Insol.	Silica.	
2.528	33.9 per cent.	31.5 per cent.	
2.776	61.2 "	48.3 "	
2.654	84.4 "	84.0 "	(chert).
3.225	19.0 "	17.7 "	18.9 per cent. loss on ignition.

"E, is a soft, carbonaceous black slate, with shining particles, and apparently obliterated fossil stems. Sp. gr. 2.531; insoluble, 83.9 per cent.; silica, 54.2 per cent.

"F, was composed of three bands:

1. Calcareous band (green) containing much iron. Sp. gr., 2.765; insoluble, 43.4 per cent.; silica, 34.7 per cent.
2. Arenaceous band (green), in flinty black slate. Sp. gr., 2.488; insoluble, 78.8 per cent.; silica, 53.6 per cent.
3. Jasperized slate. Sp. gr., 2.627; insoluble, 92.6 per cent.; silica, 85.7 per cent.

"G is chert mostly, with some dolomite.

Plate VI.

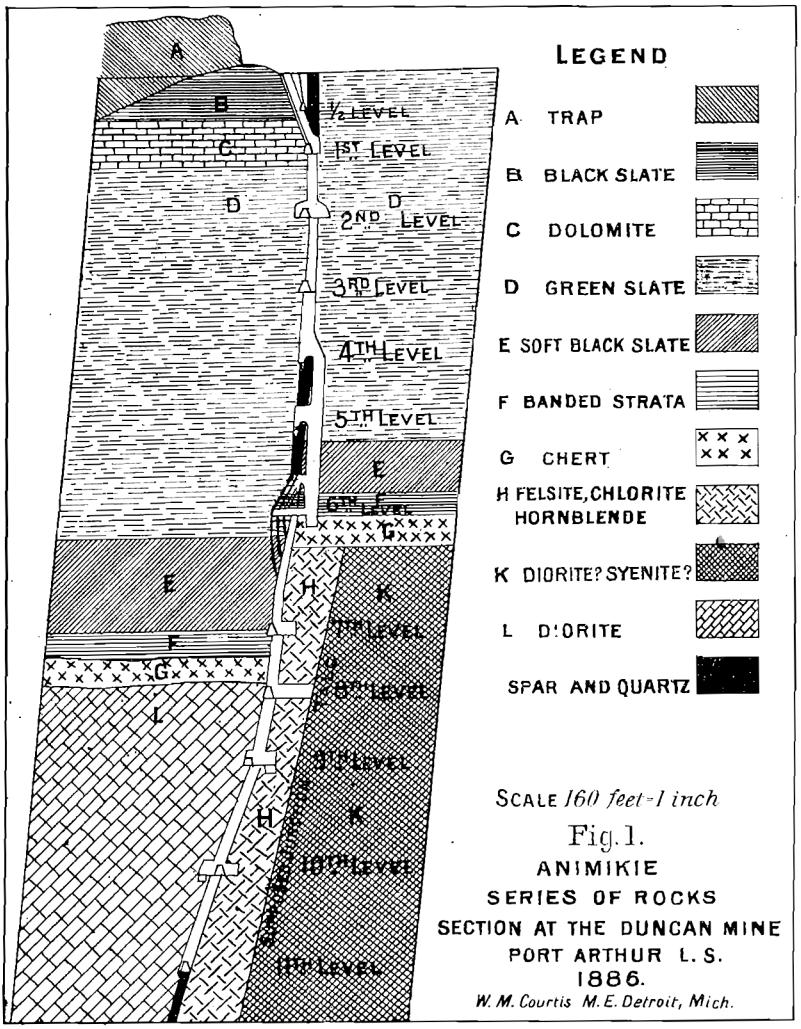


Fig. 1.

ANIMIKIE SERIES OF ROCKS SECTION AT THE DUNCAN MINE PORT ARTHUR L. S. 1886.

W. M. Courtis M. E. Detroit, Mich.

From a paper by Mr. W. M. COURTIS, vol. xv, Trans. American Inst., Mining Engineers.

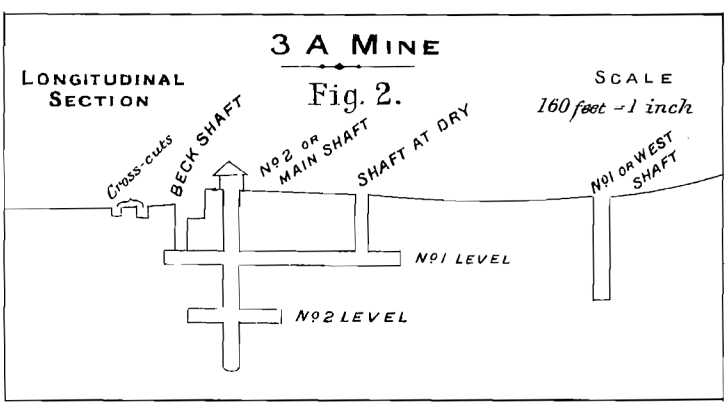


Fig. 2.

From a drawing given in Mr. P. MCKELLAR'S Pamphlet on "Mining on the North Shore L. Superior," 1874.

Port Arthur group of veins—continued.

"This band is so tough, that a party of excellent Cornish miners made, on contract, but five feet per month for two months in sinking an inclined shaft. On one seam, the diamond drill worked for eight hours, using up a bit, and took out but six inches of core, drilling about one foot in that time.

"Mr. Caswell describes a section of the quartz thus: 'Fine-grained, with some faint, skeleton-like crystals of augite scattered through it. Their character could not be determined exactly.'

"'Dolomite, dark-colored, effervescing in warm acid, with remains of fibrous diallage or hornblende, partly altered to serpentine mass. Quartz grains are scattered through it.'

"The vein seems to have been shattered at this point to thousands of stringers spreading through thirty to forty feet. Above, the vein was six to eight feet of solid gangue; below, as far as sunk on it, the foot-wall seemed perfect, to which these stringers were coming in from the south. These stringers carried in this belt much galena and zinc-blende, but not give above nine ounces in silver for highest assay.

Sp. gr.	Insol.	Silica.
2.713	32.8	32.8 Olive-green dolomite.
3.023	69.8	69.8
2.738	55.0	55.0

"H. seems to be a belt of much broken-up rock, parts of it much altered, probably from the effect of the vein. Sometimes the drill would be in a solid red felsite, then in solid hornblende, then in talcose or chloritic seams, or the rock would take the form of a diorite for some feet, and then go back into solid hornblende.

Sp. gr.	Insol.	Silica.	
2.962 per cent.	32.8 per cent.	29.5 per cent.	Hornblende.
2.830 "	59.1 "	46.5 "	Mixed.
2.624 "	93.4 "	71.0 "	Felsite.

"As we entered the body of solid rock marked K, the drill-hole, being vertical, passed farther away from the vein, the rock became fine-grained, and increased in silica, mica replacing the hornblende to some extent. Sometimes there would be pretty large crystals of orthoclase. In certain parts, without any sign of vein-stringers, there would be amygdules of calcspar, various specimens of core giving up from 6 to 25.5 per cent. in acetic acid. The most calcareous had a specific gravity of 2.703; insol., 55.6 per cent.; silica, 42 per cent.; loss on ignition, 5.3 per cent.; in acetic acid, 25.5 per cent. Nothing was taken up with the magnet, but there was more or less pyrite in the mass.

Port Arthur group of veins —continued.

"K, is described from Mr. Caswell's sections, except the part carrying the most mica :—

Sp. gr.	Insol.	Silica.	Appearance.
2.737	89.1	64.0	Syenitic.
2.651	84.6	70.5	Syenitic, Granitic.
2.655	86.0	78.0	Porphyritic.
2.773	70.8	56.5	Dioritic.
2.980	83.2	44.9	Hornblendic.

"The core at 650 feet from the surface showed :—

1. Plagioclase, much altered and very dusty, but with banding still visible.
2. Quartz, in pellucid masses and grains, with some large and many small fluid inclusions with moving bubbles. The fluid cavities in the quartz are very pretty.
3. Hornblende, much altered, with greenish veins running through it; pale green color, and only slightly polarizing.
4. Apatite. The rock is much altered, and is probably of the same family as at 800 feet and 809 feet (diorite ?).

"Core at 800 feet from surface (diorite ? hornblende schist ?) :—

1. Hornblende, in green crystals, showing cleavage-lines of 124° and dichroism very distinctly. In some places altering slowly to brown biotite.
2. Orthoclase, cloudy and irregular in color, showing cleavage-lines. It may be plagioclase, a point which can only be decided by angle of absorption.
3. Quartz, pellucid grains, abundant between hornblende crystals.
4. Apatite, abundant in colorless crystals.
5. Plagioclase, faintly banded between crossed nicols.

"Core at 809 feet (diorite ?) :—

1. Plagioclase, much decomposed, but distinctly banded.
2. Orthoclase, some cloudy crystals.
3. Hornblende, the same as at 800 feet, but more altered.
4. Apatite, in colorless needles, and some large white crystals.

"L, wherever penetrated, seemed to be a typical diorite—was at least so called by every one seeing it, though it has not been yet determined microscopically. Specific gravity, 2.869; insol., 69.8 per cent.; silica, 5.7 per cent.

"I am indebted to Mr. Caswell for the determination of the slides, as a friendly matter for my private information.

"The rocks marked H and K crop out about 14 miles to the north of

the mine, and have been called metamorphic Huronian by geologists describing this section. They present the same appearance as the cores, a brecciated, wavy mixture of hornblendic, felsitic and granular patches." (G.)

Port Arthur group of veins —continued.

The silver in the vein was, as shown, all found above the first level, where the upper bed of black argillite formed one wall of the vein. And Mr. Courtis, writing me, says the best ore in the mine was obtained from near the engine-house winze, near the letter "A" in stope "A" (See Plate V., fig. 1). He says:—"In sinking this winze, which was at the junction of a spur going south-east from the main vein, we took out $3,500 in rich specimens, and supposed it denoted a large body, but the stope extended but a few feet each side and ran into poor ground, whereas we expected a block of rich ground from No. 2 shaft to the Sulphide Cut." He goes on to say that at this point there were stringers running parallel to the vein in the south wall, and that "the main vein was barren. The stringers carried more or less silver, which made in bunches of ore worth $1 a pound. From "A" (See Plate V., fig. 1) "we took out about $1,500 in one blast; two inches above it, trap made the walls and *horses* in the vein, and no more silver was found. The stringers pinched out both east and west."

Occurrence of ore bodies.

The history of this mine, as gleaned from Mr. Peter McKellar's statements, seems to have been somewhat as follows:—

History of mine and work done.

The vein was discovered in 1867. During the summer of that year and the following winter, trenching was done on the back of the lode at several places, and two shafts were sunk, one to a depth of thirty or forty feet and the other to a depth of sixty feet from the surface. From the bottom of the latter a cross-cut was driven across the lode. At first, silver was got in small bunches in the form of leaves and fine strings penetrating quartz, spar, blende and galena, in a streak of those minerals running along within two feet of the south wall. In sinking, it was lost at a depth of about eighteen feet, but found again in the middle of the vein in the cross-cut at the sixty feet level. Several barrels of ore were taken out, reported to have run from $200 to $300 per ton. The mine was then closed, owing to a disagreement between the owners and to want of funds, which led to a chancery suit, so that altogether, including expenditure thus incurred, some $25,000 to $35,000 were spent.

The mine was opened again in 1870, when it was bought for some $75,000. The main shaft was sunk to a depth of 135 feet, drifts were driven on the lode at the first and second levels, and cross-cuts at several places. One of these latter was driven south for 100 feet, in

Port Arthur group of veins —continued.

expectation of cutting another lode. A good many thousand dollars were spent in further tracing the vein on the surface, and they then began to follow up the silver in the drifts, and a few days after, orders were given to shut down, so the mine was again closed in the middle of the summer of 1873. The results of this work were that they failed to find any lode in the cross-cut south. They got silver at several points in the drift, and took out a barrel or two of very rich ore a few days before closing. The vein was found to continue large all the way down, the hanging wall only being seen in the cross-cuts.

In November, 1873, it was again started under the name of the *Duncan Mine*, having formerly been called the *Shuniah*. There were several reports of silver having been struck at various places, but Mr. Courtis says:—"All the reports that the *Duncan* had struck silver below seventy feet were false.....In January, 1877, however, plumbago was struck at a depth of 315 feet." (B.) He further says:—"The richest ore has assayed, in bulk, 2,020 ounces, the poorest concentrations seventy-three ounces, and as about sixty tons of rock are concentrated into one, the original stamp rock is often pretty poor. In some parts, especially near the surface, the stamp rock has assayed six to eight ounces, taking out the whole rock for six to twelve feet wide. These rich places also give some hundreds of pounds of very rich ore.....The very rich argentiferous zinc blende is found only at the surface. Although large quantities of zinc blende are found below seventy feet, it contains only a trace of silver." (B.)

Occurrence of ore.

Prof. Chapman, in speaking of this surface blende in the beforementioned report, says:—"The yellow blende holds in most samples a small amount of silver. Some fragments of this blende gave me also in one assay a trace of gold corresponding to about two pennyweights in the ton."

Developments in lower part of mine and results.

Regarding the developments in the lower part of the mine, it would seem that after sinking into the Archæan, no silver was found to any extent, although the vein still carried the other metallic minerals, which, whilst nearly always free from silver, or very poor in it, occasionally assayed high. The vein was much smaller and less solid than at the surface, with numerous branches coming in on the hanging wall, whilst quartz replaced the spar gangue found above, the spar being only found in a few stringers and filling vugs. In boring the diamond drill hole "U," sludge assays were got, giving from $110 to $2,500; and Mr. Sargent, speaking of this point in writing to Mr. Courtis, says:—"A diamond drill hole was bored from the shaft east, ninety-one feet, and meeting with good sludge assays for quite a distance, and one small speck of native silver being found, a drift was

run in that direction, but was discontinued at ninety feet, as the vein had pinched to a thread, and only a few specks of silver had been found in a small seam in talcose slates on the south. Some little native silver was found in the shaft from twenty feet above the level to fifteen feet below; in every instance as a thin coating on the felsite breccia, and not in the quartz. The vein was pretty well filled with felsite horses." Port Arthur group of veins—continued.

The mine closed finally in the fall of 1881, having been worked almost continually since its discovery in 1867, although with very varying vigor, the force varying from two men to one hundred. Mine closed.

Besides other surface work a mill of ten head of stamps with four Frue vanners was built at the mine, and operated for a couple of months. Mill.

According to Mr. Courtis, the total product of the mine amounted to about $20,000 worth of ore, whilst the total outlay, including cost of property amounted to about $500,000. Expenditure and returns.

Besides those shown in the illustration, Plate V, I find there were other drill holes bored, viz.: Horizontally, N. and S. from the 11th level; one W. from the end of the 9th level, and one near No. 2 shaft, the latter to seek for silver in the lode between the 6th and 7th levels, amounting in all to about 600 feet, which added to those shown on Plate V, makes a total length of holes bored of about 4,884 feet. Diamond Drill Holes.

Dr. Selwyn in visiting the mine in August, 1872, found development work in progress on the vein on the adjacent property to the west of the west winze. This consisted of three test pits, respectively fifteen, thirty-four and twenty feet deep, placed equi-distant, and testing a length of vein of some 600 feet beyond the west winze.

The Beck, or Silver Harbour Mine.

This mine has been opened on a vein running E. N. E., and dipping at a high angle to the N. W. It has a brecciated character and is about five feet thick. The gangue consists mostly of white granular quartz, but barite, calcite, fluor and amethyst are also present with much iron pyrites, galena and blende. The silver occurs mostly as argentite, but also in the native state. The country rock is here much the same as at the *Thunder Bay Mine*, and consists of smoke colored cherts and dark argillaceous shales, running nearly horizontally under what appears to be a bed of coarsely crystalline trap. The junction of the Animikie and the Huronian lies about half a mile to the north of the mine. Vein Characteristics. Enclosing rocks.

This vein was discovered in the summer of 1870, and during the winter of 1870–1, a force of about fifteen men worked on it, who did History and results.

Port Arthur group of veins —continued.

some surface exploration, built three or four houses and sank a forty foot shaft. Work on the shaft was then suspended and developments made on the vein in the surface bed. In the winter of 1871-2, a new manager took charge who continued the workings in the surface bed. A number of good buildings were erected and a dock built, at which the largest steamers could lie. Work was stopped in the fall of 1872.

Ore obtained.

"The vein showed a considerable quantity of silver in the upper siliceous and dolomitic bed, but towards the bottom of the shaft in the argillaceous beds it was irregular and poor" (F). Mr. Courtis states that 125 barrels of ore were shipped, reported to be worth $300 per barrel, but proved only to assay $17 to the ton (B). Mr. McKellar who saw this ore in the barrels before it was shipped, accounts for its low yield thus: "No wonder by the way it was assorted.....the greater part of it was very poor, although some was good." (F.)

The company working this property paid $10,000 in cash for it and guaranteed to spend $100,000 in developments.

It has not been found possible to obtain any plans, etc., of the underground workings of this mine, and as it was found impossible to personally visit it, the above description has been necessarily compiled from the writings and statements of others, chiefly from those of Mr. Peter McKellar in his paper on Mining on the North Shore of Lake Superior.

Algoma Mine (*Macgregor Township*).

This must not be confounded with the mine of the same name in the township of Neebing.

According to Dr. Selwyn, who visited this place in August, 1872. this vein strikes about E. N. E. He makes the following remarks on the phenomena there observable. It is "half a mile east of Silver Harbour, and similarly situated at the base of a diorite bluff, fifty to sixty feet high. Here they have sunk through about thirty feet of soil or clay before striking the rock which is the usual cherty banded shale traversed by a brecciated vein of quartz, calc-spar and rock fragments, holding galena and pyrites in nests and small aggregations of crystals. The shaft is at present only twenty feet deep. Captain Talon stated that in another shaft sunk on the run of the vein to the eastward, they had driven towards the diorite bluff and struck it, cutting the flat shales like a wall, but that there was no indication of a vein at the junction. This would show that many of these diorite bluffs are dykes and not interposed beds."

Lambert Island.

This island consists of trap and on it some $500 were expended in 1884, in testing a vein of rose colored quartz with fluor spar. The vein strikes about N. W., and is from eighteen inches to three feet thick. A shaft was sunk on it, but did not penetrate the trap to the argillites supposed by the owners to underlie it. Port Arthur group of veins continued.

Cariboo Island.

Some surface exploration has been done on veins in the Animikie rocks here, but with little or no result.

Blende Lake.

Two or three test shafts have been sunk on a vein carrying argentiferous galena, said to run $14 to the ton in silver. It cuts the Animikie rocks of the vicinity.

Singleton Mine.

This is the name given to a small opening made on a vein of granular white quartz about one foot thick, from which some rich bunches of native silver were obtained. It is situated within the town limits of Port Arthur in the Animikie rocks of that locality.

Walbridge Mine.

This is in the north-west corner of the township of Neebing, and according to Mr. Peter McKellar's descriptions, it would seem that the vein worked here ran nearly E. and W. and dipped at a high angle to the south. It has a width of some twenty-four feet and is well defined. It carries galena, blende, copper and iron pyrites in bunches, stringers and disseminated in grains through a gangue of calcite and quartz. The *country* consists of the siliceous and argillaceous beds constituting the lower division of the Animikie rocks of the district. In 1863, the property was bought for $1,200 or $1,400 from the original owners, by Detroit capitalists, who kept a party of six to seven men at work on it during the summer and following winter. Some trenching was done on the back of the lode at various places, and a forty foot shaft was sunk on the copper-bearing part of the lode. The miners said there was a two to three inch streak of ore in the bottom of the shaft, and the vein increased in richness in depth. They also got some good shows of galena in some of the open cuts on surface and traced the vein for a considerable distance. The developments were made with a view to selling the mine, but not having been successful in this, no more work was done (F).

Port Arthur group of veins continued.

Dr. Bell, in his report on this district made in 1870, also describes the following veins as occurring in this vicinity:—

Algoma Mine.

This is on the adjacent lot to the last. "Three veins, one of them thirty-one feet in width, and holding galena, occur here." There is an outcrop of a highly ferruginous sandstone, giving on analysis about 37 per cent. of metallic iron.

Paresseux Rapids.

A ten to twenty-five feet vein shows here, crossing the river in an E. N. E. direction. In a gangue of barite, calcite, quartz and fluorite, it carries a little galena, blende, copper and iron pyrites.

Lots 4 and 5 Paipoonge.

On the north bank of the Kaministiquia river, a vein three to four feet thick occurs running north eastward. It contains a little copper pyrites, iron pyrites and galena in a gangue of barite, quartz, calcite and fluorite.

Mining Lot M. (McIntyre Township).

On this lot is a large barren vein, having a total width of forty feet, coursing N. 50° E. and dipping to the S. E. at 80° from the horizon. It has a coarsely brecciated character, much of it consisting of a network of small veins of quartz with a little calcite. It cuts the arenaceous beds, and dark slates all weathering to a dark iron black.

Mining Lot C. (McIntyre Township).

A vein carrying copper pyrites cuts the same ferruginous sandstones mentioned as occurring at the *Algoma Mine.*

DIVISION II.

Silver veins in Archean rocks.

The members of this group are still silver-bearing, but occur as said in the rocks of the Archean age, and from the data obtainable, apparently in that sub-division known as the Huronian system.

The three A. Mine.

Vein characteristics.

This vein strikes N. 75° E, and dips slightly away from the vertical. It has a thickness of from eighteen inches to two and a half feet. The gangue is mostly quartz with a little calcite, "through which are

irregularly distributed the ores of iron, copper, lead, zinc, nickel and silver, with some cobalt and gold as shown by the assays. The silver is found native and combined with sulphur and nickel, thickly penetrating the vein stone in small and large patches, in some of which it is very heavy" (F.) The ore is stated to have been as rich as much of that at Silver Islet. One sample of the ore is said to have assayed 1.4 per cent. of cobalt, and 25 per cent. of nickel. Port Arthur group of veins continued.

The enclosing Huronian rocks here consist of grey dolomitic schists, associated with dark green compact diorite, whilst dark greyish red, felsitic syenite occurs a short distance to the south. The dip of the strata is nearly vertical. Enclosing rocks.

The discovery of this vein was made in the winter of 1869 and 1870. A considerable amount of work was done on it. The accompanying sketch plan and section of the mine up to March, 1874, taken from Mr. McKellar's paper on Mining on the North Shore of Lake Superior shows the underground work. (See Plate VI, fig. 2). On surface the vein has been traced over half a mile. During the winter of 1871-2 two miners worked on the lode and took out twenty-two barrels of ore. Towards the fall of 1872, the sinking of the shaft was begun and the work of development carried on for some time. The silver seems to have lasted down but to have been pocketty. I have been unable to ascertain when operations were discontinued, but Mr. Courtis, writing in February, 1877, speaks of the mine as closed, He also says that the value of the ore obtained was probably about $2,000. Work done and results.

Near three A.

Mr. Courtis mentions the discovery of a two feet vein of milky quartz in the vicinity of the last mentioned mine, carrying native bismuth and yielding on assay a little silver. It was traced for some distance, and a few shallow pits were put down on it. (B.) Bismuth.

Cornish Mine.

Active operations were commenced on veins at this place in the spring of 1873, and continued for about a year, but apparently without any satisfactory result. The veins strike about east and west, and are said to be in the Huronian, and to carry much blende, galena and iron pyrites.

Emmons' Mine.

This mine is situated on Lot A in the township of McIntyre on the Dawson road, about five miles from Port Arthur. Dr. Selwyn, who visited it in 1872, describes it thus: "The 'mine' consists of one pit

The Port Arthur group of veins concluded.

twenty feet deep, full of water, sunk on a thick vein of white calc-spar mixed with quartz, often showing amethystine colours, and both traversed by thin strings and cubic crystals of galena, also spots of mispickel and iron sulphurets, and more rarely, copper pyrites. The rock is a hard, white-weathering silico-felspathic gneiss, sometimes epidotic and dioritic, probably Huronian.

Dawson Mine.

The same authority also mentions the occurrence of a vein at this point on a property known as R 2, about three and a half miles up the Dawson road from Port Arthur. It strikes about E. N. E. and, is in hard cherty silico-felspathic rocks, probably near the junction of the Huronian and Animikie rocks.

RABBIT MOUNTAIN GROUP.

The Rabbit Mountain group of veins.

Mr. Oliver Daunais, a trapper and explorer, besides his many other discoveries, located the first vein in this district at the spot where the *Rabbit Mountain Mine* now is, having had it pointed out to him by an old Indian. The great richness of the ore found there caused the revival of interest in the Silver Mining of Thunder Bay, and the commencement of the present era of activity, the inauguration of which has been largely due to the hopeful and energetic initiative of Mr. T. A. Keefer, of Port Arthur.

Conditions of occurrence.

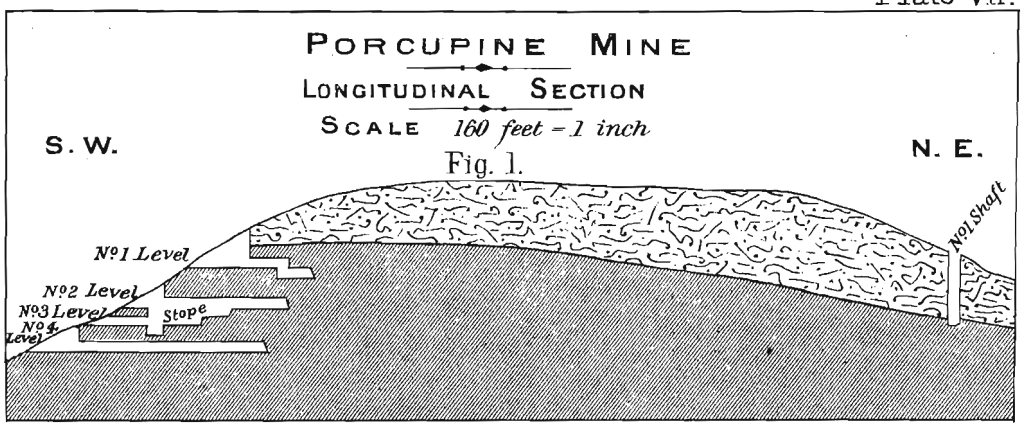
The conditions of occurrence of this group are somewhat different to these of the others situated on this line of discoveries in being further removed from the northern boundary of the formation, and from the outcrop of the lower siliceous division. They are all in the upper argillaceous division with its associated trap sheets, the argillites here being soft and black, and showing little or none of that silicification and mergence at places into the cherty rocks which characterises these beds at some other places. In a preliminary examination of the rocks of the vicinity, no developments of chert were found even in the lower levels. These rocks show, however, at the *Victoria Mine* at a point about three miles north-east from the *Beaver Mine*, alongside the road from that place to Murillo, at a level of about 350 feet below the adit of the latter mine so that the downward extension of the argillaceous beds in this district must be considerable.

Rabbit Mountain Mine.

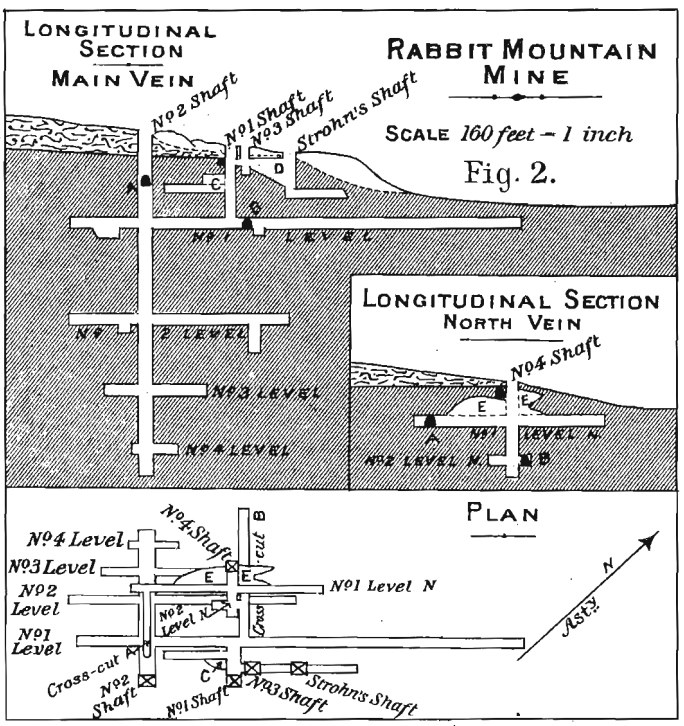
Vein characteristics.

This vein strikes N. 35°-45° E., and dips at an angle of about 65° to 70° to the N. W. The vein is a composite one, consisting of a number of branches and stringers interlaced, and is about four to six feet in thickness, although much wider in places. The ore

Plate VII.



From Sketch survey made by E. D. INGALL, M. E.



From plans and data supplied by Mr. W. C. McCOMBER.

EXPLANATION.

TRAP. ARGILLITE. CROSS-CUTS.

consists of native silver and argentite, accompanied in considerable quantity by blende with a little iron pyrites and galena, and occasionally copper pyrites in a gangue composed of quartz, calcite and green and purple fluorite. The accompanying plan and section will show the amount of work done to test the vein. (See Plate VII, fig. 2). A good show of rich ore was obtained on surface and caused great excitement in the district. On surface, the vein has been proved for a length of some 800 feet to the south-west, by two trenches and cross-cuts into the side of the ridge along which the vein runs. It is thus exposed at two places, one of which is 500 and the other 800 feet from the main shaft. At the first point the vein shows four feet thick, but the cut was not through the vein. No mineral was visible there. In the second cut a similar quartz vein showed, but it carries a little galena, calcite and green and amethystine fluorite. The vein was in the trap at this place. The Rabbit Mountain group of veins continued.

As will be seen by a reference to the illustration, the lithological environment of the vein is similar to that of many of those already mentioned, and the developments have been made, as at those places, following the vein downwards through the trap sheet, which it intersects at the surface, into the dark colored, soft argillites below. On either side of the valley, in the bottom of which the vein has been worked, are high bluffs, showing horizontal argillites, capped again by the usual vertically columnar sheet of trap from 80 to 100 feet thick, whose contact with the supporting argillites is, on the south side of the valley, about 150 feet above the mouth of No. 2 shaft. Whether the lower trap sheet at the mine represents a portion of the upper one, brought down into its present position by faults, it is impossible to say without a much more detailed study of the ground than time allowed to be made, but it seems more likely that the trap at the mine is a separate sheet occurring lower in the formation. Enclosing rocks.

South-west of the mine a small dyke of compact basic trap is seen to cut the argillites in the before mentioned cliff and runs up into the capping sheet of trap. It strikes about N. W., or in such a direction as to cross the vein a little to the east of No. 2 shaft, and Capt. McComber states that they crossed it in the underground workings. It is only a small dyke and can be seen cutting the lower trap sheet near the shaft, whilst above in the cliff it has apparently faulted the strata, the bottom of the capping trap being 13 feet lower on the west than on the east side of the dyke. This would seem to show that the dyke is younger than either of the sheets of trap, although it cannot be very plainly seen on the ground that it cuts the upper one whilst beyond the fact that the dyke rock may be a little more compact than Trap Dyke.

Rabbit Mountain group of veins continued

the upper part of the capping sheet, no mineralogical or structural difference between the two is discernible by the eye, and they both appear to be compact basic traps. The argillite immediately below the upper capping trap appears to be somewhat indurated, and is paler in color than the argillites of the vicinity.

Parallel veins.

A parallel and similar vein to the last mentioned crops out about 100 feet north-west of the main vein, and dipping at a flat angle to the south-east would join the main vein a little below the No. 2 level. (See Plate VII, fig. 2, north vein.)

About 300 yards N. N. E. from No. 2 shaft and a little way beyond the mill, a vein is seen to outcrop in the base of the hill, forming the north side of the valley. It is similar in nature to the main vein, and about four feet thick, and appears to be parallel with it, both in strike and dip, and a blast put into the outcrop at this point whilst I was there showed some very good ore. The vein in this exposure has argillite for its southern or foot wall, which is opposed to the trap forming its hanging wall, which latter has either been faulted down by the vein from a higher position or is a dyke. In ascending the bluff rising to the north of this vein, the argillites are seen to occur above this again, whilst capping the whole, comes the columnar trap, which is apparently the equivalent of that on the other side of the valley.

Developments.

Figure 2, Plate VII, shows the underground work done upon the vein up to the end of May, 1887. As shown, most of the ore taken out up to that date had come from depths of 100 feet below surface and under, where shown *stoped* out at "C," "D," and "E" in the figure, but good ore has been struck in other parts of the mine below this from time to time, and I myself saw some rich ore in No. 2 shaft at No. 2 level.

Stamp mill.

A stamp mill with a capacity of fifteen tons per diem has been erected near the mine for the treatment of the low grade ore which is left after selecting out that which is rich enough to be barrelled up and sent direct to the smelters. Here the battery slimes are run over Frue vanners, and the concentrates thus taken out are sent to the smelters. Capt. McComber, who was the manager in 1886, claimed that these concentrates ran as high as $4,000 to the ton, and averaged $1,500. The slimes which pass over from the vanners are settled in tanks, and then amalgamated in pans. These slimes are said to average about 8 ounces of silver to the ton. The amalgam thus obtained is retorted in the usual manner to separate the mercury and the silver, and the latter is cast into bricks at the mine. Capt. McComber also stated that the milling ore was averaging $80 to the ton, whilst the tailings from the mill only show a content of about 1.5 oz. per

E. D. INGALL, PHOTO., 1886. IVES-PROCESS ; G. E. DESBARATS & SON, MONTREAL.

RABBIT MOUNTAIN SILVER MINE.
LOOKING EAST.

The bluffs on either side consist of columnar trap, (diabase) capping the argillites in which the intervening valley has been eroded.

ton. The mill, however, proved to have been placed in rather an unfortunate position, as it had frequently to be stopped on account of scarcity of water supply. Rabbit Mountain group of veins continued

Since its discovery in 1882, the work of testing this vein has been proceeded with in a very spasmodic manner, having changed hands several times and been worked with forces varying from two to sixty men. It stopped work recently on the 16th December, 1887. The accompanying view of this mine shows the bluffs spoken of and the position of the different buildings, etc. On the left hand side in the foreground is the shaft house over No. 2 shaft, with its dumps of ore and rock extending outwards from it, and the engine house showing just over the outer end of the nearest one. Over the top of the shaft house further away towards the north bluff is the mill building. All the rest are dwelling houses, etc. History of mine. View of mine.

Rabbit Mountain Mine, Jr.

This name has been given to the workings on a vein which crops out on the adjacent property to the last mentioned about 400 fteet N.W. from No. 2 shaft. It is about four to five feet thick, striking parallel with the *Rabbit Mountain* vein, and dipping towards it at an angle of about 75°. The vein-stone consists of calcite and white and amethystine quartz, with pale green fluorite, and carries blende, copper and iron pyrites. It outcrops in the same bed of trap which is seen at the *Rabbit Mountain Mine*, but owing to the ground rising about fifty feet from that point, the seventy-five feet shaft sunk on it had not at that time penetrated to the argillites below, which would probably account for the fact that the work done seems to have yielded little silver.

Porcupine Mine.

Here a fair amount of development work has been done on a vein which strikes about N. 65° E., dipping S.E about 75° to 80°, and has a thickness of from two to five feet. Its contents are similar to those usually found. The fluorite is coloured both green and amethystine, and the quartz often assumes the latter colour. A special mineralogical feature of this vein is the occurrence of the carbonate of barium or witherite, a specimen of which was analysed in the laboratory of the Survey by Mr. Hoffmann, who says "So far as I am aware this is the first time that this mineral has been met with in Canada" (See Report of Progress, 1885, page 29 M). The peculiar talcose material which occurs in some of these veins is also present here to a certain extent occurring in con- Vein characteristics. Witherite. Talcose material.

Rabbit Mountain group of veins continued

nection with the ore bodies. It consists of a white or pale green material impregnating the vein stuff, which is quite soft and greasy when first taken out, but afterwards dries and hardens. The bulk of the silver occurs in the form of sulphide in nugget and leaf form, which is accompanied by a small proportion of metallic silver in wire and mossy form.

Enclosing rocks.

The enclosing rocks of the vein are as usual black argillites, capped on top of the hill with a sheet of dark compact diabasic trap. The faulting of these rocks by the vein has not been so great here as in some cases, only amounting to some 16 feet downthrow on the east side as seen in No. 1 shaft, which at the time of my last visit was down 57 feet, the junction of the argillite and trap being met with at 35 feet on the foot wall, and 51 feet on the hanging wall side. As shown in plate VII, fig. 1, nearly all the development works have been made in the vein where it cuts the argillites.

History.

This work was commenced in the spring of 1884, and has since been continued spasmodically with long intervals of inactivity, owing to the intention of the owners having been to simply prove the value of the vein with a view to sale, and not to work it. Mr. T. A. Keefer, one of the owners, states that about $10,000 had been expended on this vein to date, which expenditure had been more than repaid out of the proceeds of the sale of the ore obtained.

Beaver Mine.

Vein characteristics.

Two veins have been worked on in this mine. The main vein cuts in a northwesterly direction across a ridge about 200 feet high having a steep bluff face to the N.W., whilst it is intersected about 300 feet in from the face of the ridge by a cross vein running in a northeasterly

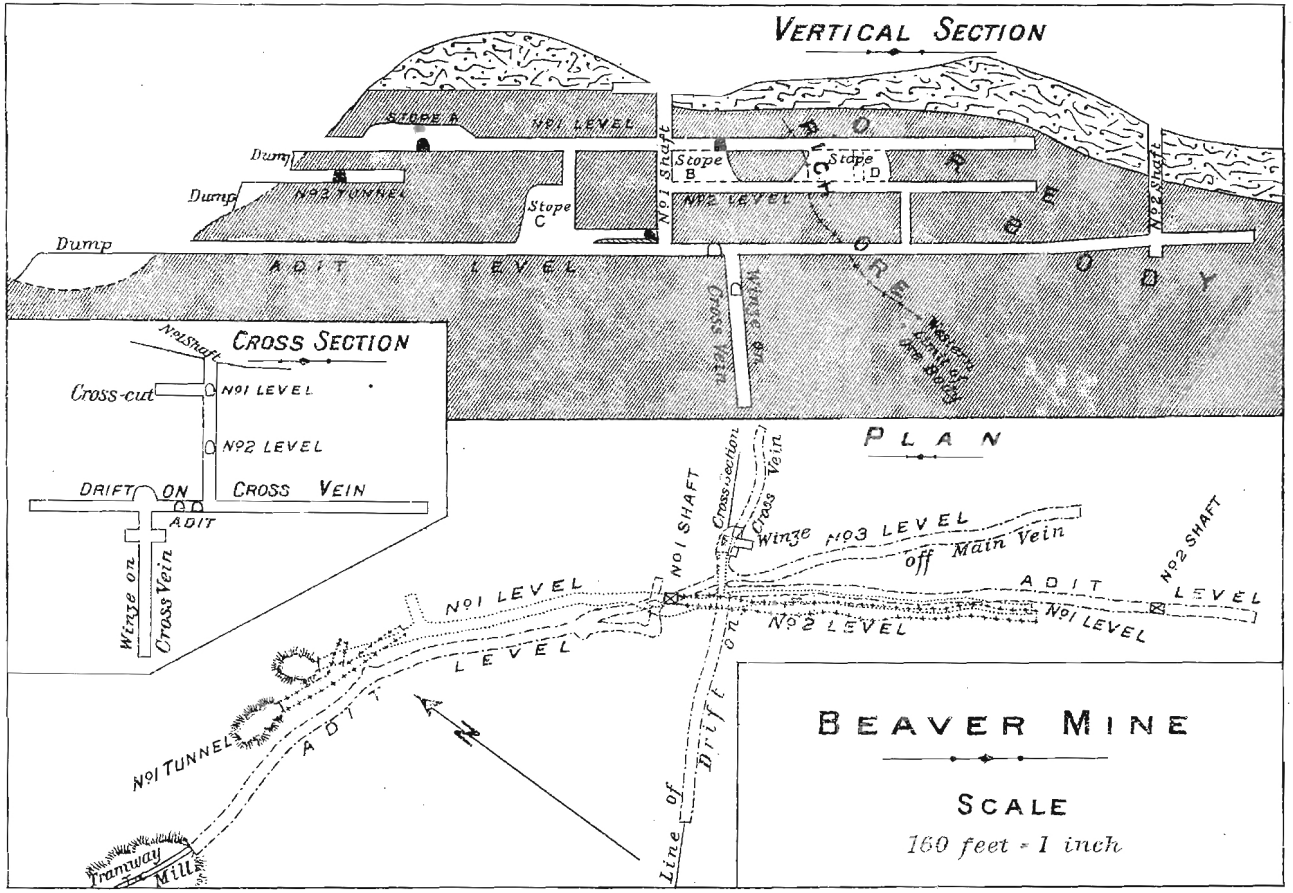
Cross-vein.

direction or parallel to that face. The cross fissure is very irregular and hard to follow, varying from a few inches in width to almost nothing. It was drifted on in No. 1 level for a short distance, and followed also on the adit level below for a distance of about 350 feet, but being very irregular, and only carrying a little mineral here and there, it was not considered profitable to follow it any further. The main vein has an average width of about four feet, although in parts of the mine it has pinched out to a mere thread. The contents are, as usual, yellow and dark coloured blende, with some iron pyrites and a little galena in a gangue consisting for the most part of calcite with some colourless and amethystine quartz, and a little fluorite which is generally green, but occasionally purple. The silver occurs in the ore

Silver ore.

bunches chiefly as argentite, in nugget, sheet and leaf form, with occasionally a little native silver. A marked peculiarity of this vein

Plate VIII



EXPLANATION.

TRAP.

ARGILLITE

CROSS-CUTS.

From measurements made by E. D. INGALL, M. E., Plans supplied by Mr. E. COSTE, M. E., and Section published by the *Thunder Bay Sentinel.*

is the occurrence of the greasy talcose substance which is very abundant in the orey parts of the vein occurring in the fissures and cleavages of the gangue minerals, and surrounding pieces of argillite enclosed in the vein. It is very soft when first taken out, but hardens somewhat on exposure to the air. It occurs as white pearly films and incrustations, and also as pale green matter filling interstitial spaces. Some of this latter kind was examined qualitatively in the laboratory of the Survey, and Mr. Hoffmann says that the examination made showed it to be talcose in its nature, but that properly it was neither talc nor serpentine, as it was found to contain too much water for the latter. It is most likely closely allied to the mineral saponite, a hydrous magnesian silicate mentioned by Dana as occurring in the traps of this region. The ridge spoken of consists of black soft argillites from its base to within about fifty feet of the top from which point the rock is trap of the usual kind. The rocks have been faulted slightly by both veins.

Rabbit Mountain group of veins continued

Talcose material.

Enclosing rocks.

The work done in testing and opening up the vein is best appreciated by a reference to Plate VIII* which shows the developments to the spring of 1887.

Developments.

The history of this mine has been a very instructive example of what difficulties are to be met with in developing the veins of this district, and how they may be overcome by pluck and energy. The vein where first discovered on the brow of the hill, was solid and well defined, and where it passed down into the argillites below the trap, some good ore was obtained. In the drifts in the upper part of the mine it retained its definite characteristics, but in opening up upon it lower down in the adit level, considerable difficulty was experienced in following it, and it was found to be small and irregular, and for long distances was represented by a mere seam until the cross vein was reached and also for some distance on the other side of it. At the time of the last visit made drifts were being driven either way on the cross vein, with a view both to test it and also to cross-cut for the main vein to see if it had been by any chance left on either side in driving the adit level. This indefiniteness at this point seems to have resulted in the drifting of No. 3 level beyond the cross vein off the course of the main vein, as will be seen in the plan. Finding nothing but a small stringer in this direction, surveys were made, a course which should evidently have been adopted long before, and these having shewn what a very wrong direction the drift was taking to strike No. 2 shaft, where the vein showed definite and strong, a fresh start was made from the drift on the cross vein, and the adit level as well as Nos. 1 & 2 levels above, were driven forward to connect with No. 2 shaft, with the result that

History of mine.

* On this plate No. 1 Tunnel in Plan should be No. 2.

Rabbit Mountain group of veins continued

the vein was found to become strong and definite, and the body of very rich ore* was found which has made the prospects of the district look so much brighter. This vein was discovered shortly after that at Rabbit Mountain, and work was commenced on it by the owners to test it in the fall of 1884. This was continued with a small force of men until the sale of the mine to an American capitalist, who proceeded at once to equip it for work on a larger scale, and to open up the vein with most commendable vigour, with the results before mentioned.

Stamp mill.

A mill has been erected about half a mile from the mine, on Silver Creek, to treat the lower grade ore which occurs with the smelting grades. It has a capacity of about thirty tons per diem. The rock, after passing through the rock-breakers and two patent pulverizers,† is carried by the water over four Frue Vanners and a Golden Gate concentrator, whilst the slimes from these pass into settling tanks, the deposits from which pass to the amalgamating plant on the lower floor, which consists of two amalgamating pans and the accompanying settling pans.

Shipments of silver.

Some idea of the richness of the ore body mentioned may be gleaned from the following statements made by *The Algoma Miner and Weekly Herald* of August 27th, 1887, where it is stated that "the total value of the products of the Beaver mine for the past two and a half months in smelting ore and concentrates from the mill is $93,000. This may be relied upon as being authentic." There is every reason to believe this to be correct, as I am informed that the Customs export entries for Port Arthur showed that $190,000 of ore were exported during 1887, the greater part of which certainly came from this mine.

Silver Creek Mine.

Vein characteristics.

This is yet another vein in which silver has been found. It is from two to three feet thick, and strikes about N.E. in practically the same direction as the *Porcupine* vein, and for the slight depth to which it has been followed is about vertical. The preponderating mineral in the vein stuff seems to be calcite, which is accompanied by a little colorless quartz and some green fluorite. The unbroken part of the vein did not present much mineral to the eye, but the ore pile, which contained some eight tons, and had, I understand, come from the bottom of the shaft, where they get all their silver, contained the usual

---

* The value of the ore in sight in this body in the fall of 1887, has been variously estimated at from $1,500,000 to $3,000,000. The most reliable authorities, however, estimate it nearer the lower figure.

† I understand that since the date at which the mill was visited, stamps have been substituted for the patent pulverizers.

metallic minerals, viz., blende, both light and dark coloured, with some pyrites and a little galena, whilst the silver showed in the form of leaf and film argentite. Rabbit Mountain group of veins continued

The vein runs into a little ridge consisting of argillite capped with trap, which rocks have been faulted by the vein, the capping trap showing on the east side of the vein at the edge of the ridge, argillite being opposite to it on the other wall, the remainder of the trap sheet being most probably higher up on the other side, where the cover on top of the ridge prevents it from being seen. Enclosing rocks.

The test work done here has not been extensive, consisting of only a 75-foot tunnel driven into the base of the hill, on the course of the vein, at a depth of about fifteen feet below the bottom of the before mentioned trap, from the middle of which tunnel has been sunk a small test pit said to be 70 feet deep. This work was first prosecuted by the original owners, in the summer of 1885, who sold an interest shortly afterwards to the same American capitalist who owned the *Beaver Mine*. Under the new owners a little more work was done, with the result, as asserted by Mr. Crowe, under whose guidance it was done, that good ore was struck in the bottom of the shaft. The ore on the dump purporting to come from this point showed enough silver to class it as good mill rock. The energies and attention of the owners being required in the development of their other mine (the *Beaver*), work was discontinued on this vein until a more convenient season. Mr. T. A. Keefer, one of the owners, says that the total amount expended was about $3,000, and that the total value of the ores taken out, some of which was sold and some left in the dump, about covered this expenditure. Developments and results.

Little Pig Vein.

Through this property runs a high ridge, with a bluff facing north-west, a few chains from the base of which and parallel to it runs the Colonization road, connecting these mines with Port Arthur. A little way from its base and parallel to this bluff runs the vein which is known by this name, with a strike of N. 50° to 60° E. (mag.), and dipping about 70° to 80° to the S.E. It shows a thickness of six feet in some places, whilst in others it is split up so much as to leave the question of its thickness undeterminable. The vein-filling consists in places almost altogether of coarsely crystallized calcite, whilst at others a saccharine and crystallized white and amethystine quartz predominates, calcite playing a secondary part and being accompanied by a little purple fluorite, whilst the metallic minerals are represented by light coloured blende and galena. At places the vein is quite rusty from the decomposition of iron pyrites. Vein characteristics.

Rabbit Mountain group of veins continued

The bluff consists of the usual dark colored argillites for 125 feet above its base, on top of which rests about 20 to 30 feet of columnar compact blue-grey trap, which sometimes carries a little iron pyrites.

The work done to test this vein to the end of 1886 consisted of three small tunnels driven into the base of the bluff to cross-cut the vein at about 40 feet below its out-crop on the side of the ridge. These are about 200 feet apart, and from their ends a small amount of drifting has been done on the vein amounting in all to about 60 feet. This work was commenced in 1885, but most of it was done after September, 1886, at a cost, it is said, of about $1,500.

Elgin Vein.

About half a mile to the north of the *Beaver Mine* a vein has been located, named as above, which strikes about E.N.E. and dips at about 80° to the N.W. It consists of a number of parallel stringers distributed through a width of about ten feet of the enclosing argillite, which rock is capped by trap about thirty feet above the outcrop of the vein. The metallic minerals, which are very abundant and mostly crystallised, are represented by light and dark coloured blende, with galena and copper and iron pyrites in a gangue consisting mostly of white and amethystine quartz, with some dark purple, white, and light yellow-coloured fluorite and a little calcite. A 30 foot shaft represents the testing work done on the vein, which does not seem to have shown the presence of much rich ore, although the occurrence of silver in the other metallic minerals present, was demonstrated by an assay of some of that class of ore, which was made at the *Silver Mountain Mine* assay office, and gave $10 to the ton, as stated by the owner.

Other Veins.

Besides those already mentioned, many other similar veins have been located, upon which more or less test work has been done. The most important of these are known as follows: *R 48*, *Big Bear*, *Beaver Jr.*, *Badger*, *Rothwell*, *Peerless* and *Victoria*, all of which, with the exception of the first, are shown upon the Sketch Map.

R 48 is a vein cutting the east face of Rabbit Mountain about three-quarters of a mile north of the *Rabbit Mountain Mine*. On the *Big Bear* vein, which was located in 1886, a fair amount of development work has been done, and it is claimed that samples of ore obtained from the outcrop assayed from $8 to $124 per ton. The name of *Beaver Jr.*, has been given to a vein about one-quarter of a mile north of the

Beaver Mine. It is one of the south-easterly dipping series. The *Badger* is a south-easterly dipping vein on which test work is being done by American capitalists. On the *Peerless* vein, a small test shaft was sunk in the summer of 1886. The *Victoria* is the name given to a vein on which some little surface work has been done, which yielded vein stuff in which the metallic minerals were plentiful, but which at the points opened upon, does not seem to have yielded on assay more than a few dollars to the ton of ore. The veins at the two latter places are in a much lower horizon than the rest, being in the siliceous division underlying the black argillites.

Rabbit Mountain group of veins concluded

The Silver Mountain Group.

This group received greater attention and closer study than the others with regard to the lithological environment of its veins, the details of which are represented in the accompanying contoured map of that district, which whilst, of course, specially illustrating the conditions of occurrence of this group, yet apply also in many particulars to the rest of the silver districts.

The rocks lying so nearly flat, it was deemed advisable, in constructing a map shewing this lithological environment, to contour it so that the vertical relationships of the different beds might be apparent at a glance. In a rough country such as this, and with the difficulties and delay consequent upon this roughness, this object could not of course be accomplished in any reasonable time with very great accuracy, and a method had to be adopted which would give reasonable results with the necessary rapidity. This was accomplished by levelling along the Colonisation road with an ordinary Y level, and leaving B.Ms. where it crossed the location and township lines. The profiles of the country were obtained over the rest of the area by levelling over the location and township lines with a hand-level and target staff, and connecting these as often as possible with the road B.Ms. when in calculating the results any discrepancies (which were not found to be very great) were distributed over the whole series in such a way as to be very slight at any one spot. The positions of the intersection of the contour planes with each profile having been worked out and transferred to the map, the contour lines were joined up in between points with the help of the general knowledge of the surface shape of the ground gained in the examination of the district.

Method adopted in contouring map.

The geological structure of the country, as worked out by the help of these levels, is shewn in the two sections given below the map, which speak for themselves. The upper one has been made nearly parallel to

Vertical sections of map.

Stratigraphical relations of rocks of district.

the direction of the greatest dip of the formation as far as it can be determined, and shows the Animikie rocks resting in a nearly horizontal attitude on the Archean rocks to the north. Passing through Silver Mountain it shows the upper argillaceous division resting on the lower cherty division and overlaid by the sheet of trap forming the top of this hill, whilst the measured displacement of all these rocks by the two chief veins intersecting the hill, is also apparent. The lower section is approximately parallel to the line of strike of the silver-bearing rocks, and shows the different levels of some of the principal trap sheets of the district. Assuming that there has been no faulting of the measures, other than those visible and measureable ones produced by most of the veins, this difference of level along a section practically parallel to the line of strike, must represent actual differences of geological position, and as in the study of the other parts of the Animikie area, such undoubted cases have been frequently found of trap sheets occurring at various geological horizons in these rocks, not to refer to the local evidences to be mentioned later on, it was not considered reasonable to assume the existence of a number of dislocations of considerable extent to account for these differences of level, of the existence of which dislocations no other evidences could be found.

Trap at different levels in formation.

Correlation of different trap exposures.

Whilst it is therefore apparent that many of these different exposures represent individual and separate sheets of trap at various geological horizons, the correlation of some of the trap areas with each other seems reasonably possible. Thus, Table Hill and Wedge Hill areas are probably simply outlying patches of the sheet that caps the argillites of Brulé Hill, this sheet lying above the Palisades sheet, and some hundred feet of the argillite being interposed between the two. Again, it seems more than probable that the trap sheets capping Silver Mountain, Silver Bluff and Boundary Hill are all portions of the same sheet. The Divide Ridge sheet would seem to dip under Silver Bluff, unless its south side has been let down by a fault passing through the valley between them, which might possibly be a fault of the existence of which there is some evidence at Contact Ridge, where the beds of the lower division are seen turned up into an almost vertical position against the Archæan rocks. In the case of the other areas, there is no reason to suppose but that they are sheets of trap of varying extent occurring at different places in the formation. From their irregular nature, the extent of those where only the top of the sheet is seen, the rest being covered up by surface deposits, can only be conjectured, the areas where this occurs are shown by the drift color on the map. There are fourteen areas of trap shown on the map, which I shall speak of as Brulé Hill, Wedge Hill, Table Hill, Outlook

Hill, Palisades, Silver Falls, Silver Hill, R 93, R 63, R 160, Silver Mountain, Boundary Hill, Silver Bluff and Divide Ridge traps. Two of these are undoubtedly intrusive, viz., Palisades and R 93. At the former place, the sheet can be distinctly seen in the cliff, as represented in the section, to divide into three tongues in passing eastwards, with argillites between. The lowest one thins out and stops in a short distance, whilst the upper and middle ones continue on, and form the upper and lower benches of the eastern end of the hill. Had these been separate flows, with deposition of sediments in hollows on their upper surfaces, there would be now some recognizable line of division, such as can be seen between the different trap flows of the Keeweenian rocks, even where they are separated by no sedimentary beds. But a careful study on the ground showed no such visible division. That there is no recognizable alteration of the argillites overlying the lower sheet, might be considered to disprove their intrusive nature; but when one sees that neither is this the case with those lying immediately below the same sheets, that such alteration is very seldom seen at any similar contacts over the whole region, and that where it does occur, it is slight, and extends over only two or three inches of thickness, and might therefore be easily overlooked, then it is plain that this negative evidence is of no account.

Description of trap exposures

Intrusive sheets.

The R 93 ridge consists of a sheet of the ordinary trap in the lower cherty rocks. It presents some peculiar features, which render its true relationship to the enclosing rocks very difficult to make out, on account of the absence of any sharp line of demarcation between the two, the cherts near the trap seeming to have taken on some of its nature. This will be seen on referring to the notes of the microscopic examination of the rocks, given in Appendix I. The sheet, which in the middle of the north face of the ridge is some fifty feet thick, showing the usual vertically columnar structure, seems to thin out going south, and in following it round the ridge both on the west and east sides. The specimens 317, 318 and 319, Appendix I., were got from the ridge near the south-east corner of location R 93, where there seemed to be three distinct layers of rock—317 representing the middle one, 318 the lowest, and 319 the uppermost. Specimen 320 came from some chert-resembling beds lying on top of the trap sheet at a point about a quarter of a mile north-west of the last-named, whilst 325 is from a similar position at a point about a quarter of a mile west again from the latter place. No. 325 seems to be the only typical chert amongst them, several of the others probably owing their peculiar mineral composition to an injection of trap material

R 93 ridge rocks.

amongst their particles at the time of the intrusion of the sheet. Specimen 323 is from the undoubtedly trappean part of the sheet. Typical beds of the lower division rocks appear both above and below this, all around. Judging from the irregular occurrence of this sheet, its wedge shape, and the alteration of the beds above it, it can be safely asserted that it is an intrusion.

Irregularities of contacts of trap and sedimentary beds.

Irregularities of the lines of contact of the trap with the underlying sedimentary beds are also seen at other places, one of which is shown in the illustration entitled "Trap Flow on Argillites, Animikie Series," where it will be seen that the contact of the trap and argillites is much lower on the left-hand side of the picture than on the other, and this without any signs at the place of any faulting. This might of course be explained by supposing the trap to have flowed out over an eroded surface of the argillites; but in view of the number of other evidences in this district of the intrusive nature of these sheets, it would seem more probable that this is due to the same cause, and that the intrusion has passed from one plane to another in seeking the path of the least resistance. A similar case to this was noticed on the southern edge of the Silver Mountain sheet, and also at the R 160 ridge; but owing to the exposures being nearly covered with detritus, they were not so plain as the one illustrated, which is on the north side of Brulé Hill.

The surface of this latter hill slopes away to the south, where at an estimated distance of about three miles, a high hill is seen to rise apparently composed of the argillaceous division beds, in which several trap sheets can be seen, all of which from their position would overlie the Brulé Hill trap.

Others trap exposures.

Of the other trap areas there is little to say. Outlook Hill appears to consist altogether of trap, but there is so much cover on top that it is hard to say whether some argillite may not be found capping it. The Silver Falls sheet only shows where the creek falls over it, and for a little distance around, with a smooth ice-grooved surface, being otherwise hidden by surface deposits, so that its extent must remain conjectural. It shows a thickness of 25 feet in the falls without the bottom showing. The R- 160 trap would seem to overlie the R. 63 sheet, with a slight development of the argillites in between, the latter sheet being traceable down to within a short distance of the former, and seeming to pass under it.

The levels of the lower surface of the Silver Mountain sheet were accurately ascertained at many points all around the hill, and when worked out, seemed to point to a very irregular under-surface. A curious thing bearing on this question is noticeable at Lizard Lake, at

the eastern end of which are visible a few feet of the argillites with the usual columnar trap on top, which would seem to point to considerable irregularity in the under-surface of the trap in this vicinity.

It is a curious fact that none of the dykes, which must certainly exist here, have yet been located, which contrasts forcibly with the coast section with its numerous examples, and it would appear that in the Silver Mountain area they must have weathered away more easily than the surrounding rocks, and so be covered up with the drift.

Microscopical characters of traps.

The nature and lithological affinities of these rocks will be seen by referring to Appendix I, where notes of their microscopical features will be found, (See specimens Nos.,259, 301, 323 and 338,) from which it would seem that they can all be classed as diabases. They vary from very compact dark-colored resinous rocks to medium coarse-grained greyer varieties, these differences showing in different parts of the same sheet, so that no distinction can be made between them in this way. About their field habit there is nothing peculiar, except that they are massive rocks nearly always showing a characteristic vertically columnar structure, sometimes accompanied by horizontal joint planes.

Sedimentary rocks.

Difficulty is also experienced in correlating the different exposures of the sedimentary rocks of the formation, owing to the fact that they seldom retain, for any considerable distance, characteristics by which detached portions of the same bed might be recognized, so that it is only by the general concensus of the evidences that an opinion can be formed of their relationships.

Lower division.

The separation of the rocks into an upper and lower division has been spoken of already earlier in the report, so that nothing remains but to describe the local characteristics of the various exposures of the different kinds of rock within the area under review. To begin then with the lower division, it consists in this district almost altogether of the siliceous rocks, which, whilst presenting great varieties of appearance, have all certain characteristics in common. In association with these are certain dolomitic and calcareous layers. On the map they are represented by the lightest shade of Payne's grey, the gradual mergence of this color into the darker tints, representing the upper division, being intended to show the absence of any sharp line of demarcation between the two divisions.

A study of these rocks in the field, coupled with the microscopic examination of a number of thin sections of different varieties, reveals the facts of their origin. They are seen to have been fragmentary rocks, consisting of rounded and sub-angular fragments which have been subsequently changed very much by the deposition of infiltration-products around their constituent particles, this action having gone so far

sometimes as to change the particles themselves and almost entirely obliterate them. A very good description of their microscopic characters is given in Appendix I. (See specimens Nos. 281 and 325.) In the field they are found to present very various appearances, the same bed to a superficial observer looking quite different at different points not far removed from each other, sometimes appearing quite granular and at others quite compact. They also assume very various colours—grey, light green, black, rusty, etc. Some of them on weathered surfaces are all pitted with little cavities which have hackly surfaces, from which atmospheric influences have removed some soluble mineral, leaving considerable hydrated iron oxide. All varieties contain more or less iron, either in the form of hydrated peroxide, giving them a general rusty appearance, or as magnetite, the percentage of the latter sometimes ranging so high as to give the rock a very high sp. gr., which together with the dark compact fracture so produced would cause the careless observer to mistake it for some of the compact varieties of the trap of the neighborhood. They sometimes also contain iron in the shape of pyrites.

Microscopic characters of cherts.

Ferruginous cherts.

The interstitial matter nearly always consists of silica, which on weathered surfaces, stands out as a fine reticulation from the removal of the more easily soluble particles. When, however, this interstitial matter consists of calcite, as it sometimes does, the reverse is found to be the case, and the particles are left projecting. In these granular varieties the particles seem to be very constant in size, varying from 0.02 to 0.06 of an inch in diameter. Imbedded with these more plainly fragmentary beds are sometimes rusty brown earthy layers, and also compact flinty layers of a black, brown, red, milk-white or green color. Microscopically, these latter can be seen to be due to the action of the infiltrating waters having gone so far as to completely or almost completely merge the particles into the general mass of the replacing silica. The various stages of this process can often be seen in the same specimen or thin section. In some cases ,traces of the original particles are left, as a white, red or brown mottling of the stone, whilst, when the mottling is red on a dark green ground, a very ornamental stone is the result. These varieties sometimes show a wavy, somewhat agate-like, structure, and occasionally crystals of calcite are distributed through them porphyritically.

Infiltrated silica.

Wavy bedding. A very constant and marked feature of the more granular beds is their wavy, irregular bedding, which, together with the general rusty appearance and the reticulation on the weathered surfaces already spoken of, constitute their most salient features. These beds are at places much broken up and fissured, the cracks being filled with crys-

tallized white secondary silica, super-imposed upon which, in one instance in a vug, were found rust-colored rhombohedra probably of altered ferruginous dolomite. An anthracite-resembling mineral is also found occasionally in these rocks in a similar relationship, and one specimen shows nodules consisting of concentrically arranged chalcedony surrounded by radiately crystallized vitreous quartz, with angular fragments of a similar nature imbedded in this anthracitic mineral.

Dolomitic and calcareous layers.

The calcareous and dolomitic portions are only developed to any extent locally, although the whole formation contains more or less of these minerals distributed through it. These beds where developed present a dark grey or cream coloured fracture, the weathered portions being generally very rusty, They often enclose fragments, nodules and sheets of jasper with hackly exterior surfaces, and present other curious features. One specimen, for instance, has the appearance of a conglomerate, and is made up of round pebble-shaped portions of a dark slate colour imbedded in a lighter coloured crystalline matrix, which on exposed surfaces is weathered away, leaving the pebbles standing out. They both effervesce with acid, the matrix, however, more freely than the other portion.* Another specimen is somewhat similar, but the dark imbedded portions are platy and angular, looking more like broken fragments of a thin bed, and though soft enough to scratch with the knife, and generally resembling the dark pebbles of the first mentioned, will not effervesce with cold acid.

From these and other appearances, it would seem that these dolomitic and calcareous layers are most likely due to a similar process of alteration and infiltration to that which has acted in the silicification of the rest of the beds and, that whenever this process of dolomitisation was going on in a bed whose composition and structure admitted of it, and which enclosed thin seams or portions not amenable to these changes, the crystallising power of the carbonates has broken these portions into fragments which have thus got distributed through the mass in such a manner as to form breccias, etc. The want of homogeneity of these dolomitic layers is well shown by the streaky structure brought out on exposed surfaces by weathering.

Dip of Formation.

With a few exceptions, which will be seen by reference to the map and are due to local causes, these lower division beds are found dipping at low angles. The most notable of these exceptions occurs towards the south end of Contact Ridge, where they show in the bed of a stream in an almost vertical position at the foot of a cliff of granitic gneiss.

* Mr. G. C. Hoffmann, who recently made a chemical examination of such a specimen, found that whilst the nodules or pebbles were distinctly dolomitic, the matrix contained no magnesia.

They here consist of brownish red jasperry layers, interleaved with green chloritic slaty portions, which have a resinous lustre on the bedding plane.

Basal conglomerate.

Patches of a basal conglomerate are occasionally found lying in hollows in the old Archean sea-bottom near the northern fringe of the Animikie formation. The imbedding paste is dark, and whilst containing some carbonates, does not in general effervesce with acids, whilst the fragments which are mostly sub-angular, seem to consist in general of granitic material.

Upper division rocks.

The upper division rocks consist nearly altogether of soft, black argillaceous rocks, which, where the bedding planes are numerous, put on a very shaly appearance. The dark colour seems to be due to the presence of carbon in some form as on ignition they lose their blackness and assume a dark buff tint. The amount of contained carbon, and consequently their colour varies very much at different places even in the same bed, at some places being considerable, as at the *East End Mine* at Silver Mountain, whilst at others the lesser amount present causes the argillites to assume more of a grey-slate colour. A very common but a very unequally distributed constitutent is calcic carbonate, and layers of a purely calcitic and dolomitic nature are developed in these upper beds in a very similar way to those mentioned as occurring in the lower division, which is exemplified in the argillites underlying the trap of the R 160 ridge. The large *bombs* which have been mentioned by other writers as occurring in these beds are frequently found to effervesce with acid and are probably concretionary. This idea is borne out by the fact of the concentric arrangement of the pyrites which is found in them, and which generally shows when they are broken across arranged as a ring parallel to and near the exterior surface. Seen in place, the bedding planes of the enclosing argillites are found to bend up around the spherical ones, whilst in the more lenticular, apparently only partially grown examples, very similar effects are observable.

Bombs.

Silicified argillites.

At some places, whilst the argillites retain their general colour and appearance they are found to be hard from silicification, and sometimes in thin chips show dark rounded grains surrounded by transparent crystallised silica. Again, portions of beds which are at one place typical dark, soft argillites, at other places very nearly approach in appearance the lower cherty division rocks, as in the instance of the beds immediately underlying the trap of Silver Bluff which, in their composition and appearance, resemble much more closely the latter than the former,* whilst stratigraphically they appear to occupy the

* See Appendix Specimen No. 303.

position of the westward extension of the pure argillitic upper beds constituting Silver Mountain.

For this reason they have been colored on the map, an intermediate tint between those appropriated to the upper and lower divisions. The reason for thus correlating them with the Silver Mountain beds, is found in the fact, that they lie similarly between a trap sheet which is evidently part of that capping Silver Mountain and the top of the cherty division proper. In the Silver Mountain section at the north-west corner of location R 83, the top of these cherty beds is marked by the occurrence of some compact milk-white, red and black jaspery beds, which are also traceable east, through location R 64, whilst similar beds are found underlying these Silver Bluff upper division beds about the north-east corner of location R 65. A curious rock occurs at this place immediately under the trap sheet, whose microscopic characters are described in Appendix I. (See specimen No. 302). It seems to be due to a mingling of some of the trap material amongst the particles of the sedimentary beds immediately adjacent to it, either by original injection or subsequent deposition by waters infiltrating through the trap sheet above, and is somewhat akin to the rocks described from R 93 ridge. Sometimes the silicification has been confined to small portions of these upper beds when we get as shown in the Divide Hill section, the usual soft black argillites with seams and beds of red jasper through them. At the western end of this ridge, which, extending along the north shore of Whitefish Lake, forms the divide between the water-sheds of the Pigeon and Whitefish rivers, this is well shown, lenticules and more continuous bands of red and white chert occurring between the bedding planes of the more argillaceous parts, which bedding planes bend up over the lenticules, producing a general waviness of the bedding approaching that exhibited by the typical lower cherty rocks. I noticed in these jaspery and cherty seams the curious vertical tubular cavities which have been mentioned by previous observers. They have a curious hackly inner surface, and are filled with iron rust as are also numerous little fissures which run from side to side of these seams.

Partially silicified upper division beds.

In fact, the sedimentary beds of this formation, as they appear in the district under consideration, and also as far as observed along its northern fringe, both east and west of this, would seem to have been originally deposited as a series of sands and clays, the former largely predominating in the bottom, and probably near the edge of the basin of deposition, and becoming less prominent and extensive away from this edge, whilst above a certain ill-defined horizon, the clays would form the great bulk of the deposits, and preponderate more and more

Probable origin of sedimentary rocks.

as we pass away from the edge of the basin. As one would expect in the clay deposits proper, there would be occasional beds of sand, and in the sandy parts, beds of clay, whilst there would also be beds of sandy clay, and this intermixture would be more frequent as the fringe of the area of deposition was approached. Subsequent infiltration of chemical waters would then produce just such a state of things as already described. The clay beds being impervious would remain unaltered and be now represented by the soft black argillites. The sandy clays would become partially altered and produce the intermediate beds, whilst the sandy beds being quite permeable, would offer no resistance to complete alteration into the different varieties of cherts described, and when this alteration had gone so far as to quite obliterate the particles, we should get the jaspery beds.

These sands would seem, so far as a microscopic examination has gone, to be just such as would be produced by a disintegration of the older Archean rocks, especially of those of the Huronian division of them, and the varying composition of the sands produced from such a variety of rocks would, when decomposed by the infiltrating waters, account for all the various decomposition products observed in their microscopic sections and otherwise, such as silica, calcite, dolomite, various decomposition minerals of felspar and hornblende, etc., oxides of iron and so on, and would besides this also account for the varying extent of the alteration produced at different places, the mineral constituents of some of the particles being more readily alterable than others, and supplying by their decomposition a corresponding variety of material.

Archean rocks of district.

As shown, the Archean rocks project from the north into the area covered by the Silver Mountain map. Exposures are not very frequent over this area, which is largely drift covered, but where these rocks do show, they present the characteristics of the great division of rocks known as Laurentian. This mass may be said, in general terms, to consist of granitic and gneissic rocks. They have a general pink appearance, from the great preponderance of pink felspar. Occasionally they carry some hornblendic mineral, which, sometimes shows as locally developed bands of schist. Both the gneissic and the granitic variety are at places intersected by a reticulation of veins of a rock which is composed of quartz and pink felspar, the latter largely crystallised and predominant. These veins cut across the foliation of the rock in all directions, sometimes running with it for short distances, and then crossing to another foliation plane. Where they cut narrow and identifiable bands of gneiss they appear to have faulted them. In one instance, the edges of a hornblendic schistose band, thus

apparently faulted, were turned towards each other on the different sides of the faulting vein. A description of the microscopic characters of a specimen from these rocks obtained near *Woodside's* vein is given in Appendix I. (See specimen No. 277). These Laurentian rocks having been so well and fully described at various times in the publications of this Survey, nothing more need be here said.

As before pointed out, the drift deposits cover all the lower lying country, the rock showing only occasionally. As far as such a thing is possible, the area covered to any extent by these drift deposits has been represented on the map, but it is hardly necessary to point out that in such a section of country this can be done, only with an approach to accuracy. Drift deposits.

They consist of stiff white clay, sands and gravels. The former seems to preponderate in the greater part of the area forming the basis on which rests the soil. The latter are well seen in the banks of Whitefish River, where exposures frequently fifty to one hundred feet in height are presented, consisting either altogether of gravel or more frequently of clay, sand and gravel interstratified, and containing boulders of granite, gneiss, trap and chert, with occasionally argillite, whilst at one place, veinstone was noticed to occur. These boulders are in most places very numerous.

The general surface of the drift deposits in the valleys would seem to be about 300 feet below the tops of the hills, below which level again the streams have cut deep valleys with steep sides, often 100 feet high, this surface being also further cut up by steep sided gullies forming water courses in the spring, but otherwise dry. The depth of the drift covering represented on the vertical sections appended to the map has been assumed from the data furnished by the sections afforded by these stream valleys.

In passing down the bed of the Whitefish river, and at some other places, several ice polished surfaces of rock were met with, on which the striæ were found to have the following directions at the different places observed:—N. 70° W., N. E., N. 80° E., N. 70° E., E. & W., N. 60° E. Glacial striæ.

Silver Mountain Vein.

This vein cuts through the middle of the hill of that name, with a general direction of a little north of east, whilst it dips to the northward at 80° to 85°. It has caused the formation of two indentations in the general contour of the hill, the one on the east side being comparatively slight, whilst on the west side about half a mile of valley has been denuded out adjacent to the outcropping of the vein. It is a Silver Mountain group of veins.

The Silver Mountain group of veins continued.

very strong and persistent fissure, showing at frequent intervals right across the hill for a distance of over a mile, appearing to split up at either end and become less strong, and also to change its direction, as shown in the map, where, at its eastern extremity, it is seen to strike about N.E. after leaving the brow of the hill, whilst at the western end it would seem to split up into two branches, both of which take a much more northerly direction than the general strike of the lode, throughout the greater part of its length. The change of strike which would result from the descent from a higher to a lower level, due to the dip of the vein, would not be nearly sufficient to account for this change of direction, which is possibly due to the dying out of the fissure at either end. A theory was at first held locally that there were two veins at the east end, and that the portion of the vein striking north-east was a branch of the main vein, joining it near "the cave," (see Plate IX., fig. 1), whilst it was believed that the main vein must continue on its original course down the valley. A careful examination, however, shows no grounds for such a supposition, and no reason for believing that two veins of different periods of origin exist, one being silver-bearing and the other barren.

Rocks faulted by vein.

The enclosing rock is argillite, surmounted, as usual, by a sheet of columnar basic trap, the faulting of which by the vein is clearly visible at the east end, and amounts there to eighty feet.

Vein characteristics.

Along its outcrop in the trap sheet, and for some little distance below it, the vein is large and solid, and from four to six feet thick, whilst in the argillites below, as one would expect, it does not retain its width so persistently, the fracturing force having in the looser rock become distributed over a wider area, so that at places the vein is only represented by a number of small indefinite stringers distributed through a wide area of the rock, whilst a few feet further on, these have been found to come together and form a large, solid vein. In these solid parts, large caves or vugs occur, several of which open up to the surface on the brow of the hill at the eastern end.

"Gangue" minerals

The vein stone consists of calcite, barite and quartz with fluorite, the different minerals preponderating at different places. The barite seems to be confined to those parts of the vein which are in contact with the trap or a little distance below it, whilst calcite and quartz form the preponderating minerals in the argillites below; the fluor-spar, although plentiful in places, generally playing a secondary part. These differences of gangue give a very different appearance to ore from different parts of the vein. Thus, around the rich ore at No. 4 pit, and in the other end of No. 2 level, the vein stuff was very beautiful, consisting of a crystalline mixture of translucent white and amethystine quartz,

with green fluorite and a little calcite, whilst in contrast to this, in the developments at the other end of the vein, the silver minerals have been found in a white saccharine gangue consisting mostly of white barite and calcite, with a little colorless quartz, and occasionally a little green fluorite. The vugs are generally lined with large cleavage masses and crystals of calcite, and in one there were found well-formed small crystals of that mineral showing the prism, terminated with faces of the rhombohedron, upon which were superimposed small crystals of iron pyrites. The metallic minerals are represented by blende, both light and dark-colored, galena and iron pyrites, with occasionally a little copper pyrites, the silver occurring both native and as sulphide or argentite. The latter is the most common, forming films, sheets and solid nuggets often several ounces in weight, whilst the former occurs in films, but more often in fern-like and wire forms.

The Silver Mountain group of veins continued.

Metallic minerals.

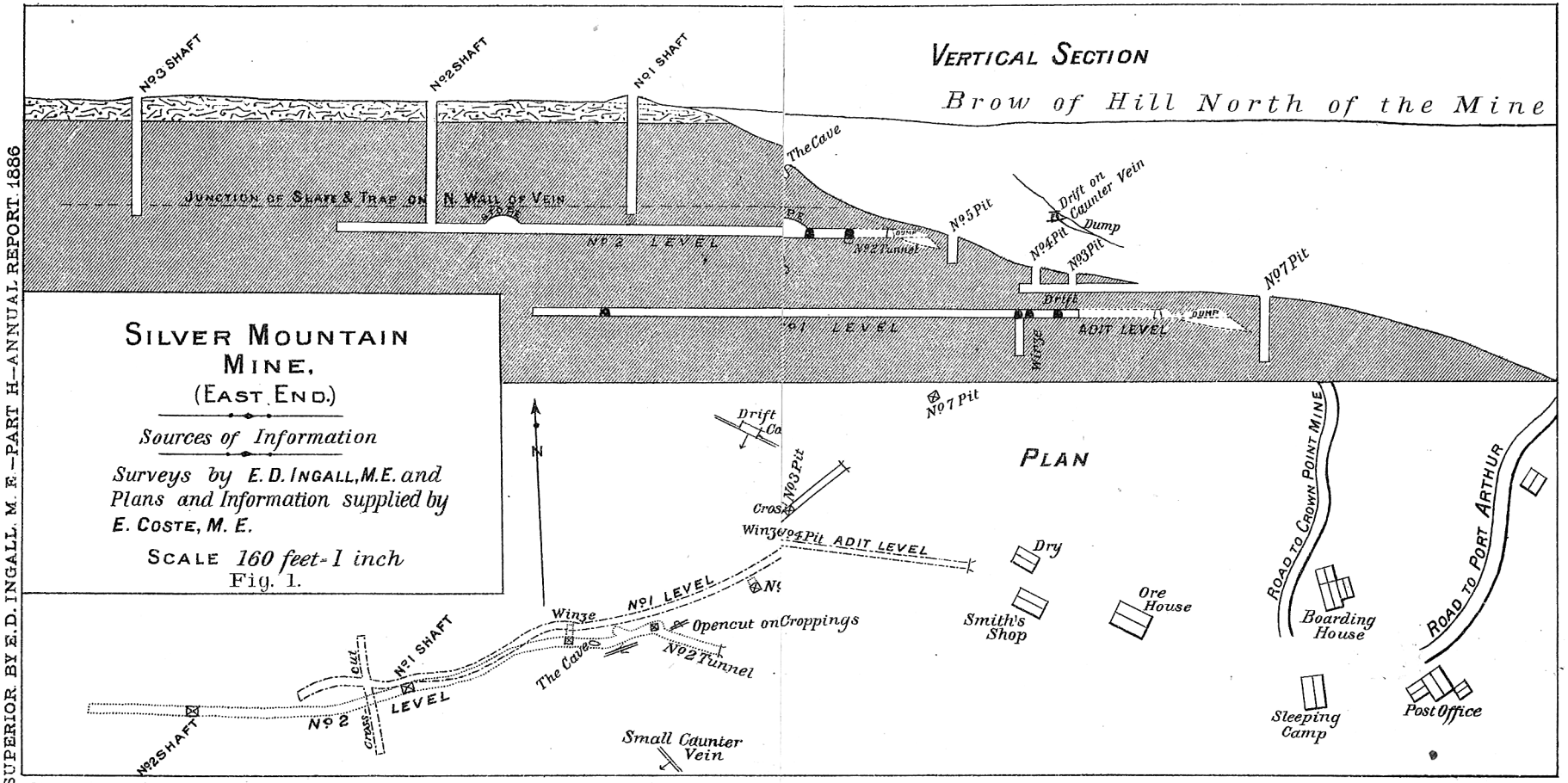
Silver.

The enclosing or country rock of this vein shows no very particular features which distinguish it from the other veins already mentioned, except that the argillite is probably somewhat more carbonaceous in places. This is notably the case around the developments made on the eastern face of the hill, and was especially noticeable in the driving of the adit, when the miners used to come out looking quite black, which characteristic, together with its softer nature, serves to distinguish the argillites in the neighborhood of this vein from that enclosing some other veins in the district. It shows a system of jointing in places, at one in two directions—one N. 15° E., dipping 85° E., and the other N. 85° E., dipping 85° S., the latter direction corresponding to one of the two prevalent in the rocks of the coast section. The capping trap presents no features of marked difference to that already described. The accompanying illustration (Plate IX., fig. 1, p- 72 H.) shows the position of the country rocks on the south or foot wall of the vein and also illustrates their displacement by it, the lower dotted line representing the under surface of the trap sheet on the opposite or hanging wall.

Enclosing rocks.

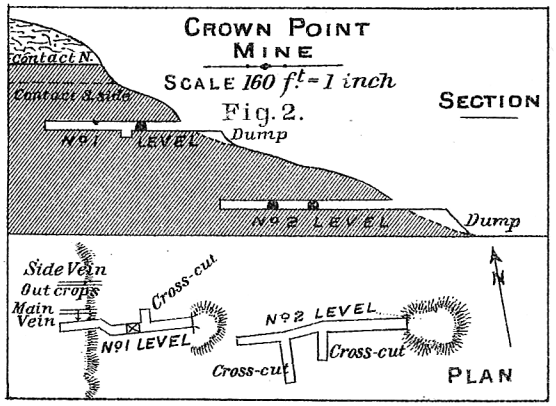
The work done on this vein is mostly represented in Fig. 1, Plate IX., which shews the developments made on its eastern end up to the end of July, 1887, but besides this, several test pits, etc., have been sunk on the outcroppings, for a distance of nearly 4,000 feet beyond No. 3 shaft, the positions and heights of which will be seen on reference to the accompanying contour map of the Silver Mountain mining district. These developments on the west end of the vein have been made chiefly at three points. The pit nearest to the east line of R. 56 location is only about 8 feet deep. Passing westwards, we come to a small cross-cut tunnel driven into the

Development work.



From the nature and incompleteness of the information obtainable, the above is necessarily diagramatic.

DESBARATS, LITH.



From Surveys made by E. D. INGALL, M. E.

EXPLANATION.

TRAP.

ARGILLITE.

CROSS-CUTS.

The Silver Mountain group of veins continued

side of the hill through the argillites for a distance of about 25 feet at which distance it cuts the vein at about 25 feet below its out-crop. From the end of this tunnel, a small shaft has been sunk to a depth of about 30 feet upon the vein. Further west again another similar cross-cut has been driven in through the argillites for a distance of about eighteen feet to the vein, and about twenty-seven feet beyond it. It cuts the vein at a depth of about twelve feet below its out-crop, which is here just underneath the lower surface of the sheet of trap capping the argillites. Below the floor of this tunnel a small pit, about fifteen feet deep, has been sunk on the vein.

The extent to which the vein has been tested at its eastern end is best understood by reference to Plate IX., fig. 1, which shows the developments up to the end of July, 1887, of which nothing further need be said beyond pointing out that in putting together the various data from which the illustration has been compiled that an error has crept in and No. 3 shaft should be shown at a distance of 820 feet west from No. 2 shaft, instead of as therein represented.

Erratum in illustration.

Occurrence of rich silver ore.

The first ore discovered here was remarkably rich. It was obtained from No. 4 pit (Plate IX., fig. 1) and carried a large percentage of native silver and argentite, accompanied chiefly by dark-colored blende. The native metal occured in the leaf and wire form, whilst the argentite occured in leaves, sheets, and as nuggets weighing often several ounces, which latter occurred quite plentifully in some spots. On my visit to the place shortly after its discovery, I saw a cigar box full of such nuggets which had been taken by the discoverer out of a few cubic feet of rock obtained in sinking the discovery pit (No. 4), and I feel sure that several tons of ore could have been obtained from this spot which would have averaged from $1,000 to $2,000 per ton. This was, of course, exceptionally rich and, although silver bearing rock has been found at several other spots in the vein, none of it has been so rich as this, nor, up to the present time, do the developments on the east end of the property seem to have resulted in the proving of any extensive bodies of ore. An encouraging fact is found, however, in the presence of good ore in the vein, running about $127 to the ton* at the west end, about a mile distant from the first mentioned, and it would seem strange if, between these extreme points, the vein were found barren of any bodies of payable yield and size. The developments, however, at the western end of the vein have not yet been extensive enough to throw any light on the extent of the body of ore there discovered.

"Caunter" veins.

Some good silver ore was also obtained in the two small caunter-veins shown on the plan on either side of the main vein. The one on the south shows in the trap, whilst the drift on that on the north is in the argillite just below the trap-bed.

*See Report of Geological Survey, 1886. Part T. Assays Nos. 48 and 49.

The history of this mine has been as follows:—It was discovered in the fall of 1884 by Mr. Oliver Daunais, before mentioned as the locator of the *Rabbit Mountain* vein and of the chief veins of that district. This gentleman, together with his associates, finding such rich ore as mentioned, took up locations including the vein for over a mile. The property was then dealt with in separate halves, known as the East and West ends respectively. The former was shortly afterwards leased to some American capitalists on a twelve months' option, and these gentlemen commenced operations in the spring of 1885, and continued with a considerable force until the end of the same year, when having, it is said, expended about $10,000 in work, their option having expired, and the results of their work not having come up to their expectation, they did not feel inclined to give the price asked, and the mine reverted to the original owners, who then interested with them the Messrs. Trethewey, who had formerly managed the *Silver Islet Mine.*

The Silver Mountain group of veins continued

History of mine

During the year 1886, no work was done, with the exception of a little occasionally undertaken by the owners, which, however, resulted in their striking some more silver bearing rock in the upper tunnel on extending it some little distance beyond the point at which the American company had left off and where the vein had been poor. In the fall of 1886 a company was organized in Liverpool, Eng., to purchase and work the mine with a share-capital of £100,000, under the name of the *Silver Mountain Mine Company (Limited)*, which has carried on operations ever since. According to the prospectus the capital was distributed as follows:—

Purchase of property and costs of floating Co. (paid by vendors)....	Cash, £30,000 Shares @ £1 25,000	
		£55,000
To be allotted to directors in lieu of remuneration for two years, and to other parties for services rendered in connection with the formation of the Co.—Shares @ £1 each.....		9,000
		£64,000
Leaving for Working Capital.....		36,000
Total.....		£100,000

The west end property was bonded also, but after a little work had been done with very encouraging results, the parties got into litigation as to who should have control, which of course put a stop to any further work, and it has remained in that state ever since. Operations were carried on at this point in the winter of 1885-6.

Crown Point Mine.

The Silver Mountain group of veins continued.

The vein here was discovered shortly after that at Silver Mountain. It is about three to four feet wide, although as in the case of the other veins of the district, sometimes split up and rather indefinite, and represented only by numerous branches through the *country* rocks. As far as developed up to the end of 1886, barite and calcite had been the preponderating minerals in the vein-stuff, which were accompanied by a little colourless quartz and some green and purple fluorite, in which gangue, in the orey parts, were to be found blende, galena and pyrites, the silver being in the form of argentite in leaf and nugget.

Enclosing rocks.

The enclosing *country* rock is very similar to that at the *Silver Mountain Mine*, the argillite being black and soft. The enclosing rocks are similarly faulted by the vein, but in the opposite direction, and to a much less extent than at that place, there being here a down-throw on the south side which only amounts to some sixteen feet. The capping trap has been described as a tolerably fine-grained, very much altered diabase by Mr. W. S. Bayley, who made a microscopic study of a specimen of this rock taken from near the vein. (See Appendix I., No. 259).

Developments.

The workings on the vein have all been prosecuted in the upper portion of the black argillites, and are comprised within a depth of 140 feet below the capping trap as shown in the illustration (Plate IX, fig, 2) which gives the developments made on the vein up to the end of 1886. These have all been made by the original owners, who have not had capital enough at command to open up the vein to a greater extent, although the results have certainly been encouraging.

Another vein.

About ten chains N.W. from this place occurs another very similar but smaller vein which was found cutting the capping trap, and a small amount of test work done to trace it down into the underlying black shales which was, however, stopped before anything very definite had been proved, owing to the parties who were prosecuting the work, finding that the vein was not on their own property.

Palisades Vein.

Vein characteristics.

Here a vein has been located and some little work done to test it. It contains the usual metallic minerals, which are plentiful in places, in a gangue of calcite with colourless white and pale amethyst quartz and a little fluorite occurring in scattered particles and mammillated layers, the surfaces of some of which have a tendency to assume an amethyst colour, the rest of the mass being emerald green. The vein,

where worked on, is entirely in the soft black argillites and shales below the lower tongue of the trap sheet which caps this hill. Of this trap, Mr. W. S. Bayley says "this is a medium-grained diabase with the typical diabase structure." (See Appendix, specimen No. 338). The Silver Mountain group of veins continued.

The developments to the end of 1887, consisted of a small cross-cut tunnel driven southwards into the base of the hill at a depth of about 40 feet below the outcrop of the vein and the base of the trap sheet, which, at a distance of fifty feet in from its mouth has intersected the vein, from which point a shaft has been sunk on it said to be fifty feet deep, and to have shown the enclosing rock to be argillite all the way down. At the end of the tunnel, the vein consists of numerous branches and stringers distributed through a thickness of about ten feet of the argillites. Developments.

Scripture's Vein.

This is a two to three feet vein showing in the capping trap bed of Silver Bluff, and the sedimentary beds below it. It is filled mostly with crystallised barite, giving the veinstone a confused interferent platy structure. The vein has a somewhat banded appearance at this place, owing to the presence of a two to four inch rib of green fluorite on each wall, and to a banded appearance of the barite filling near the walls. A little white quartz is also present. Very little metallic minerals were visible, but as only sixty feet of the vein was exposed in the cliff, the talus covering up all below, and as no development work had been done on it, very little is as yet known about it. No appreciable faulting of the rocks has been produced by the fissure. Vein characteristics.

The enclosing rocks of this vein consist of an upper bed of the usual trap of the district underlaid by a highly siliceous, wavily-bedded, flaggy rock with marked vertical jointing in two directions. These have already been described more fully, and their microscopic characters referred to. (See Appendix I., specimens, Nos. 301, 302 and 303). Enclosing rocks.

Silver Hill.

Two veins have been located at this place and worked upon to a small extent. The most southerly one presents the feature, at one opening, of two distinct ribs, one made up of barite crystallized in radiating platy forms, whose interstitial spaces are filled out with crystalline colourless quartz, whilst the rest of the vein at this spot consists for the most part of calcite, in coarsely crystallised masses, accompanied by a fair amount of, mostly colourless but sometimes amethystine, quartz, some barite and a little pale green fluorite. At another open- Vein characteristics.

The Silver Mountain group of veins continued.

ing again, the vein consists almost altogether of calcite, with quartz and green fluorite and very little barite. The work done on this vein to the end of 1886, consisted of a few shallow test pits, sunk at intervals apart, over a distance of 150 yards on the outcrop of the vein.

The other vein cuts the hill and is smaller and less definite than the last, averaging about one foot thick as far as exposed, and showing similar filling to the other, only that the barite is absent The work done to the end of 1886 was slight, consisting of three small open cuts driven in on the vein, one above the other, on the west side of the hill. The enclosing rocks of these veins consist of highly ferruginous cherty rocks, accompanied at places by compact jasper bands and ferruginous dolomite beds which, on the hill, are capped by a bed of trap. A little native silver and argentite has been found in the vein on the hill.

Silver Falls Vein.

Vein characteristics.

This is a large vein, and, as far as proved by the present developments, differs somewhat from the rest of the veins in the district. In the shaft, at the surface, it showed vein matter over a width of fifteen feet, but at the time of my visit, October, 1886, the work done had not been sufficient to demonstrate exactly its dimensions and nature. In a sample of about ten pounds, obtained by the owners from some distance down in the shaft, the vein stone consisted of an intimate mixture of compact quartz with some dark material, giving it a general dark greenish-grey appearance, which was relieved occasionally by the occurrence of quartz of a pale pink, amethyst, or more often white colour, with pale pink and cream-coloured dolomitic spar occasionally. The jointing surfaces were faced with a dark, probably plumbaginous coating. At other places, the pink spar constituted the bulk of the vein, and on the presence of this spar and its resemblance to similar vein-stone which had accompanied the silver of *Silver Islet*, the owners based hopes that similar rich ore might be found in their vein. In places a good proportion of finely disseminated iron pyrites was visible in the above described sample.

Enclosing rocks.

The enclosing rock of this vein consists of the jaspery and cherty rocks of the lower division, which here, adjacent to the vein, present the unusual feature of being much contorted, which is in great contrast to the usually flat position of the rest of the Animikie formation of the vicinity. This disturbed condition will be apparent on referring to the map, from an examination of which it will be seen that the beds turn down sharply on the hanging wall of the vein, whilst they dip steeply the opposite way on the other side, and again reverse their

dip about seventy paces further down the creek, where they show in a little fall of about twenty feet. This is probably a local effect produced by the vein, which has probably faulted the rocks. These rocks here carry at places little interbedded lenticular patches of crystallised vein minerals, which enclose sometimes a little iron and copper pyrites, and all of which are probably due to infiltration into spaces formed by the folding of the rocks. The Silver Mountain group of veins continued.

To the end of 1886, the work done consisted of a fifty-feet shaft sunk on the vein, from which, at a depth of about forty-five feet, a cross-cut fifteen feet in length was driven across it. Besides this, some surface strippings were made, extending over a distance of about fifty yards of the outcrop of the vein. Work done.

R 64 Location.

Several large veins occur on this property, of thicknesses varying from three to eight feet, and showing all the characteristics of definite fissures. In their contents, the various forms of quartz preponderate, which are accompanied in places by varying proportions of green fluorite, calcite, and occasionally a little barite. At one exposure, the vein consists almost entirely of solid vitreous silica, and has a marked, banded or combed appearance from the "cone in cone structure" produced by the different coloured layers (amethyst, white, translucent, etc.,) of the quartz being arranged parallel to the faces of the terminal pyramid. The fluorite seems to have been mostly deposited between the irregular surfaces of these layers. The metallic minerals represented by blende, galena and pyrites occur occasionally, both disseminated, and the latter also as very thin films coating cleavage planes, jointing, etc. The enclosing rocks comprise the jaspery, magnetitic and rusty siliceous beds of the lower division. (See Appendix I., Spec. No. 281.) Vein characteristics.

The work done has been so far confined to the tracing of the veins and to the sinking of shallow test pits on their outcrops. Work done.

Other Veins.

Several other veins have been located in this district on which a little test work has been done, viz.: on Locations *R 79* and *R 111*, and on *Tchiatan's* vein on Location *R 115*. These are all in the siliceous rocks of the lower division. *R 79* vein is filled at one place with a gangue of saccharine quartz and spar, the latter mostly calcite, whilst at another opening it consists altogether of compact vitreous, iron-stained quartz resembling the gaugue of the gold veins of the Huronian areas of this region. It carries a little disseminated pyrites, galena and blende.

The Silver Mountain group of veins continued.

The *R III* vein is very similar to most of those already described, carrying a little of the usual metallic minerals in a gangue of calcite, amethystine and colourless quartz and green fluorite. On this vein the prospecting work done to the end of 1886 had been inconsiderable, consisting of several test pits on the outcrop of the vein, tracing it for a distance of about two hundred feet, and a small thirty feet tunnel driven into the base of the ridge on which the vein outcrops and cross-cutting the same at a depth of about twenty feet below the surface.

Tchiatan's vein is large and compact, about three to four feet thick, on which, besides some surface work in the outcroppings of the vein, a shaft has been sunk said to be forty feet deep. Judging from the ore dump at this point, the vein has carried considerable quantities of blende, which, with a little galena, occurs in a gangue similar to those already described, but carrying occasionally a little flesh-coloured barite. The blende is light-coloured, and occurs largely crystallized in solid ribs and masses.* An examination of the rock broken shows that the beds encountered in sinking this shaft somewhat resemble those already described as occurring at the south end of Contact Ridge, viz., red jaspery beds separated by dark-green chloritic layers.

Woodside's Vein.

Vein in Archean rocks.

This example differs from the others within this area, in that it occurs in the Archean granitic and gneissic rocks underlying the Animikie, the northern fringe of which is most probably located in this immediate vicinity, being covered up by the drift which hides every, thing for some distance to the S. of the Whitefish river. The vein in its nature and contents is very similar to the rest, and carries blende-galena and pyrites distributed through the usual gangue in moderate profusion.† The pyrites occurs occasionally in peculiar ring-like or rather more hexagonal arrangements in the calcite, the centres of the rings etc., consisting also of the latter mineral. Purple fluorite also occurs in the joint fissures of the enclosing granitic and gneissic rocks. The work done up to the middle of October, 1886, consisted of some explorations and pits in the out-crop of the vein over a distance of about 100 yards, and of a twenty-five feet shaft, sunk on the hanging wall, which had just reached the vein at that depth.

Whitefish Lake Group.

The chief examples of the vein phenomena of this group which were visited are described below, together with the special conditions of their occurrence. They all occur in the district immediately sur-

*See Report of Geological Survey of Canada 1887, Part T, Assay No. 43.—Idem, 1886, Assay No. 45.
†Idem, Part T, Assay No. 44.

rounding this Lake. They are known as the *Sunset Lake*, *Medicine Bluff*, *Caldwell's*, *Scripture's*, *Hurlburt's*, *Geroux's*, *Laplante's*, *Arrow River Mining Co.'s* and *Whitefish Lake Mining Co.'s* veins, and all except the three first mentioned, which are in the upper black argillite division, occur in the lower siliceous rocks, and are located within a distance of about two miles from where these rocks abut on the Archean gneissic and granitic rocks to the north. Enclosing rocks.

The veins visited in this area were found to have much the same contents as those already described, viz., blende, galena and pyrites in a gangue composed of very varying percentages of calcite, and colourless, white or amethystine quartz with green fluorite, barite being only occasionally present. The metallic minerals are by no means present at all the places at which these veins have been exposed, being fairly plentiful at some of the places, whilst at others, the gangue minerals are almost or entirely free from them. General characteristics of veins of the group.

Up to the end of 1886, no extensive bodies of silver bearing ore had been found in any of them, and in fact at those places where good silver had been reported as found, it had been removed so completely as to render it difficult to find more than traces of the silver minerals here and there.

The rocks of this area show much the same features as those presented by the Silver Mountain district, viz.: a general division of the Animikie rocks into an upper argillaceous and a lower siliceous division. The latter form the northern fringe of the formation, and occupy all the lower lands to the north of the range of hills, forming the divide between Whitefish Lake and Whitefish River, their line of contact with the Archean rocks to the north, being roughly coincident with the course of that river. Passing southward from this, one comes in the higher levels of the south side of the river valley to the more argillaceous beds of the upper division, which shew, however, some tendency in character towards the lower siliceous division, whilst further south on the other side of the lake the lower beds are rarely if ever seen, and the upper argillaceous beds seem to be more largely developed and to closely resemble the typical black soft argillites of this formation. Geological features of the district.

These beds in the already mentioned range of hills north of, and in the others surrounding Whitefish Lake are all capped at about the same level by the usual columnar trap, whilst at lower levels on the north shore of the lake there are evidences of the existence of another and inferior sheet of the same. This inferior sheet shews at the water level along most of the north shore of this lake, and is noticeable in passing north along the trails leading from the lake to *Laplante's* vein near Little Traps.

Gull Lake, and to the *Arrow River Mining Co.'s* vein on Whitefish River.

Vertical section of the formation—Laplante's Trail.

The vertical dimensions of the sections obtained in passing over these trails were measured with the aneroid on several occasions, and gave the following mean results:—

Trail to Little Gull Lake:—

500 feet	.....	Top of hill
400 to 500 feet	.....	Upper trap sheet.
260 " 400 "	.....	Exposures of argillaceous beds.
200 " 260 "	.....	Covered.
0 " 200 "	.....	Over lower trap sheet.

In descending the northern face of this hill, these same argillaceous beds were found to underlie the upper trap, but seem to have thinned out in this direction, and they measure here only about 50 feet, the lower siliceous beds occupying all below this until the Archean surface rises from beneath them to the north. To the west of this hill lies the one on whose northern and eastern slopes are located the workings on *Giroux's* and *Hurlburt's* veins and the lower surface of the trap sheet capping it having been measured in the same way, is found to occur at a height of about 450 feet above the lake with a thickness of about 100 feet, whilst further north, the lower surface of the trap capping one of the Outpost Hills immediately north of *Laplante's* vein, was found to be at an elevation of about 700 feet above Whitefish Lake, and its upper surface at nearly 800 feet.

Another vertical section of the formation.

In passing over the trail a mile or two west from the last mentioned one, from the lake to the *Arrow River Mining Co.'s* works, the following vertical section was obtained in a similar manner.

360 feet	.....	Top of hill
280 to 360 feet	.....	Upper trap sheet } shewing in a hill a little
180 " 280 "	.....	Argillaceous beds } to the east of trail.
140 " 180 "	.....	Covered
0 " 140 "	.....	Over lower trap sheet.

This hill is one of those forming the divide range between the Lake and Whitefish River, and in descending its northern face a diminishment similar to the above-mentioned, is observed of the thickness of the upper division beds lying between the capping trap sheet and the lower siliceous division rocks, the latter constituting all the rock exposures along the trail from this point, on in a northerly direction till their contact with the Archean is reached.

In neither of these sections is the lower trap sheet met with in descending the northern face of the range, as the ground never comes

down to the level at which its upper surface shews on the Whitefish Lake side, so that the question as to whether it extends that distance, and therefore underlies the cherty rocks there exposed, or whether it thins out in going north, is still unsettled.

The composition of these various rocks has been described in the foregoing parts of this report, and the features presented by them at the various points visited, are dealt with later, so that nothing further need here be said.

Sunset Lake Vein.

Whitefish L. group of veins.

This vein at the place where the chief development work has been done upon it is enclosed in siliceous beds, lying on a sheet of trap which shows in a little cliff to the south of the workings on the north shore of the little lake, known by the above name. About 100 yards to the north of this spot, beds of a higher horizon show in a bluff, consisting of black argillites capped with the usual columnar trap of the district. The vertical section of the beds here, is therefore, as follows, commencing from the level of Sunset Lake upwards.

Vertical section of the formation.

130 to 160	feet	.....An estimated thickness of columnar trap.
110 " 130	"	.....Black argillites and shale.
30 " 110	"	.....Covered.
20 " 30	"	.....Covered (at thirty feet workings on the vein in the siliceous beds).
0 " 20	"	.....Lower sheet of trap.

This brings us to the top of the ridge separating Sunset Lake from Whitefish Lake, from which point there is a fall of about 280 feet to the level of the latter lake, in the descent of which by the trail, however, the rocks below the upper trap are all found to be covered up.

Intrusive trap sheet.

The lower trap sheet shows considerable evidence of being an intrusion. It is darker and more compact than the upper one, especially towards its upper surface, where it has been in contact with the overlying rocks, which, by cooling this part more rapidly than the central portion, would have produced this compactness, whilst in descending the little cliff, we find the rock assuming a much coarser and more distinctly crystalline texture. The extremely smooth upper surface of this sheet would also seem to point to its being an intrusion amongst smoothly bedded rocks, as the absence of any grooving or polishing forbids the supposition that it is, like some of the similar smooth surfaces of this district, due to ice-planing.

The work done on the vein has been very little, consisting of a fifteen-feet test-pit and some surface work in the outcrop at various points.

Medicine Bluff.

Whitefish L. group of veins continued.

Two veins have been tested to a small extent in this vicinity, on mining locations R 208 and R 119 respectively. The work to the end of 1886, at the former place, consisted of a small cross-cut, driven

Location R 208.

about thirty feet through the argillite into the side of the bluff near the top to intersect the vein, which here dips at 80° to the north, from the end of which drift a little pit has been sunk. These developments have not been prosecuted far enough to prove much about the vein. Medicine Bluff itself consists of black, soft argillites and shales, capped by a columnar bed of trap. About half a mile to the east of the before-mentioned workings, the section presented in the bluff is as

Vertical section of the formation.

follows:—The contact of the argillites with the trap is found to be 400 feet by aneroid above the water of Whitefish Lake, the trap having an estimated thickness of from 100 to 150 feet above this point, whilst below it the argillaceous beds show at intervals for a distance, vertically, of about 150 feet, everything below this being covered up by detrital matter fallen from the cliff above. The name Medicine Bluff is derived from the occurrence in the face of the cliff of a mineral efflorescence, which is probably alum, stained with hydrated iron oxides derived from the re-action of the oxidation products of the pyrites on the shale in which it occurs. It is said that the Indians gather it for medicinal purposes, hence the name.

Location R 119.

The vein on R 119 location lies about half a mile to the west of the last-mentioned point, and skirts along the base of a bluff which rises out of a swamp, and consists of columnar trap for the greater part of its height of 300 feet, as measured by aneroid. Just at its base, argillites are seen to underlie it, only showing, however, a thickness of a few feet above the surface of the swamp. They appear to be mostly soft, but not so dark in color as the typical black argillite, whilst at other places there are portions whose coarser grain would relate them more to sandstones. The work done consists of a cross-cut driven in through the argillites of the hanging wall for a distance of about twenty feet, when it reached the vein. At this spot, the edges of the argillites lying in a horizontal position come abruptly up against the trap forming the cliff, and there is some appearance of this trap being a dyke running parallel with the vein, and cutting both the before-mentioned horizontal trap sheet and the underlying argillites; but further work is required to prove this. It is also difficult to decide, without working over a much larger area than was possible in visiting this spot, whether the capping trap here found at the level of the lake is part of that sheet which in the vicinity rests on the argillites at

a height of 400 feet above this level, and is faulted down into its present position, or whether it is a sheet occurring lower down in the formation. Whitefish L. group of veins—continued.

Caldwell's Vein.

This vein shows a little to the west of the trail going to Little Gull Lake from Whitefish Lake, cropping out on the side of the hill which rises to the north of the western end of Whitefish Lake, over which the trail passes. Where seen, it is enclosed in rather hard, dark argillites, which show a tendency in places to approach in their nature the more siliceous lower division beds. The vein shows here about four feet thick, dips steeply to the south, and passes a little above this spot upwards into the trap sheet which here caps the argillites and forms the top of the hill. The vein is here seen to have faulted the enclosing rocks several feet. Little or no work has been done on it. Rocks faulted by vein

Scripture's Vein.

A vein known by this name occurs some distance further up this trail, where it is seen to be enclosed in the typical jaspery and wavily bedded ferruginous cherty rocks of the lower siliceous division, which, in the neighbourhood of the vein, are plentifully penetrated in all directions by stringers filled with crystallised quartz, the vein itself being entirely made up of this mineral of the various colours prevalent in the district, and showing a tendency to a cone-like structure. The vein is solid, and four feet thick, dipping to the south. The work done consists of an open cut driven into the side of the hill which it intersects.

Hurlburt's Vein.

Passing westwards from *Scripture's*, we ascend the steep east-facing slope of a hill, showing about 150 feet of the wavily-bedded silico-ferruginous rocks capped by a sheet of trap about 100 feet in thickness. A little pit about six feet deep has been sunk in the vein where it outcrops about fifty feet below the trap. About half a mile further west, on the run of and presumably on the same vein, some little work has been done in its outcropping, and it is said that good ore, carrying native silver, has been obtained at both of these places. None, however, was to be seen at any of the accessible points, although an assay of some picked pieces from the first-mentioned developments gave nearly two ounces to the ton,* showing that the metallic minerals therein contained carried silver, as none of the silver minerals proper

* See Report of Geological Survey of Canada, 1887. Part T Assay No. 38.

Whitefish L. group of veins —continued.

could be detected in the rock, even with the lens. The latter, or most westerly workings, occur on the north slope of the same hill, and the enclosing rock of the vein is here a hard, dark silicified argillite, the edge of the capping trap sheet showing a short distance to the south at a little higher level than the workings.

Geroux's Vein.

The workings at this place are apparently upon the extension of *Hulburt's* vein, and are situated on the north face of the same hill, about half a mile west of the last-mentioned point. At *Geroux's* workings, the enclosing rocks belong to the typical cherty and dolomitic beds of the lower division, between which and the overlying trap sheet intervene some ten to fifteen feet of the black, soft argillites which show in a thirty-feet cliff about one-quarter of a mile south from the workings.

A curious feature here presented consists in the occurrence amongst the cherty rocks proper of a light green dolomitic rock, whose colour is found to be due to the plentiful distribution through it of a pale green aborescent or fibrous mineral, probably actinolite, which has most likely been developed in the dolomitic bed by subsequent metamorphism.

Below this point, the ground falls away rapidly to the north and west for a vertical distance of about 200 feet, over which area nothing but chert and jasper beds are to be seen, which a mile west of this are found to abut against the pale pink gneissic rocks of the Archean.

Laplante's Vein.

Contact of Animikie and Archean rocks.

About a mile and a half north-east from the last mentioned, on the line of junction between the Animikie and Archean rocks, test shafts have been sunk on two veins running parallel to each other on either side of a ridge of the latter, which is flanked on both sides by the Animikie jaspers and cherts. The shaft on the east vein is about thirty feet in depth and sunk on an indefinite vein or lot of branches and stringers distributed through a dark-green, *slickensided*, chloritic material, which may be possibly part of the vein, and having a general dip towards the north-west, whilst the strike is north-east. In the thirty-feet shaft on the opposite side of the ridge, a well-defined, solid four-feet vein is visible, going down about vertically as far as followed. It has evidently faulted the enclosing rocks, as the one wall consists of the gneiss, etc., of the above-mentioned ridge, whilst the ferruginous, jaspery and cherty beds form the opposite or W. wall. Just at the

top of the shaft, the original contact of these two systems of rocks is well shown, the gneiss being overlaid by a thin sheet of jasper in a horizontal position, which at places has been denuded off so as to be no thicker than one's hand. Whitefish L. group of veins continued.

Arrow River and Whitefish Lake Mining Companies.

At the place shown upon the Sketch Map, the two above-mentioned companies have done a small amount of testing, both working on the same vein. It shows as a solid four-feet vein on the surface at one place, whilst at another there are eight to ten feet of solid vein stuff, but as is so common in these veins when followed down, it is at places all split up. Its dip would appear to be to the south, although the developments have not gone far enough to prove exactly. It outcrops in an area of the typical lower siliceous beds which show as the surface rocks for over half a mile south of the vein, being exposed along the trail leading to this place, and are again seen on the Whitefish River, about a quarter of a mile to the north of the same spot, where they come in contact with the Archæan. The enclosing rocks present no peculiar features, except in the occurrence towards the bottom of the shaft of a rock having more the color and texture of some of the argillites of the upper division, but which differs from them in being much silicified and hard. The bedding planes of the rock were found to be frequently coated with a black material that rubbed off and resembled graphite.

A peculiar feature is presented by some of the calcite in the gangue, which often has quite a pearly lustre and tendency to curvature of the cleavages, which variety is often stained dark by some material not determined, but that it is merely calcite is shown by its free effervescence with acids and by its cleavage angles. Other somewhat marked features are the occurrence of the quartz in veins intersecting the calcite and crystallized in the freer spots and cavities, and the presence of dark streaks through the gangue, which, judging from their dark-greenish-black, lustrous appearance, are probably some chloritic decomposition product. The work done consists in the main of two shafts sunk on the vein, each about thirty feet deep, at a distance apart of about 900 feet, with some little workings in the outcrop between them.

About half a mile to the south of this point, a couple of shallow pits have been sunk on a solid five feet vein which is enclosed in the siliceous rocks. As far as can be seen it dips to the north at 65° to 70°.

General Characteristics of the Silver Veins.

In order to complete the study of this subject, it will be here necessary to give a resumé of the characteristics of these veins, and to mention some of the general conclusions which may be based thereon.

Strike directions.

A study of the Sketch Map will show that as regards their strike-directions, they resolve themselves into three groups: A N.W. group, a N.E. group and an E. and W. group. The N.W. direction of strike is most characteristic of the Coast group, the famous *Silver Islet* vein being the most striking example of this, whilst all the rest of this group run parallel with it. The chief example outside of this is the *Beaver Mine.*

All the veins of the Rabbit Mountain group, with the already mentioned exception of the *Beaver*, may be classed as N.E., whilst the *Thunder Bay Mine* vein also belongs to this series.

The last series do not run in general due east and west, but a little N. of E. and S. of W. To this series belong nearly all the chief veins of the Port Arthur group, with the exception just mentioned, and nearly all the Silver Mountain group.

Dips of veins.

The dip of these veins is not sufficiently worked out to form any basis for classification as most of them have not been followed deep enough to be quite sure of what their real underlay is, and some of them have changed their direction of dip in depth as at the *Shuniah Mine.* In this connection, it may be useful to suggest that when too little of a vein is visible to decide its direction of dip, the study of the displacement of the rocks generally produced by these fissures will often aid in determining this point, as in nine cases out of ten, the lowering of the rocks has been on the hanging wall side, whilst the extent of the displacement may give a rough idea of the strength of the fracturing force producing the fissure, and therefore of the extent and definiteness of the vein.

Physical characteristics of veins.

The physical characteristics of these veins present some features of interest worthy of notice by those working on them. These, as one would expect, vary with the nature of the enclosing rocks; in the different varieties of which the fissuring force would have different effects. Thus, as a general rule, the veins in the trap beds are wide and solid, the proportion of the wall rock enclosed by the vein filling being comparatively slight, whilst in the argillites below, they are apt to be very irregular, and at times difficult to follow, being at one place large and solid, and at another all divided up, and represented by numerous small stringers and branches distributed through a great thickness of the argillites, these changes often occurring very suddenly in following

them. This is just what might be expected of the action of a force tending to produce a fracture in such rocks, for where the argillites were more compact, the force would act only over a small space, whilst in the more shaly parts there would be a tendency to give rather than to fracture, and the force would get distributed, and again, the trap being a more rigid and compact rock with jointings far apart in it, and those vertical, one would expect a wider fissure with definite walls. This would also apply, of course to the lower siliceous division where solid, whilst in the varieties with much bedding structure, the results would resemble more those produced in the argillites, and this is found to be so. This would probably account for the great width and solidity of most of the Coast group of veins which, in a general way, distinguish them from most of the rest of the veins under study; the former having been opened upon nearly altogether where they intersect trap dykes, or in their immediate vicinity, whilst the workings on the latter are almost altogether in the veins where they cut the argillites.

Irregularities in structure of the veins.

These irregularities in width have in some cases disheartened operators, and led them to believe that their vein had "pinched out," but in view of the explanations just tendered it may be usefully pointed out that such fears will generally prove to be unfounded, and that where the extent of the accompanying faulting of the enclosing rocks is considerable, and there is other evidence to believe that the fracturing force was such as to produce an extensive and persistent fissure, a little pluck and energy in following it up will generally take one through the disturbed parts to where the vein will again be found wide and solid, and this has been found to be the case already in several instances. The definiteness of the bounding walls of the veins, it need hardly be pointed out, also varies with the rock they are in, in a similar way. Some of them, as at Jarvis Island, show *slickensided* walls in the vein matter itself, and other evidences of movement since filling. *Slickensided* surfaces are, however, not very common in the district.

Slickensides.

Contents of the veins.

The vein-filling minerals consist in general of quartz, barite, calcite and fluorite constituting the basis of the gangue, in which occur the different metallic minerals, viz., blende, galena, pyrites of various species, and occasionally some sulphurets of copper, whilst the silver in the orey parts occurs as argentite and in the native state, the former being the most common. At places, the veins carry a dark green, probably chloritic material which on some surfaces has a bright, waxy lustre, whilst occasionally a soft, greasy, talcose material, probably Saponite, accompanies the ore, notably at the *Beaver Mine*, and to a lesser extent at one or two other places. Carbon in various forms has also been found here and there, whilst in some of the *vugs* in the veins, which

Chloritic and talcose materials.

Carbon.

have been found near the surface, stiff clay and ochreous material have sometimes been obtained, along with nuggets of argentite, the former, however, having evidently been washed in from the surface, and has thus imbedded the silver minerals already existing in the *vugs*.

Silver Islet vein exceptional.

These, then, are the mineral constituents of these veins but the *Silver Islet* vein forms somewhat of an exception, in that it carried, besides these, various arsenical and antimonial ores of silver with compounds of nickel and cobalt, and other metallic minerals which have, so far, not been found in the rest of the veins. Other salient features were the pink and cream-colored dolomitic spar which so frequently formed a characteristic and prominent constituent of the gangue of the rich ore, and the predominance of native silver in the rich parts, whereas in the rest of the veins, though this form of silver occurs in considerable quantity at places, yet argentite seems to be the form in which it is generally found.

Gas and mineral waters.

It is interesting to note that both the mineral waters and the inflammable gas that were met with in opening up the *Silver Islet Mine* have also been encountered at other points in the district.* At the *Rabbit Mountain Mine*, in one of the lower levels, I saw water running over the breast of the drift which gave off a faint odor of sulphuretted hydrogen, and was depositing a white flocculent material, whilst both at this place and at the *Beaver Mine* I was informed that small quantities of inflammable gas had been met with.

Variations in texture, etc., of gangue.

The general appearance of the filling differs very much at different places in the same vein, owing to the frequent variations in the proportions of the different minerals constituting it, and to the various colors some of them assume. The texture of the vein rock differs also very much, owing to the differences of crystalline aggregation of the minerals, varying thus from a compact, vitreous, crystalline or saccharine to a very coarsely crystalline gangue, whilst at other places, the vein-stones present more of a brecciated appearance, consisting of angular fragments of the enclosing rock, cemented together by the gangue minerals, and often with empty spaces between.

The coarser textured vein-stones are generally found, as might be expected, where the clear space to be filled up has been large, which, as pointed out, has generally been in the trap, so that the Coast Group of veins often present this character, as do the others also where they outcrop in the trap, and it is in these positions that the large crystal-lined cavities and *vugs* occur. The minerals which mostly affect this

* Inflamable gas also comes up at several points in and around Thunder Bay, causing considerable ebullition in the water and keeping it open all the winter. On one of these Mr. Murdoch, C.E., has placed a small tank connected with an inverted funnel anchored on the bottom and it affords sufficient gas to keep a good sized light burning.—A. R. C. SELWYN.

connection seem to be the barite and calcite, especially the former, the frequency of whose occurrence characterizes the gangues of the above-named group of veins, which thus contrast with the more commonly finer grained vein stones of the other groups, which consist more generally of varying amounts of calcite, quartz and fluorite. It need hardly be pointed out, however, that these distinctions are only based on the general prevalence of certain constituents and conditions of texture, etc., and not on any hard and fast lines.

Distribution of metallic minerals in the veins.

Through these different kinds of gangue are distributed the metallic minerals in a very irregular manner. Sometimes they are very plentiful, whilst long stretches of vein are frequent, which are quite free from them. When they are present, they occur mostly in bunches and more widely disseminated whilst more rarely they show as streaks parallel to the vein walls, a mode of occurrence more frequently affected by the Coast group than by the others.

Mode of occurrence of silver ore in the veins.

The distribution of the silver minerals in the veins is similarly very irregular, so that the rich ore generally occurs in detached bodies of very varying dimensions, surrounded by very poor or quite barren areas of the vein; the frequency with which they occur and their extent when found, constituting, of course, all the difference between success and failure of the mines.

Descriptions of the different minerals of the veins.

The details of the characteristics of the different minerals are as follows:—The quartz occurs massive, crystallized, and in granular crystalline form, transparent, white and amethystine in color, the latter being very characteristic of these veins. It sometimes fills the whole vein, and is occasionally seen crystallized in the wedge-shaped spaces between radiately arranged crystals of barite, and also similarly a jaspery form was seen to have filled out spaces between calcite crystals. It is also very frequently the case that thin films of colorless quartz are found in the cleavage planes and minute fissures in the calcite, which films do not show on the fresh fracture, owing to the similarity of appearance of the two minerals, but stand out on weathered surfaces as a regular reticulation from the removal of the surrounding calcite. The smaller vugs are generally lined with pyramidal crystals of this mineral. It is more common in the veins where they occur in the sedimentary beds than where they are in the trap. There is nothing particular to note about the barite except that it is generally white, but sometimes flesh-colored, and occurs sometimes crystalline, but more often largely crystallized in confusedly interferent platy combinations. The calcite occurs both crystalline, crystallized and in coarse cleavage masses. Where it occurs freely crystallized, as in vugs, it most commonly takes the shape of double-ended scalenohedra, but sometimes exhibits the prism terminated by faces of the rhombo-

Quartz.

Barite.

Calcite.

hedron. Mr. H. P. Brumell, who applied the alcohol flame test to a large number of specimens of this mineral from this district, reports finding strontium in nearly all.

Fluorite. The fluorite occurs granular, crystalline, crystallized and in mammillated forms, whose surfaces are often made up of faces of the cube. When crystallized, it occurs in well-formed cubic crystals or in groups of the same. Its color is most commonly light-green, but it shows amethyst tints nearly as often, whilst some of the layers of green fluorite show a tendency to this amethyst color on their mammillated surfaces. Occasionally, detached, well-formed crystals, occurring in *vugs*, are pale yellow or colorless.

Chloritic material, etc. The description of the saponite has been given in mentioning its occurrence at the *Beaver Mine*, and the presence of chloritic material has also already been alluded to. This latter, although not part of the veinstone proper, is yet of frequent occurrence, and its very dark-green or almost black, soft varieties have been occasionally mistaken by prospectors for plumbago, which is considered a favorable indication in the district.

Carbon. The association of this latter mineral, and the occurrence of other forms of carbon in connection with these veins, has already been mentioned at several places, and the favor with which it is regarded as an indication arises from its close association with the rich ore of *Silver Islet*. The anthracite-resembling form which is occasionally found in the veins, as well as in the enclosing rocks, would seem in composition to be almost pure carbon, showing, as it does, no volatile matter on being heated. It has been described as altered bitumen in the "Geology of Canada," 1863.

Water and gas. An analysis of one of the mineral waters has already been given in speaking of *Silver Islet*, so that no more need be here said regarding them, except, that if the managers of the mines could be induced to collect samples, further examinations might give interesting results. Of the gas we unfortunately know nothing, except that it is inflammable. I was never fortunate enough to be present when any was met with, but explained to some of the managers how it might be collected, thinking that a preliminary examination of such a sample might be of use, but my efforts to secure some have so far been in vain.

This completes the description of the non-metallic contents of the veins, the characters of the metallic minerals being given below,

Blende. dealing with them in the order of their prevalence. The blende comes first in importance, being the most plentiful. It occurs both crystallised and in cleavage masses, often of considerable extent. It is sometimes disseminated through the gangue, and often forms solid ribs, etc., traversing it. It frequently occurs thus along the walls of

the fissures, and as crystalline growths starting out from them into the veinstone. It shows both lighter and darker coloured varieties, the former more often as detached disseminated crystals, whilst its more massive occurrences are generally of a very dark brown colour or almost black.

Galena.

The galena does not play such an important part, nor generally exist in such considerable masses, but is generally disseminated. It also shows sometimes as films, sheets and little patches in the jointings and cleavages of the veinstone, which, from having a dull, leaden surface and dark color, somewhat resemble similar occurrences of argentite, from which they can be readily distinguished, however, by cutting with the knife, when they break up into little grains showing the characteristic bright cleavage surfaces of galena. Both the blende and this mineral are often found in the *vugs* and open spaces in the veins, in beautifully perfect crystals, the latter showing most commonly in combinations of the cube and rhombic dodecahedron.

Pyrite.

The pyrite is found to a lesser extent than the two last mentioned. It occurs often well crystallised in small cubes coating the crystals of quartz or calcite, which are found lining *vugs* and also disseminated in the gangue and to a less extent in films and dendritic markings in the jointings and cleavages of the gangue minerals. It is also found sometimes in the rocks of the district, especially in the trap, but sometimes in the argillites, cherts, etc., and occasionally in considerable quantity adjacent to some of the veins as at the *3 B* vein, on Big Trout Bay.

Other metallic minerals.

Besides these more important metallic minerals, others are found in connexion with them, viz., marcasite and pyrrhotite, which are, however, rather rare, whilst copper is represented, especially in the Coast Group, by chalcopyrite and copper-glance, the latter being often argentiferous.

Occurrence of the silver minerals.

So much then for the metallic minerals which form the associates of the silver minerals proper: the mode of occurrence of the latter will be now described. In the ore bodies, the metallic minerals are generally present in large quantity, blende generally predominating largely, although galena sometimes plays a prominent part, and through these minerals are found distributed the argentite and native silver. Sometimes these silver minerals are distributed through the gangue minerals themselves, the others being hardly represented at all.

Argentite.

The argentite which is the most common is found in nuggets of various sizes in the *vugs* bearing the impress of the quartz or calcite crystals which usually line them, and also in thin films coating the surfaces of such crystals, and in the joints and cleavages of the gangue

minerals, whilst it is also occasionally recognisable in the cleavages of the blende. Where filling in larger cracks, it, of course, occurs in thicker sheets, whilst at times, when very thinly distributed over cleavage planes, it assumes dendritic forms. Sometimes these films are found to merge at places into the native metal as if from a partial reduction of the sulphide. It is sometimes stated in the district that it occurs in the argillites themselves, but in these cases it is always found to be in thin joints and cracks in them. The native silver occurs in thin sheets, films and facings in a similar way to the last and also in wire and fern-like forms, the latter in *vugs* at times forming a very beautifully moss-like lining to them. In one or two instances these wires etc., were found seemingly penetrating small crystals of blende, or as if that mineral had crystallised around them. With the exception of *Silver Islet*, this form of silver seems to be more characteristic of the ore bodies near the surface and to be replaced by argentite in depth, which would seem to show that it is probably due to the reduction of that mineral to the metallic state by surface waters.

Native silver.

Dendrites.

Besides the dendritic occurrences of argentite, other dendritic films and stains are common in the cleavages and jointings of the veinstones. These have often been mistaken by prospectors for argentite, but to the experienced eye, whilst greatly resembling it, they have yet a distinguishable difference of colour and lustre. In composition they are probably oxides of iron or manganese.

Results of assays made.

Assays have been made in the laboratory of the Survey, to the number of about forty-nine, of specially selected specimens, with a view to get some further knowledge as to whether or no the other metallic minerals carry the precious metals. These specimens were selected on account of their holding as large a proportion as was obtainable of the metallic minerals, and where possible, which was seldom however, these different metallic minerals were obtained free from admixture with each other.* A careful record was kept of the mineral contents of each one submitted for assay and the study of these in connection with the results obtained point to the following conclusions, viz:—that the metallic minerals when free from visible silver compounds, carry none of that metal, or when they do so, its proportion is very small. The likelihood of their carrying any silver seems to be in the order in which they are here named, viz:—blende, galena and pyrite, only one instance being found in which the latter mineral did so, where being the only one visibly present in the specimen of veinstone treated, the assay yielded about half an ounce of silver to the ton.

* See Reports of Geological Survey for 1886 and 18 7. Part T.—In nearly all the instances of specimens submitted for assay they carried enough of the metallic minerals to constitute good milling ore, had these minerals proved to contain as much silver as was credited to them in the district.

All the specimens were also examined for gold at the same time, but only showed traces of it in a few instances, and in those nearly always in specimens where the blende preponderated, pyrite being absent except in one instance, although one might have expected gold in connection with the pyrite considering its frequent association with that metal in gold veins proper.

As has been mentioned in connection with *Silver Islet* and the older mines, these metallic minerals or rather the galena and blende get enriched with silver in the ore bodies, and it has often been asserted that the very dark-coloured blende which so frequently occurs in this connection is always rich in silver, but some of the assays made prove that this is not always so. Of two specimens of such blende each accompanied by a little gangue, one showed no silver and the other gave about 337 oz. to the ton. In the latter instance, the attached gangue carried a little visible argentite, but not enough to account for so high a yield.*

Assays.

In the study of these assay results, no connection was noticeable between the different kinds of gangue in which the minerals occurred and the presence of silver. Further details of these assays will be found on referring to the reports of Mr. Hoffmann of the work of the Chemical Branch of the Survey for 1886 and 1887, and other assay returns of specimens from these veins will also be found scattered through similar reports in the volumes of the Survey for some years previous to this.

Relationships of different vein.

Materials.

A much closer and more extensive study than the time at disposal has allowed of, would be required to determine the relationships of the various minerals to each other, and whether they all owe their presence to the continuous action of one set of forces, or whether they have been formed at different periods. So far as the study has gone, however, some suggestive points have been made out. For instance, the presence of the films of silica deposited in the cleavage planes and minute fissures traversing calcite would seem to prove that quartz must have been infiltrated after the calcite had been formed, whilst in other cases, these minerals are found so related to each other that they would seem to have been formed about the same time, which is probably due to the existence of quartz of two different ages, one deposited later than the other. There are some similar evidences of the presence of both primary and secondary calcite, the latter kind showing in the *vugs* as finely formed small transparent crystals, generally scalenohedra, but sometimes a combination of prism with rhombohedral terminations. These are there superimposed upon minerals which are otherwise

Primary and secondary quartz and calcite, etc.

* See Report of Geological Survey of Canada for 1887. Part T Assays 35 and 36.

generally found coating the other kinds of calcite whose coarse cleavage masses and opaque white appearance contrast strongly with the characters presented by the secondary forms.

Probable mode of deposition of silver minerals.

The mode of occurrence of the silver minerals, too, would seem to show that their presence was due to a later infiltration of silver-bearing waters subsequent to the deposition of the gangue minerals; occurring as they do, deposited in the fissures which traverse these, in the cleavage planes of the calcite and coating crystals of silica, etc., and as one would expect forming larger masses or nuggets in the wider spaces or *vugs* in the vein. This deposition seems to be confined to the permeable minerals and parts of the gangue as might be predicted, and I cannot recollect seeing the silver compounds actually in minerals such as quartz or barite which are evidently not adapted to this method of enrichment. It would also be in keeping with the facts noticed regarding the other minerals; the compact pyrites not being argentiferous, whilst the presence of cleavage planes in blende would allow of its enrichment in this manner at points where such deposition was going on. It is also noticeable that, so far, no instance has been observed of the secondary calcite carrying silver in this way. Mr. Courtis records a curious association of minerals which he observed at *Silver Islet*. He says:—"The breast of the stope showed a coating several inches thick of a spongy silver in which were imbedded, like plums in a pudding, double-ended quartz crystals."*

Possible sources of silver.

Many suggestions have been made by various observers as to the probable source whence these silver minerals have been derived. Some have thought them to be due to the same volcanic action to which are attributable the presence of the traps in the formation, and that the silver has been brought up by thermal waters accompanying these intrusions, but, as the fissures intersect and dislocate the trap sheets and dykes equally with the other rocks, the former must have been formed and solidified long before the fissures. The fact, however, remains that all the ore bodies found so far, occur near or within a reasonable distance of trap in some form, either in dykes, as in the case of the Coast group, or in sheets, as with the other groups. This suggests the idea that the silver may be derived from them by decomposition of some of their mineral constituents carrying minute quantities of silver, by waters infiltrating downwards through all their joints and pores, and that these waters passing onwards and soaking into the permeable parts and minerals in the gangue of the veins, have there deposited their silver contents, the various forms of carbon present in the sedimentary rocks having had some influence in effecting this precipitation. The presence

* See Transactions American Institute of Mining Engineers, Vol. XV, page 674.

of the soft talcose and of the various chloritic materials in this connection would seem to bear out this assumption, as they are just such decomposition products as would result from this kind of action. The most favourable conditions for the production of such results then would be :—1st. Such a combination of mineral and physical characters of the gangue as would render it easily permeable. 2nd. The presence of carbon in some form. 3rd. The presence in the adjacent trap of the silver-bearing constituent, and also of a jointiness and fissuring allowing of the infiltration of the decomposing waters. In this way we would expect more effect from the very jointy, columnar and more extensive sheets than from the more compact and less extensive ones. Thus, it would be only where all these conditions were combined, which would only be at spots, that the deposition of the silver minerals could be expected to take place, a view that goes far to account for the mode of occurrence of the rich ore in the veins in detached bunches varying much in size and frequency, and for the total absence of silver in the intermediate stretches of the veins, as well as for the curious fact that the metallic minerals carry no silver remote from the rich parts.

Probable conditions of deposition of silver minerals

Movements subsequent to the formation of the veins (of which there is some evidence at places) would also tend to produce favourable conditions by fissuring and rendering the gangue minerals more permeable. These hypotheses might be held, by those who have the idea that the trap forms a single flow or sheet at a definite horizon in the formation, to necessitate the conclusion that the ores would be found only near the surface, but when we remember that this is not so, and that the trap sheets exist at various horizons all through these rocks, it will be seen that no basis for such an assumption exists, and that they are just as likely to be found in depth as at the surface. The above hypotheses must, of course, be only taken as suggestive, as there are yet many gaps in the evidence and points yet open for study, one in particular as to whether the traps do or do not contain any silver, a point that can, of course, only be settled by an extensive series of carefully made assays of these rocks, such as have been made in investigating similar phenomena at other places.

Conclusion.

In concluding this study of "Silver Mining on Lake Superior" from the standpoints enumerated in the preface, the results may be summarized as follows :—

Part of the area of the Animikie or silver-bearing rocks in Canada has been fairly prospected, although not nearly so thoroughly as it might, and probably would have been, but for certain adverse, economic

Extent of silver formation explored.

General results of explorations.

conditions previously mentioned. This search has led to the discovery of very many veins, some of which have been proved by development to contain extensive bodies of very rich silver ores. A great many of the other veins found have also yielded smaller quantities and specimens of similar ore, whilst in a great many none has been found so far. In the two latter cases, however, it generally appears on investigation, that the work done to test the veins has been so slight as to leave the question of their capabilities as ore-producers still unsettled, which also applies to many of the mines which were opened during the earlier periods of the history of the district and are now closed. In these, although much more was done than mere surface testing, and although shafts, etc., were sunk, still these underground developments were in most cases not sufficiently extensive to disprove the existence of ore bodies of sufficient extent and frequency to pay.

Results of prospecting and developement of silver veins.

Amongst the chief results of all this prospecting work have been: the proving of the widespread occurrence of rich silver ores throughout the formation, and the existence of very numerous veins, on very many of which, if properly handled, successful mines, besides those already in operation will be opened up. Of course, many of them may not thus reward the efforts made to develop them, but this is no more than occurs in every mining district in the world, and we cannot expect the one under study to prove an exception.

Lessons taught by past experiences in the district.

One of the most important lessons taught by past experience is, that owing to the mode of occurrence of silver in the veins, they require more extended underground developments to prove their value than most other lodes, and that unless this is borne in mind and acted upon in the future, and unless the developmental works and drifts are kept well ahead of the stoping out of the ore bodies already found, and the operating companies provide in the start a sufficient capital to do this, the failures of the past will be repeated in the future. Regarding the statistics of the yield of silver from this district further details will be found in the article on silver by myself in the Report of the Geological and Natural History Survey of Canada for 1886, Part S, pages 73-5.

APPENDIX I.

NOTES OF MICROSCOPICAL EXAMINATIONS OF ROCKS FROM THE THUNDER BAY SILVER DISTRICT.

By Mr. W. S. BAYLEY
OF
THE JOHNS HOPKINS UNIVERSITY,
Baltimore, U.S.A.

Microscopical characters of rocks of silver formation.

No. 85.—McKellar's Point (*from near the end*). This rock is composed of felspar, quartz, green hornblende and magnetite. The felspar is in rudely outlined lath-shaped crystals, and in irregular grains between the other constituents. It is very much altered, and as a result of this alteration, is filled with inclusions of red iron compounds. These are scattered throughout the material of the crystals and grains, but are most abundant around their exterior portions. Kaolin and chlorite are the remaining products of its alteration. The quartz occurs in irregular areas and in club-shaped masses, intergrown with portions of the red felspar. The green hornblende is only sparingly present. It is found in little plates and shreds, and in allotriomorphic grains between the other components. It has undergone chloritization, resulting in the breaking up of the grains into small particles and fibres which are irregularly intermingled with the felspar and quartz. Magnetite is closely associated with the chlorite derived from the hornblende. It is also occasionally present in little grains in the felspar. In the latter case it is sometimes surrounded by rims of brown biotite. Apatite and sphene (?) also occur in small quantity.

From the examination of this single specimen it would seem necessary to regard the rock as closely allied to those of Irving's augite-syenites,* which are like the contact rocks on Pigeon Point,† at the junction of olivine-gabbro and an acid eruptive.

* Copper-Bearing Rocks, p. 112-125, Pt. XIV.
† Amer. Jour. Sci., Jan. 1889.

Microscopical characters of rocks of silver formation—continued.

No 113.—JARVIS ISLAND (*from North of Shaft*). In number 113 the original structure of the rock is still preserved. Very much altered lath-shaped crystals of plagioclase lie in a mass of red felspathic substance and secondary quartz. The quartz is either in little club-shaped masses filling the angular cavities between the large plagioclase crystals, or is in micropegmatitic intergrowths with the red felspathic substance. Wedge-shaped aggregates of chlorite, brown mica and green horn-blende, in the midst of which are often to be detected little areas of augite, leave no doubt that the latter mineral was once an important constituent. Apatite, magnetite, pyrite and a few plates of hematite are the remaining components.

The rock is evidently a much decomposed diabase. Its characteristics are very similar to those of diabases which have suffered alteration as a consequence of their penetration by solutions emanating from masses of acid eruptive rocks.

No. 128.—JARVIS ISLAND (*from North Side of Shaft*). Number 128 appears to be a rock whose characteristics are intermediate between those of No. 85 and No. 113. The outlines of the felspars can be detected only in rare cases. The quartz is present in those forms usually resulting from a secondary origin. Green hornblende is more abundant than in either one of the two rocks described above and is not infrequently possessed of its own crystallographic outlines. Only the minutest traces of augite can be discovered. Magnetite is more abundant than in the first two rocks, and is usually in rod like forms. A little apatite, leucoxene and secondary brown mica are also present.

The nature of the rock is probably the same as that of Nos. 85 and 113, i. e., it is was originally a diabase, which has been altered in the same way as has the gabbro in Pigeon Point, at its contact with an acid eruptive rock.

No. 127.—JARVIS ISLAND (*altered argillite*). This rock is quite different from either one of the others described. It is probably an altered slate or argillite. The least altered portion of the section examined consists of quartz, felspar and chlorite, with a few other subordinate substances. Its structure is that of a typical phyllite.

In the more altered portion, the felspar is bounded by traces of crystal outlines. It is red through the inclusion of little plates of hematite, and can occasionally be detected with twinning lamellæ. The green mineral corresponding to the chlorite in the least altered portions, is here grouped into little sheaves of fibres, which, between crossed nicols, give bright polarization colors. It has been changed into a micaceous substance with many of the properties of green biotite.

In its original state the rock was probably a slate, which under the

influence of some eruptive mass (probably of the composition of No. 85 or 113) has recrystallized, with the addition of felspathic substance derived from the eruptive which produced the recrystallization. Microscopical characters of rocks of silver formation—continued.

OF THE FOLLOWING THIRTEEN SPECIMENS, THE SLIDES WERE RECEIVED FROM MR. E. D. INGALL.

You will notice the three traps (Nos. 259, 301 and 338) are, as you intimated in your note, very similar, and are probably parts of the me great flow. They differ merely in state of preservation.

The granite (No. 277) possesses peculiarities which distinguish it from ordinary intrusive granite. The pressure phenomena show that it has undergone considerable change since it was first produced. It would be supposed that as a consequence of this pressure, schistosity would have been induced. The specimen sent me is too small to distinguish this structure, if it does exist. The question whether the rock is metamorphic or intrusive will have to be left for you to decide. As a result of the microscopical examination, it would be most natural to suppose that the rock (whatever it may have been originally), was subjected to pressure after the present minerals had been formed, otherwise the structures observed would be impossible to explain. Whether the same causes first produced the rock and then by further action produced in it these pressure effects, is difficult to determine. While the question as to the origin of this rock is not positively decided, it would, I think, be safe to say that it is probably of metamorphic origin.

Nos. 259, 301 and 338 are all typical traps, c. i. are diabases, more or less altered. Of these, No. 338 is the least changed.

No. 338. PALISADES.—This is a medium-grained diabase, with the typical diabase structure. It consists of lath-shaped crystals of twinned plagioclase in a ground mass composed almost entirely of augite. The plagioclase is fresh in part, when it is almost glassy in appearance, and possesses very well defined twinning lamellæ. The angles of extinction measured against the line of union between contiguous lamellæ indicate that the predominating variety is labradorite.

Most of the plagioclase, however, has undergone alteration, and has thus given rise to secondary products, the most important of which are calcite and chlorite. The former occurs in very small quantity, and is found in little irregularly shaped grains near the periphery of the felspar crystals. The chlorite penetrates the plagioclase substance in little veins, and is also found around its edges.

Microscopical characters of rocks of silver formation—continued.

The augite is of a very light wine color. It fills in the interstices between the felspar. When fresh, its cleavage is very perfect, the section seemingly being made up of little square blocks of augite. In most cases, this mineral has undergone considerable change. Chlorite and a yellowish green aggregate of an earthy substance have taken its place.

In one or two instances, a yellowish substance, consisting of an aggregate of little fibres, looks very much like serpentine, which has been stained yellow by iron salts. It may be due to the alteration of an original olivine constituent. Magnetite in grains, apatite in long, slender needles, and a little leucoxene, occur as accessory minerals.

No. 301. SILVER BLUFF, R. 61 (*Trap from six inches above contact*), is not quite as fresh as 338, nor quite as much altered as 259.

Little cores of augite can be detected in the abundant chlorite which makes up the greater part of the slide. The magnetite, instead of existing in little irregular grains scattered among the other constituents, occurs in skeleton crystals, as is frequently the case in basalts.*

No. 259. CROWN POINT (*Trap from above tunnel*) is a tolerably fine-grained, much altered diabase, in which the original structure can still be very readily discerned.

The felspar occurs in lath-shaped crystals, with very ill-defined outlines. These crystals often contain so many inclusions of various kinds, and are frequently so much altered, that they are in some cases almost opaque. Chlorite, mica and calcite are the predominating products of alteration. Where it could be measured, the angle of extinction in this felspar was very small, thus indicating oligoclase, as the principal felspathic constituent.

The augite, which originally filled in the spaces between the felspar crystals has almost entirely disappeared, and in its place there is found a yellow mixture of chlorite and another mineral of a finely fibrous structure. The pleochroism of the chlorite is scarcely perceptible, and the polarization colors between crossed nicols are extremely weak. Rutile and leucoxene usually accompany these secondary products as inclusions, and a very small amount of secondary brown pleochroic biotite is not uncommon around the edges and in the interior of the aggregates.

Large crystals of very light green apatite and considerable magnetite are scattered throughout the rock, the latter being often surrounded by a rim of biotite. The similarity between these three slides is so great that they may well (as far as the microscopic examination goes) be considered as sections of rocks which originally formed part of the same "flow."

*Rosenbusch: Mikroskopische Physiographie I, 1885. Stuttgart. Taf. III., Fig. 2.

No. 277. WOODSIDE'S (*Granite*) at first sight appears to be a typical granitite, very much like the Huronian granite of the Wisconsin Survey. A closer examination, however, shows it to possess characteristics which serve to distinguish it from most of the granites heretofore described as existing in this neighborhood. Almost the only constituents are quartz, orthoclase, plagioclase and chlorite. Microscopical characters of rocks of silver formation—continued.

The quartz is clouded with inclusions of red and green earthy substances, little folia of chlorite and hematite, and is particularly rich in liquid inclusions containing movable bubbles.

The orthoclase is clouded in consequence of its alteration. The principal product of this alteration is kaolin, though frequently scales of chlorite are quite abundant. By far the greater proportion of the felspar is triclinic. This triclinic felspar seems to be of three distinct kinds:—1. Microcline, with its twinning lamellæ, crossing at angles of 90°. This is very fresh and glassy, and contains almost no inclusions. 2. A plagioclase, with tolerably broad twinning lamellæ. This has suffered alteration to a considerable extent. For reasons which will be mentioned hereafter, its extinction could not be measured. 3. Another plagioclase, with broad twinning lamellæ, the extinctions of which it was impossible to measure, in consequence of the great amount of change which it has undergone. The twin structure in many cases could only be detected after very careful search.

The chlorite is evidently the product of the alteration of biotite. It possesses all the characteristics of chlorite which has been thus developed. The original structure of the mica is preserved, and in not a few cases, traces of the biotite can still be detected.

The most interesting point in relation to this rock is its structure. All the constituents look as if they had been crushed. Their contours are not as regular as in the case of most granites. On the other hand, pieces of one mineral seem to have been shoved into the others. The chlorite occurs in very thin plates between the felspar and quartz, as if it had been squeezed by great pressure.

The most undoubted evidence of pressure, however, is the existence in the plagioclase of a very well marked cleavage, in most instances as well marked as in the case of calcite. In one piece of microcline, while the centre was to all appearances compact, the edges possessed very sharp cleavage lines, cutting each other at angles of 82°-83°. In addition to this, almost all the twinning lamellæ are bowed and twisted, just as in the case of the plagioclase in the gabbro of Penig.* For this reason, as mentioned above, exact determinations of the plagioclase were impossible. In addition to the original twinning, a secondary twinning was often observed, as a consequence of the action of pressure.

* Lehmann: Entstehung der altkrystallinischen Schiefergesteine, etc. Taf. C., Figs. 1 and 4.

Microscopic characters of rocks of silver formation—continued.

No. 281. R. 64. LOCATION (*Chert*).—This rock is composed in greater part of what were originally round and irregular pieces of felspar, in a ground mass of quartz. The felspar has for the most part been entirely replaced by its various decomposition products, viz., calcite, chlorite and hydrated iron oxides. That portion which has not undergone this alteration has been completely replaced by silica, so that round, cloudy areas of silica (principally in the form of chalcedony) now appear where originally felspar existed. These pseudomorphs are usually marked by a rim of green or red color, probably due to chlorite and iron oxide, which separated out either previous to or coincident with the silicification process. Immediately outside of these rims there is deposition of chalcedony, which forms a feathery periphery extending from all sides into the interstices between large quartz grains, which in turn form a mosaic in the centre of the spaces between the original grains of felspar.

Scattered through the slide, both in the larger grains and also in the interstices between these, are little cloudy, almost opaque, areas, which under crossed nicols, resolve themselves into calcite. The centres of these little areas are dark and structureless, while the outer portions are composed of the perfectly crystallized mineral. This calcite has every appearance of having been enlarged, after it had once been formed, by the addition of new material around the opaque portions in a manner analogous to the enlargements of quartz grains, so distinctly shown by Profs. Irving and Van Hise, of the United States Geological Survey.

The present condition of the rock seems to be due to a very thorough process of silicification.

No. 303. SILVER BLUFF, (R. 61)—(*About fifty feet below contact.*) Is of the same general nature as the above. In this, however, the calcite occurs with chlorite and other alteration products of felspar to form complete pseudomorphs of this mineral. Round and angular grains consist now of chlorite and crystallized calcite, mixed with magnetite (which is usually found around the edges of the grain), and a brown earthy substance. The outlines of the original grains are well preserved by the rim of magnetite, but their material has entirely disappeared. From the large amount of magnetite and other iron minerals present in the slide it may be doubted whether the original grains were not augite or some other iron-bearing mineral.

A few grains are composed entirely of silica, as in the case of section 281.

The interstitial silica in this slide differs from that in 281 in that it is present only inthe form of a mosaic of quartz grains.

No. 302. SILVER BLUFF, (R. 61)—(*Top of beds close under trap sheet.*)—This rock is very remarkable. If it was ever a chert, it has undergone such deep-seated alterations that every vestige of its original nature has entirely disappeared. Microscopic characters of rocks of silver formation—continued.

Under the microscope, it is seen to consist of a granular mass of a pale yellow mineral, highly refractive, weakly pleochroic and possessing between crossed nicols bright polarization colors. This mineral, probably epidote, is intermingled with long fibres of a very light colored hornblende, pleochroic in yellow and light green tints, which, together with a little chlorite and a few quartz grains, constitute the entire rock. It seems probable that the overlying trap may in some way have given rise to this very peculiar rock.

A chemical analysis would probably reveal interesting results.

No. 317. R. 93 RIDGE—(*Middle bed of ridge.*)—Like the last rock described, this appears to be a much altered chert. So very much altered is it that a description of its microscopical characteristics is almost impossible.

Little pebbles of various kinds are included in a ground-mass of quartz grains and a black earthy material, with some magnetite. Scattered through this ground mass are numerous needles of a greenish hornblende, which in some instances are so aggregated as to form little areas, which at first glance seem to have the form of a grain which they have replaced. Upon closer examination they are seen to be merely accumulations of fibres.

In some portions of the slide, little lath-shaped crystals of plagioclase and acicular crystals of hornblende occur in a ground-mass of hematite. In these portions the structure is very similar to that so common in diabases.

No. 318. R. 93 RIDGE—(*Bottom bed of ridge.*)—Of this rock very little can be learned from the section. It is so badly stained with ochreous material as to be for the most part opaque. Occasionally a little grain of a highly refractive mineral can be detected. This is usually fibrous, and sometimes possesses an extinction angle very near that of augite. Grains of epidote can also be detected.

No. 319. R. 93 RIDGE—(*Top bed of ridge.*)—This section also is so clouded with magnetite as to render its microscopical examination almost worthless. Bands of black earthy material, containing a large quantity of magnetite, alternate with bands of brightly polarising material in fibrous forms, which under a high power are resolved into grains of epidote and fibres of hornblende.

A little hematite and some chlorite complete the list of minerals which can be determined in the section.

Microscopic characters of rocks of silver formation—continued.

The several bands are arranged in such a manner as to suggest the flowage structure of felsites, rhyolites and obsidians.

No. 320. R. 93 RIDGE—(*Upper beds of ridge.*)—Is another very peculiar and interesting rock. It consists of alternate bands of small crystals of augite, perfectly fresh and unmixed with any other materials, and other bands containing considerable uralitized augite, mixed with plates and needles of a light green hornblende, with many of the characteristics of actinolite. Fine fissures extend into the rock in a direction approximately parallel to the bands. On both sides of these cracks the minerals are stained with a brownish-red ochreous material.

I know of no rock just like this described in any of the journals. It seems to me very much like an aggregation of augite crystals in diabase, similar to the well known "Olivin-Knollen" of basalts.

No. 323. R. 93 RIDGE—(*Trap sheet.*)—Is a well defined, fine-grained, altered diabase, very similar to many others described in Mr. Lawson's Report, and like No. 259 described for you some time ago. A great deal of the augite is still fresh and of a pale wine color. That which is no longer fresh is changed into a yellowish brown earthy substance. A little uralite and chlorite occur on the borders of some of the augite crystals, but in most cases both of these minerals are so colored by the ochreous material that their detection is not easy.

No. 325. R. 93 RIDGE—(*Overlying cherty beds.*)—Is not very different from 303, except in the alteration of the rounded grains. In many cases, these consist of a very dark reddish-brown micaceous substance, mingled with a green mineral (probably of the serpentine group) and reddish-brown iron hydroxide. In some of the lighter colored grains, the remains of a colorless augite can readily be detected.

In other cases, the entire substance of the original grain has given place to silica in the form of a fine mosaic of quartz. In these, the outline of the original grain has been rendered permanent by a line of little plates of brown mica.

As in 303, the interstitial substance is quartz. Around the edges of the separate grains, crystals of quartz extend out on all sides, like the lining of a vein. Where the space between the fragmental grains was small, the two rows of quartz crystals mutually interfere and completely fill the spaces; where the intervening space was large, that portion in its centre between the rows of crystals is filled by a mosaic of the same mineral. Cracks which extend through the rock contain iron oxides or hydroxides.

APPENDIX II.

LITERATURE.

The following list includes all those works dealing with the subject of silver mining on Lake Superior, or embracing references to it, of which I have become cognisant since the commencement of the investigation.

The reference letters appended to some of them are those which have been used throughout the report to indicate the source from which each quoted item of information was derived.

Trans. Am. Ins. of Mining Engineers,	Volume ii, p. 89—W. M. Courtis.	(A)
Idem.	" v, " 473— Idem.	(B)
Idem.	" viii, " 229—Thos. Macfarlane.	(C)
Idem.	" xv, " 671—W. M. Courtis.	(G)
Eng. and Min. Journal of New York,	" xxiii, —W. McDermott.	
Idem.	" xxvi, —W. M. Courtis.	
Idem.	" xxxii, " 251—F. A. Lowe.	(E)
Idem.	" xxxiv, " 321— Idem.	(D)
Pamphlet on "Mining on the North shore of Lake Superior," 1874.....	.....Peter McKellar.	(F)
Geol. and Nat. Hist. Survey of Canada, Report of Progress.....	1866-69, page 313—R. Bell.	(H)
Idem.	1872-73, " 108— Idem.	(I)
Idem.	Various assay returns included in yearly reports of Chemical Branch.	
Can. Naturalist, 2nd Series (Paper on "Geology and Silver Ore of Wood's Location, Lake Superior"=Silver Islet).....	Volume iv, p. 37—Thos. Macfarlane.	
Idem (Paper on Mineral Region of Superior).....	" vii, " 49—R. Bell.	
Quar. Journal London Geol. Society (Paper on "The Geology of the Thunder Bay and Shebandowan Mining Districts of the North Shore of Lake Superior").....	" xxix, " 16—H. A. Nicholson.	

Milling of Silver Ores at the Silver Islet Mine.

The following figures are based upon official data of the *Silver Islet Mining Co.*, regarding the working of their mill during a period extending from May 6th, 1875, to October 31st, 1876.

Tons of rock milled			24,446
Result	1·853 % "Concentrates"	453*	
	98·147 % "Tailings"	23,993	
	100·000 %		24,446
Average yield of bar Silver (999 fine) per ton of rock milled.			8·33 ozs.
Average loss in "Tailings" per ton of rock milled			1·53 "
Original Silver contents of mill rock per ton			9.86 "
Average Silver contents of "Concentrates" per ton (200 lbs)			449·42 ozs.
Cost of working; calculated to the ton of rock milled:—			
Transport; Islet to Mill			$0.50
Stamping and Concentrating			1.97
Freight and Insurance on "Concentrates" to Wyandotte and expressage on bar Silver to New York			0.35
Smelting and Charges; Wyandotte			2.08
Total cost per ton of rock			$4.90

* "This was the 'dry weight;' although the Assay for moisture was so imperfectly done about 4 p. c. of the Silver was lost."

MINES AND MINING ON LAKE SUPERIOR.

PART H. ANNUAL REPORT, 1887.

By ELFRIC DREW INGALL, M.E.,

Associate of the Royal School of Mines, Mining Geologist to the Geological Survey of Canada.

SUPPLEMENTARY REPORT

TO

PART I.—B. SILVER MINING.

Since the completion of the report on Silver Mining, above mentioned, work has continued to be actively prosecuted in the Thunder Bay district. Information respecting this work has been received from time to time, and is given below. Details on the progress of development in this district up to the end of August, 1887, will be found in Part S, Annual Report for 1887. Recent developments Thunder Bay Silver Mining District.

The chief points of activity S.W. from Port Arthur have been at the Beaver, Badger and Rabbit Mountain Mines, and further W. at the East and West End Mines of Silver Mountain, the former being also known as the Shuniah Weachu Mine.

Besides the mines mentioned, however, many others have been operated on a smaller scale, with the object of proving various veins. Prospecting for new viens has also been actively carried on, chiefly in the western districts around Whitefish Lake.

Rabbit Mountain Mine.

The working of this mine was continued with more or less vigour during the year 1887, but operations were suspended on the 16th of December in that year.

From information received from Mr. Michael Lynch, who was underground captain at the mine, it appears that the measurements of the workings at the time of cessation were as follows: No. 3 level E. from No. 2 shaft, 160 feet; No. 3 level W. from the same, 85 feet; No. 4 level E. from No. 2 shaft, 85 feet, and W. from the same, 30 feet.

Recent developments Thunder Bay Silver Mining District.

No. 2 shaft has been sunk to a depth of 355 feet from surface. The other workings had remained as shewn in the illustration (see plate VII., fig. 2.)

According to reports received from time to time, rich ore seems to have been obtained in sinking No. 2 shaft, for, besides that mentioned on p. 70 H. as having been observed at the 2nd level, it is asserted that for the last 100 feet of the shaft rich ore was continually met with. It has not been ascertained why work was suspended at this mine, which is still idle.

Porcupine Mine.

The necessary financial arrangements not having been made for the commencement of the work on a large scale at this mine, there is little to add to the description given in the body of the report, except to record the discovery of another vein in the vicinity of the original one, about 400 feet S. of and running parallel with it. Sufficient work has not been done on this vein to ascertain its dip, but it is considered by the owners to be to the N.W., as they find the trap to be lower on that side from the faulting effect of the fissure.

Beaver Mine.

Since the last visit made to this mine in the fall of 1886, during the prosecution of the field work for the main part of this report, a large body of rich ore was discovered, particulars of which are given in the Report on Mining and Mineral Statistics for 1887, Part S of the volume for that year and by many others, notably by Dr. Lawson of the staff of the survey who, in a letter addressed to the Director, describes it as follows :—

"I was in the mine last October, and was at that time not favorably impressed with the lead, and went last Saturday prepared to meet with the same experience, but this time I was very agreeably surprised. They are working the mine by adits run in from the face of a steep hill and by shafts from the top of the hill. The lead when observed by me last fall was very lean and unprofitable, and did not show any signs of becoming richer till some time in March, and the management of the mine were so discouraged that they were on the point of giving it up and abandoning the enterprise. They persevered, however, and in March or April the lead suddenly expanded from a mere stringer or series of stringers to a wide and exceedingly rich vein of magnificent ore. I was afforded a good opportunity for close inspection for over a whole day. There are many hundreds (I may safely say more than a thousand) tons in actual sight of rich ore which will yield 100, 200, 500 up to 800 and 1000 ounces to the ton.

" I am sure that the owners of the mine have struck a bonanza, and am very glad indeed, that their enterprise has been rewarded. What the limits of the body of rich ore are I am unable to say, as there is no engineer on the property to give data for an estimate, and no very recent survey of the mine showing the relation in space of the different parts of the drifts and shafts. If you desire it I could make a survey of the mine and give you more detailed information. At its best the vein runs from three or four to five or six feet in width. The gangue is soft, being mostly calcite with some fluor spar and colorless or amethystine quartz, and through it all there is a soft, greasy material, said to be a silicate of magnesia, and called saponite by the people of the mine. This saponite appears to be a later infiltration but is often rich in argentite. Besides argentite there are native silver, sphalerite and galena. I send you by this mail a few specimens of the high grade ore. The specimens are not exceptional ones. * * * *

Recent developments Thunder Bay Silver Mining District.

" The mine may, on further exploitation of greater depths, prove even more valuable and become one of the remarkable finds in the history of mining. It will, I have no doubt, greatly encourage other mining enterprises in the district.

" (Signed) A. C. LAWSON.

" Port Arthur, June 6th, 1887."

The management have kindly furnished details of the extent of the workings completed since the compilation of the plan of the mine given in the report (see Plate VIII.) which can be corrected to March 10th, 1889, by making the below given additions.

No. 2 shaft; total depth from surface 385 feet. No. 1 level, below the adit, extends E. and W. from No. 2 shaft at a depth of 220 feet from surface measures, 550 feet W. and 200 feet E. No. 2 level below adit, at a depth of 320 feet from surface, extends 380 feet W. and 150 feet E.

No. 1 winze is sunk below the adit at a point 185 feet W. of No. 2 shaft, and had attained a depth of 280 feet connecting thus with the lower drifts. No. 2 winze connects the two above mentioned lower levels at a point 100 feet W. of No. 1 winze. No. 3 winze started below the No. 1 level below the adit at a point a 175 feet E. from No. 2 shaft, and had attained a depth of 50 feet. No. 4 winze, sinking below the same level at a point 460 feet W. from No. 2 shaft, had reached a depth of 60 feet. This, together with three cross-cuts made at points along No. 1 level below the adit, viz., at 300 and 370 feet W., at 40 feet E. of No. 2 shaft, completes the description of the exploratory work done to that date.

Recent developments Thunder Bay Silver Mining District.

With regard to the ground stoped away, it would seem that, beginning at a point about 15 feet W. of No. 2 shaft to a point 300 feet W. of the same, the vein has been nearly completely removed above the adit level to within about 10 or 15 feet of the line of junction of the trap and argillite.

Badger Mine.

This mine was started since the completion of the report, and has attained considerable prominence, its development having been attended with very satisfactory results. A reference to the "sketch map" accompanying the report will shew the position of this mine and the strike or run of the vein which is said to dip S.E.

The work done to the 1st of January, 1889, is shewn on the accompanying section (plate X), which was kindly furnished by Mr. Chas. Brent, assayer at the mine. It also illustrates the relationships of the enclosing rocks, and shows that the geological conditions are similar to those of the other mines in the district, while the details regarding the nature of the vein, noticed by Mr. Coste (see vol. 1887, p. 94 s.), show it also to correspond with the other veins.

The official and other reports since received regarding the production of ore from this mine show a very large yield for the time it has been in operation.

Jarvis Island Mine.

This mine is at present idle, operations having been suspended in October, 1888. The following dimensions of the workings at this time are taken from a section of the mine kindly furnished by Mr. Arthur McEwan, formerly the superintendent:

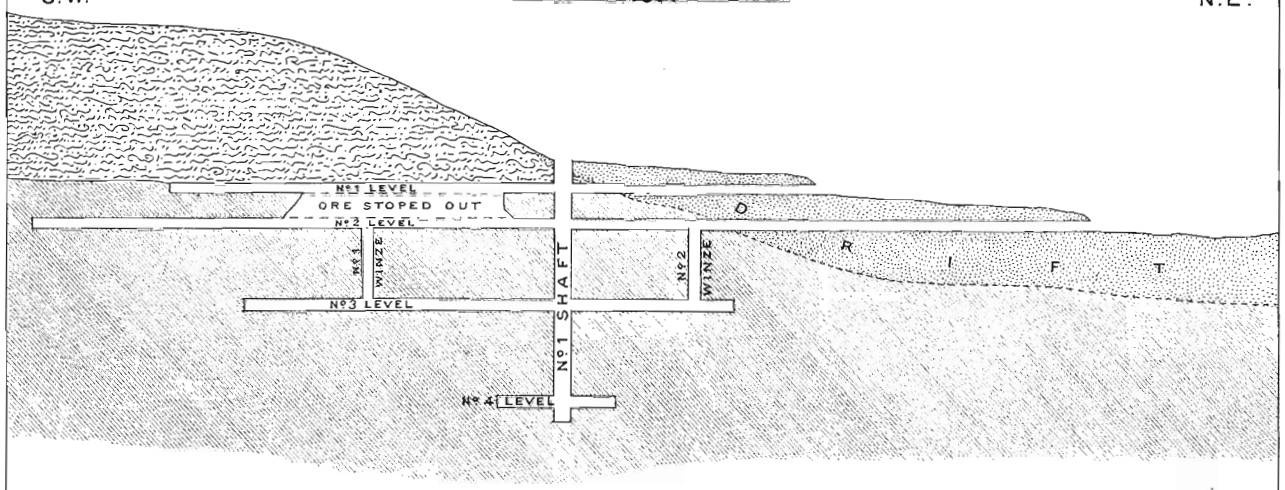
Main shaft, 270 feet from surface. No. 1, level driven S. 230 feet, ditto N. 20 feet, with a small amount of stoping done above the end. The intermediate level between Nos. 1 and 2 extends N. of the shaft 50 feet, with a small amount of ground stoped out at the end. No. 2 level measures 236 feet S. and 90 feet N. from the shaft, with a small amount of stoping done above the N. level. At a depth of 238 feet a drift (No. 3) has been run 130 feet N. and 30 feet S. At a point 50 feet S. of the shaft a winze has been sunk below No. 1 level to a depth of 35 feet.

A reference to plate IV., figure 2, will make these details plain, and by adding them, the figure will then represent all the work done at the time of closing, with the exception of a certain amount of cross cutting in various parts of the mine.

The drawing referred to also shows shafts Nos. 2 and 4, the former 50 feet and the latter 95 feet in depth, with a drift S. from the bottom,

Plate X.

LONGITUDINAL SECTION.



LEGEND.

ARGILLITE

TRAP

BADGER MINE.

SCALE,
160 feet = 1 inch.

Drawn by J. White.

G.E. Desbarats & Son, lith. Montreal.

50 feet long, and a cross cut at the end. Another noticeable point is that the drawing would seem to show that the S. wall of the northern dyke was met with in the drifts S. of the main shaft at a distance of about 240 feet from the shaft, which does not at all agree with the surface evidence, and is probably a mistake due to the very altered condition of the argillites near the dyke, causing the rock to be mistaken for trap.

Recent developments Thunder Bay Silver Mining District.

East Silver Mountain Mine.

Since the last visit made to this mine in 1886, work has been continuously prosecuted by the English company owning it, particulars of which to August, 1887, are to be found in Part S of the report of the survey for 1887, pp. 94-96. Of the work done since that date to December, 1888, particulars have been kindly furnished by Mr. Chas. M. Rolker, M.E., of New York, who then visited and examined the mine in the interests of the English shareholders. From the data thus obtained it would seem that the dimensions of the different workings were as follows, which will be understood by a reference to Plate IX., fig. 1:

No. 2 level, extended to 130 feet W. from No. 2 shaft. No. 1 level, extended to a point 590 feet W. from No. 2 shaft, which shaft has not been sunk any lower than No. 2 level, and does not therefore intersect No. 1 level. Above and below this level raises have been put up and winzes sunk at various point. Winze No. 1 (shewn in the section below "No. 4 pit"), sunk to a depth of 85 feet. Winze No. 3, at a point 320 feet W. from the last-mentioned, extends to a depth of 125 feet below this (No. 1) level. No. 4 winze connects No. 2 with No. 1 level at a point 100 feet west of No. 2 shaft. Measuring from this winze W. three "raises" have been put up from the back of No. 1 level, viz., at 100 feet W, a "raise" of 40 feet: at 300 feet W., a "raise" of 100 feet to the junction of the trap and argillite on the hanging wall of the vein, and finally, at a point 480 feet W., a "raise" of 25 feet. Besides this, Nos. 4 and 5 pits have been connected by a little drift, and ore stoped away around the latter pit to a depth of 45 feet from surface.

As mentioned in the report, No. 3 shaft is 820 feet W. from No. 2, and the dimensions of this part of the mine at the time mentioned were as follows: No. 3 shaft, 425 feet, but since sunk, it is said, to 465 feet from surface. No. 1 level, at a depth of 215 feet, driven W. from this shaft 230 feet, with a "raise" of 45 feet put up from the back of same at a point 75 feet in from the shaft.

No. 2 level, at a depth of 380 feet, extended to 125 feet east and 140 feet west, this end having, I understand, been since extended to 220 feet from the shaft.

Recent developments Thunder Bay Silver Mining District.

According to later information, received April 13th, 1889, work had been abandoned at this point, and another shaft (No. 4) had been started about 300 feet west from No. 3. This had been sunk ninety-five feet from the surface, and it is stated that from eighty feet to the bottom good ore had been encountered, consisting of argentiferous galena and blende, and said to assay from $80 to $150 per ton.

It would appear that small pockets of rich ore have been obtained at various places in prosecuting these workings, and it is said that a good bunch was encountered in No. 2 level, at a point about 120 feet west from No. 3 shaft, which is the more interesting in that the lower siliceous division rocks form the foot-wall of the vein at this point.

In the vicinity of a spot about 1000 feet north-east from the mouth of the lower tunnel (No. 1) a number of test-pits have been sunk to trace and prove two veins found there, which seem to be coming to a junction near this point. It is thought that one of them is the extension eastwards of the main vein from No. 7 pit (see plate IX.), whilst the other would seem to curve round to a more easterly and westerly course, and thus strike the bluff somewhere about 500 or 700 feet north of No. 1 shaft. These test-pits are on location R. 54, and are close to the lower limit of the upper division beds (see colored map accompanying the report), which are here, however, thrown slightly out of position by the faulting effect of the fissures. This junction-plane between the upper and lower division beds on the hanging wall of the vein has also been located in the main workings of the mine. At winze No. 1 it is met with at seventy-five feet below No. 1 level; at winze No. 3 at eighty-five feet, and at 135 feet below the same in No. 3 shaft, where it was also encountered on the hanging wall some fifty-five feet lower down, showing a very similar dip of the strata to the west, on the line of the vein, to that represented on the lower section, appended to the colored map accompanying the report.

According to Mr. Rolker's observations, with the fresh light thrown on matters by the recent developments, the lower surface of the trap rises slightly in going west, which, with the falling surface of the cherts, would show a slight thickening of the argillites in that direction, whilst the comparative horizontality of the surface of the ground would effect a thinning out of the trap sheet going west.

Recent work around this end of the mountain and the clearing in connection with it seem to have brought to light evidences of other faultings of the strata besides those found, and shown on the map, which is no more than one would expect, as doubtless all the vein fissures are accompanied by faulting to a greater or less degree, and it is not at all likely that they have been even yet all located, but rather that fresh discoveries of this kind will from time to time continue to reward searchers.

West End Silver Mountain Mine.

Recent developments Thunder Bay Silver Mining District.

Work has been prosecuted at this mine for some time past, and it is still in operation, but particulars of the developments made have not yet come to hand. From latest reports, two shafts are being sunk, one close to the eastern boundary line of location R. 56, in view of the success being attained in that direction by the East End Company.

Other Workings.

Besides the above-mentioned, which constitute the chief centres of activity, exploration has been continued with considerable energy, and testing operations have been carried on at many points, but chiefly in the Whitefish Lake district. The most prominent are the Peerless vein of the Rabbit Mountain group, and on the Crown Point and Palisades veins in the Silver Mountain district, whilst westwards, around Whitefish Lake, a fair amount of development has to be recorded on the claims known as the Silver Wolverine, Queen, Silver Fox and Silver Tip, as well as on location R. 119, at Medicine Bluff, and on several veinsin the vicinity of Atik Lake. Finds of silver ores have been reported from most of these from time to time, but no reliable data are to hand as to the extent of the ore found.

I am largely indebted to Mr. T. A. Keefer and others, who have collected and transmitted, from time to time, the foregoing information regarding the progress in the development of the Thunder Bay silver mines.

OTTAWA, June 1st, 1889.

A. P. LOW, PHOTO., 1888. THE DOMINION ILLUSTRATED PRINT, MONTREAL

Group of Esquimaux, from East Coast of Hudson Bay: taken at Little Whale River, H. B. Post.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON EXPLORATIONS IN

JAMES' BAY

AND

COUNTRY EAST OF HUDSON BAY,

DRAINED BY THE

BIG, GREAT WHALE AND CLEARWATER RIVERS.

BY

A. P. LOW, B.Ap.Sc.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
WILLIAM FOSTER BROWN & CO.
1888.

To ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I beg to submit herewith my report on the explorations about Hudson Bay during the seasons of 1887 and 1888.

At the same time I desire to tender my thanks to the officers of the Hudson Bay Company, met during the two seasons, all of whom extended to myself and party the greatest hospitality, and to whose kindly assistance the success of my explorations was, in a great measure, due.

I remain, Sir,

Your obedient servant,

A. P. LOW.

REPORT

ON EXPLORATIONS IN

JAMES' BAY,

AND

COUNTRY EAST OF HUDSON BAY,

DRAINED BY THE

BIG, GREAT WHALE AND CLEARWATER RIVERS.

1887 AND 1888.

By A. P. LOW, B. Ap. Sc.

The present report is the result of two short season's work, among the islands of James Bay in 1887, and upon the Big, Great Whale, and Clearwater rivers flowing into Hudson Bay on its east side in 1888. Owing to the shortness of the season suitable for investigation in these parts, and to the length of time required to reach and return from the field of work, only six weeks were spent in actual exploration each year, and consequently only a small area of this vast region could be explored.

Mr. J. M. Macoun acted as assistant and botanical collector, and performed his duties in all respects satisfactorily.

In 1887, a large fishing boat was procured at Collingwood, transported by rail to Missinaibie station on the Canada Pacific Railway and from there taken by the Missinaibie branch down the Moose River to its mouth. The low state of the water in the river, and the number of portages over which the boat had to be hauled occasioned considerable delay in reaching Moose Factory. Leaving Moose River, the party crossed to Charleton Island, the position of which has been fixed for longitude with chronometers by the captains of the Hudson Bay Company's ships, who have wintered there in past years. Subsequently Danby, Cary, Strutton, Little Charleton, Tiders, Solomon's Temple, Weston, Twins, Spencer, Walter, Emily, Grey Goose, Bear and Agoomski Islands were examined. Paced surveys were made around the shores of the greater number of these, as well as numerous examin-

ations inland, and their positions were fixed by latitude observations and meridional bearings taken with solar attachment to the transit instrument.

In 1888, a track survey was made up the Big River for two hundred miles, thence crossing the head-waters of Bishop Roggan River, the head of the south branch of Great Whale River was reached and the river descended to its mouth. On this survey the courses were taken with a prismatic compass, and the distances estimated by time, the rate of travel of the canoe being previously determined. Daily observations for latitude were taken as a check on the survey, also frequent observations to determine the variation of the compass.

After finishing the above, a survey was made from the mouth of Clearwater River on Richmond Gulf, for sixty miles, to the outlet of Clearwater Lake, the courses were taken with a prismatic compass and the distance with a Rochon micrometer, frequent observations for latitude and variation of the compass were also made.

Mr. C. H. Macnutt, B. Ap. Sc., who had been with me the previous year was appointed assistant, and proved highly competent for the position.

The surveys of the two seasons have since been mapped on a scale of eight miles to one inch, and form a roughly accurate map of the regions explored; they are at present awaiting further explorations on the east side of Hudson Bay before being published.

Previous Explorations and Discoveries.

It is deemed advisable to preface this report by the following short account of the discoveries, explorations, and other points of historical interest in connection with Hudson Bay up to the present date.

Hudson's Voyage, 1610.

1610.—Henry Hudson, in command of a ship fitted out by some wealthy English merchants, on his third unsuccessful attempt to find a north-west passage to the South Sea, had the good fortune to sail through the strait and enter the bay which has ever since borne his name. Sailing along the east coast to the southward until he had land on either side of him, he explored the bottom of the bay and as the season was now late, resolved to winter in a bay full of islands on the east side to the south of lat. 53° N. After passing a winter of great hardship, due to the cold, scurvy, and want of food, in the spring he started to return, when his crew mutinied, put Hudson, his son and seven seamen into an open boat and left them to the mercy of the waves and savages; nothing after was heard of the party, the ship with great difficulty reached the coast of Ireland with about one-half of the remainder of the crew, the rest having perished in a fight with natives in the straits and quarrels aboard the ship.

1611.—Sir Thomas Button was sent out to discover the north-west passage from the bay, and if possible to succour Hudson and his comrades. He crossed the bay to the northward and explored the western part as far south as the Nelson River, which he named after his mate. He wintered in the mouth of this river and called the land New Wales and the western part of the bay Button's Bay. Sir Thomas Button, 1611.

1619.—Jens Munk, a Dane, entered Hudson Bay and visited Thornfield Inlet. Jens Monk, 1619.

1631.—* Capts. Lucas Fox and Thomas James were sent out on the old quest of the north-west passage, the former being fitted out by London merchants, the latter by those of Bristol. Before leaving they were presented to the King, who gave them letters for the Emperor of Japan. Fox confined himself to the northern parts, going as far south only as Cape Henrietta Maria, and then returning home. James, after meeting Fox, near Cape Henrietta Maria, sailed southward along the west coast, thoroughly examined it, and after several narrow escapes from shipwreck through grounding on shoals, ran his ship aground on Charleton Island and wintered there. He gives a woeful tale of the hardships endured, caused by the intense cold, want of food and scurvy. He states that the cold was so intense that it froze solid, wine, sack, oil, vinegar, and even brandy; that the cook soaked his salt meat in a copper kettle close to the fire to prevent it from freezing, the side near the fire was found to be quite warm while the opposite side was frozen an inch thick, this would prove that the climate is either much milder at present during the winter, or that James was given to exaggeration, most probably the latter. Thinking that the ship was beyond repair, in the spring he built a pinnace, but when the ice cleared it was found that the ship had not suffered much damage, after repairing it he returned home. Fox and James, 1631. Intense cold.

The entire western coast having now been explored, the impossibility of a north-west passage from it was settled, and no further voyages of discovery in that direction were undertaken.

1656.—The French† claim that Jean Bourdon was the first of that nationality who visited Hudson Bay, having sailed from Quebec by the Labrador coast and Hudson straits. That he made an alliance with the natives, and they hearing of a strange nation in their neighborhood, sent to Quebec, in 1661, to begin trade, and to desire that a missionary be sent to them. That in 1663 the Governor sent one Couture, who proceeded to the bay and erected a cross on an eminence and set up the French arms engraven in copper, taking possession of these countries for the 1656—First visit of the French.

* Forster's voyages made in the north.
† De la Poterie, Histoire de la Nouvelle France.

King of France.* This account has since been disproved, and it would appear that Jean Bourdon never entered Hudson Bay.†

The next expedition sent to Hudson Bay was for purposes of trade with the natives. According to Oldmixon ‡ two Frenchmen, Messrs. de Groisselier and Radisson, while trading with the Indians at Lake Assimponals (Winnipeg) learned from them that it was possible to proceed by land to the bottom of the bay where the English had not visited. They desired the savages to conduct them thither which they did, they then returned to Quebec where they tried to persuade some merchants to send a ship under their command to the bay to engage in trade with the Indians; being unsuccessful they proceeded to Paris, hoping for a more favorable hearing at Court, but after presenting several memorials and spending a great deal of money and time, they were answered as they had been at Quebec. The English Ambassador hearing their proposals, imagined he should do his country good service in engaging them to serve the English who had already pretences to the bay, so he persuaded them to go to London where they met with a favorable reception from Prince Rupert and seven other wealthy men and merchants who, in 1668, fitted out the Nonsuch Ketch under command of Zachariah Gillam, a New England Captain. Accompanied by De Groisselier and Radisson, he passed through the straits and thence southward to lat. 51° N., where in the Nemiscow River, afterwards called the Rupert, he held friendly intercourse with the natives, built a rough fort called Charles Fort, wintered there and returned safely the following year.

DeGroisselier and Radisson reach Hudson Bay from Lake Winnipeg.

Building of Fort Charles on the Rupert.

Upon the return of Gillam in 1669, Prince Rupert and others applied for a charter to King Charles II. This was granted 2nd May, 1670, in it they are styled the Governor and Company of Adventurers trading from England to Hudson Bay; § "and in consideration of their having at their own cost and charges," undertaken an expedition to Hudson Bay in the north-east parts of America, for the discovery of a new passage to the South Sea, and for the finding of some trade for furs, minerals and other considerable commodites, and of their having already made by such their undertakings such discoveries as did encourage them to proceed farther in pursuance of the said design, by means whereof there might probably arise great advantage to the King and his Kingdom, absolutely ceded and gave up to the said undertakers the whole trade and commerce of all those creeks, seas, straits, bays, rivers, lakes and sounds, in what latitude soever they might be, which are situated within the entrance of the Hudson Straits, together with

Charter to Hudson Bay Company, 1670.

* Joseph Robson's Hudson Bay, 1752.
† Chas. Bell's Hudson Bay.
‡ Oldmixon's British Empire in America, 1741.
§ Forster's Voyages.

all the countries, lands and territories upon the coasts and confines of the said seas, etc., so that they alone should have the right of trading thither, and whoever should infringe this right, and be found selling or buying within the said boundaries, should be arrested and all his or their merchandizes should become forfeit and confiscated, so that one-half thereof should belong to the King and the other half to the Hudson Bay Company."

Governor Bayly, 1670.

1670.—The Company sent out Chas. Bayly, as Governor, to establish a post at Rupert's River in 51° 20′ N. Lat. He was accompanied by Groisselier and Radisson and remained in the country.

1673.—Groisselier visited the Nelson, but failing to find any Indians did not remain.

1674.—It being decided that a greater trade could be done with the Indians on the west side of the bay, owing to their remoteness from the French, Mr. Bayly made a voyage in a sloop to that coast, examining the mouths of the Moose and Schatawan or Albany rivers, and passing between the island of Agoomski (called by him Diner's Island) and the mainlaind, reached Cape Henrietta Maria, entering the mouth of the Equan River on the way. It had been his intention to proceed as far as Port Nelson, but having trouble with his guide he returned from Cape Henrietta Maria. During the same summer he sent a party to explore the Nodway or Frenchmen's River, but they only ascended as far as the first fall, a short distance from the mouth.

Arrival of missionary from Quebec by Lake Mistassini.

In the fall there arrived at Fort Charles a Jesuit missionary with letters from the Governor of Quebec; this was Père Charles Albanel, who reached the bay by ascending the Saguenay River to Lake St. John, thence up the Ashouapmouchouan River, across the Height of Land to Mistassini and down the Rupert River, which flows out of that lake. An account of his trip is given in the Relations of the Jesuits.* As he left Canada in 1672, he had been two years making the trip, having been detained by the Indians, who stripped him of his clothes, so that he had to be clothed by Mr. Bayly, who received him kindly and sent him home in the ship.

Establishment of posts at Hayes Island and Albany, 1675.

1675.—Outposts were established at Hayes Island, in the mouth of the Moose River, and at Albany. A short time after this the head fort was removed to Albany, and a depot established on Charleton Island, where the ship from England discharged her cargo, furs being brought there from the posts, and the next season's outfits returned in sloops.

1682.—Three parties reached the mouth of the Nelson River within a short time of each other; the first to arrive was Benjamin Gillan, a son of Capt. Z. Gillan, who had been sent from Boston; fourteen days later came Groisselier and Radisson from Quebec; they having been

* Rélations des Jésuits dans la Nouvelle France, vol. iii.

discharged from the Company's service, returned to France, were pardoned, and sent out to take possession of the Nelson for the French king; shortly after these John Bridgar arrived to build a fort for the Company. All three parties landed, and lived at peace until spring, when Groisselier surprised Gillan and Bridgar, took them prisoners, and afterwards conveyed them to Quebec, in the meanwhile sending the other English in a rotten ship to meet the Company's ship, which they did near Cape Henrietta Maria.

1684.—Quarreling with their employers on their return to Quebec, Radisson and Groisselier again deserted to the English, returned to Port Nelson, and gave it up to the Company.

Mica mine on East Maine River.

1685.—In this year the Company had forts at Albany, Hayes Island, Rupert, Nelson and Severn; also a small post at a river on the East Main called "Ison-glass" River, where a mine of that mineral had been found, the working of which proved unprofitable.

1686.—The French in Canada, afraid of losing their inland trade with the Indians, and knowing that James II would allow no affront in this quarter to cause a break between him and Louis IV, resolved, in a time of peace between the two countries, to take possession of the English forts. The Governor accordingly sent a detachment of soldiers, under the command of Chevalier de Troyes, overland from Que-

Capture of the forts by the French.

bec, who easily took possession of the Forts Rupert, Hayes and Albany, leaving Port Nelson only to the English.

1690.—D'Iberville sailed from Quebec with two ships to capture Fort Nelson. He failed to do so, but obliged the English to abandon Severn.

1691.—Mr. Geyer, governor at Nelson, sent Henry Kelsey inland to make discoveries and extend the trade by inducing the inland Indians to come to the fort. According to his journal, produced by the Company before the Committee of the House of Commons in 1749,* "he set out from Deering's Point (probably Split Lake), where the Indians

Kesley journeys from Fort Nelson to the Saskatchewan.

always assemble when they go down to trade, to seek the Stone Indians, and, after overtaking them, travelled with them and the Nayhaythaway Indians to the country of the Naywatamee-Poets, and was fifty-nine days on his journey, including the resting days. He first went by water seventy-one miles from Deering's Point, and then laid up his canoe and went by land 316 miles through a woody country, and then forty-six miles through a plain, open country, having seen only one river in his journey, shallow, but a hundred yards over; and after crossing ponds, woods and champagne lands for eighty-one miles more, which abounded with buffaloes and beavers, he returned back fifty-four miles, where he met the Naywatamee-Poets." From this it

* Robson's Hudson Bay.

would appear that he travelled from some point on the Nelson River above Split Lake to the open country north of the Saskatchewan.

1693.—War having broken out between England and France, the Company, with the assistance of the Crown, retook Albany, Moose and Rupert forts.

1694.—D'Iberville, with two ships and 120 men, took York fort from the English, and the same year the French sent such a force from Canada that they easily drove the English out of Albany, Moose and Rupert forts. Iberville captures Forts York, Albany, Moose and Rupert.

1695.—The Company, with the assistance of the Bonaventure and Seaford, a second time recovered Moose, Albany and Rupert forts.

1696.—The English, with four ships, took York from the French, carrying the garrison prisoners to England.

1697.—The French sent a squadron of five ships under D'Iberville, who destroyed two English ships, and afterwards took possession of York and called it Fort Bourbon. By the treaty of Ryswick, signed in this year, each country was to return all places taken during the war, holding those taken previous to it. By this the only place left to the Hudson's Bay Company was the fort at Albany. This state of things continued until the treaty of Utrecht, 1713, when the French ceded all their rights in the bay to the English.

1702.—The French rebuilt Fort Severn, calling it Fort Neuve Savanne, and the river Rivière des Saintes Huiles; they also called Moose Fort St. Louis, and Albany, Fort Ste. Anne.

1714.—The English formally took possession of York and the other forts on the bay.

1718.—A wooden fort was built at the mouth of the Churchill River, and named Fort Prince of Wales. Forts re-taken by the English.

1719.—Capt. Knight sailed with two ships to search for a north-west passage from the northern parts of the bay. They never returned.

1720.—About this year the Company sent Richard Norton inland from Churchill, and, according to the testimony of Brown before the Committee in 1749, he is said to have reached the Coppermine River, but this is doubtful, as no journal of the journey was produced.

1732.—A wooden fort was erected at Moose, and a small post established at the mouth of the Slude, or East Main River. About this time a post was also built at Richmond Gulf for trade with the Northern Indians or Esquimaux. The people here on two occasions were massacred by the Esquimaux, and the post was then abandoned.

1737.—Two sloops were sent to the northward from Churchill to open trade with the natives, and look for a northern passage to the westward; this latter object seems to have never been seriously undertaken.

1740.—Henley House was built about one hundred and fifty miles up the Albany River, to prevent the Indians communicating with the French.

1741.—Christopher Middleton, sent out to discover a north-west passage, wintered at Churchill on account of a dispute between him and Mr. Dobbs; another expedition under Wm. Moor and Francis Smith were sent out to settle the matter. They wintered in the Hayes River, and an account of the expedition was written by Henry Ellis, who accompanied them.

Ellis' voyage.

1752.—Joseph Robson published an account of his six years' residence at York and Churchill, where he had been sent by the Company to oversee the construction of the stone fort at Churchill, and survey the mouths of the Hayes, Nelson, and Churchill Rivers, plans of which are published in his book. He complains of the lack of interest exhibited by the Company in regard to the interior, and says that the officers in charge had never been five miles up any of these rivers.

Capt. Coate's notes of voyages.

1727–51.—Capt. W. Coates for these years was Captain of one of the Company's ships voyaging to the Bay; during this time he kept a series of sailing notes, entering in them a full account of the geography of the Bay; these notes he bequeathed to his son, with instructions to him, not to reveal them so long as the Hudson Bay Company continued to employ him. These notes, edited by John Barrow, were published by the Hakluyt Society in 1857, and form an important source of information in relation to the coasts, rivers and islands of the Bay.

From the time of the treaty of Utrecht until after the conquest of Canada, the Hudson Bay Company confined their trade strictly to the Bay, and did not go inland until they found themselves in danger of losing their trade to the Canadian traders, who secured the fur by meeting the Indians on the headwaters of the rivers, and thus saved them the long journey to the sea.

Hearne's journey from Churchill.

The Company becoming aware of this fact, resolved also to send inland, and in 1769 despatched Samuel Hearne, from Churchill, with instructions to accompany the Indians to their hunting grounds, visit the copper mine on the river of that name, and if possible reach the sea at its mouth. After two unsuccessful attempts, he accompanied some Northern Indians and wandering over the barren lands with them reached the mouth of the Copper Mine River, then visited Great Slave Lake, and returned across country to Churchill in 1773.

On his arrival he was immediately sent inland again, to build Cumberland House, on Pine Island Lake, a short distance north of the Saskatchewan River, the first of the Company's many posts in the North-West. From this date the Hudson Bay Company entered into active competition with the Canadian traders for the inland trade, and

soon had a great number of posts scattered over the North-West and on the Mackenzie River.

David Thompson, at first employed by the Hudson Bay Company, and afterward by the North-West Company, was the first person to fix with any degree of accuracy the positions of the different posts, and make surveys through the country; he was engaged at this work from 1790 until 1812. From 1816 to 1826 he was employed on a boundary survey between Canada and the United States, from the St. Lawrence to the Lake of the Woods. Surveys by David Thompson, 1790-1812.

Philip Turner was another Surveyor, who explored extensively under the orders of the Hudson Bay Company, about the beginning of the present century, and may have made the surveys in Severn River country, as laid down on Arrowsmith's Map prepared for the Company.

In 1782, the French Admiral La Perouse entered the Bay with three war ships, and took Fort Prince of Wales, spiked the guns, and destroyed the factory, without any resistance being offered by Hearne, who was then in charge of the place; then sailing to York he destroyed a small battery at the mouth of the Hayes River, and burnt the factory, but failed to capture the Company's ships with their rich cargoes of fur. Capture of Churchill by Admiral Perouse.

1814.—Lieut. Edward Chappell, on H.M.S. Rosamond, the convoy to the Company's ships, visited Churchill and York. He published an account of the voyage, with descriptions of the Bay, and a map of the Nelson, from its mouth to Lake Winnipeg. Voyage of Lieut. Chappell.

1820.—Sir John Franklin, on his first expedition overland to the Arctic Ocean, went by way of York and the Hayes River route to the Saskatchewan; he made a track survey of the route and published an account of it, in the narrative of the journey. Since that time many other travellers have passed over the same route. Franklin's journey.

Geographical explorations of the country to the eastward of the Bay were not undertaken until about 1820, when Dr. Mendry and Mr. J. Coulson made explorations, under orders from the Company, and have left rough maps of their work. The former traversed the country from Richmond Gulf to Ungava Bay; the latter explored the East Main, Rupert and Notaway rivers, also the portage routes between the head waters of these rivers.

Shortly after this posts were built at the mouths of the Little Whale and Great Whale rivers, where important porpoise fisheries were formerly carried on, but of late years have been abandoned as being unprofitable. Fort George, at the mouth of Big River, was also built about the same time, and is at present the headquarters of the East Main district. It has been found impossible to get the exact date at which these posts were established. Establishment of posts on East Main coast.

Missionary work.

About 1847 the first missionary work among the Indians of Hudson Bay was undertaken by the Methodists. These withdrawing six years later, were succeeded by the English Church Mission Society, which has continued the work ever since, and at present has churches at Churchill, York, Albany, Moose, Rupert House and Fort George. Rev. Mr. Peck, in charge of the last place, visits Little Whale River every spring, to meet the Esquimaux who come in from the islands at that time. By the efforts of these missionaries the whole of the Indians and the greater part of the Esquimaux living around Hudson Bay have become Christianized, and their moral tone considerably elevated.

The Roman Catholics have a number of converts at Albany, who are yearly visited by a missionary of that faith from the Upper Ottawa.

Previous explorations by the Geol. Survey staff.

The explorations in this section of the country undertaken by the Geological and Natural History Survey of Canada, previous to the present, are :—

Report 1871-2. Upper part of the Albany River. Dr. R. Bell.
Report 1875-6. Mattagami and Missinaibie branches of the Moose River. Dr. R. Bell.
Report 1877-8. East coast of Hudson Bay, and country between Lake Winnipeg and Hudson Bay. Dr. R. Bell.
Report 1878-9. Churchill and Nelson Rivers. Dr. R. Bell.
Report 1879-80. Hudson Bay and some of the lakes and rivers lying to the west of it. Dr. R. Bell.
Report 1880-1-2. Geology of the basin of the Moose River. Dr. R. Bell.
Annual Report 1885. Observations on the Geology, Zoology and Botany of Hudson Bay and Strait. Dr. R. Bell. Report on the Mistassini expedition. A. P. Low.
Annual Report 1886. Attawapishkat and Albany Rivers. Dr. R. Bell. Severn and Berens Rivers. A. P. Low.

James Bay.

James' Bay.

James Bay is that portion of Hudson Bay lying south of a line drawn from Cape Henrietta Maria, on the west, to Cape Jones, on the east coast. From the head of Hannah Bay, N. lat. 50° 55′, to Cape Henrietta Maria, the distance is, roughly, 300 miles, while the average breadth is 145 miles.

From Cape Henrietta Maria the coast runs S.S.E. to Mourning Point, a low point covered with trees, near lat. 54° 38,* then south to Equan Point, lat. 53° 53′; from there it trends well to the westward, to the mouth of the Equan River, and then east of south to the mouth of the Albany River, lat. 52° 17′, thus forming a considerable bay, and not running almost due north and south as represented on all modern maps.

Incorrect maps

* Capt. Coats' Notes.

From the mouth of the Albany River the direction of the shore line changes to E.S.E. for a distance of forty miles to Cockespenny when it turns S.E. to the head of Hannah Bay. Hannah Bay is thirty miles deep, counting from a line drawn between Gull Point on the east side and the mouth of Moose River, and has an average breadth of fifteen miles.

This bay is separated from Rupert Bay by a long low point terminating in a peninsula, at one time an island, the isthmus is covered with willows and is lower than the land adjoining, the latter, on both sides, supports a thick growth of spruce and tamarac. Rupert Bay is thirty-five miles deep, with an average width of twelve miles.

The east coast of James Bay has a roughly north and south direction from the head of Rupert Bay to the mouth of Big River, one hundred and seventy-five miles. From this river the coast takes a gradual curve to the westward, the land at Cape Jones lying about east and west.

According to Capts. Taylor and Bishop, of the Hudson Bay Company's ships, the position of Cape Jones, as laid down on the Admiralty chart, is fully forty miles to the eastward of its true position; this being the case, the mouth of James Bay is that much narrower than is represented on the maps.

The Admiralty chart, from which all modern maps of Hudson Bay are constructed, was compiled in 1853 from information supplied by the Hudson Bay Company, gathered from notes and observations of the various captains of their ships; now as these observations were but approximately correct, the chart must be so also, especially in those parts unfrequented in the navigation of the bay, and such being the case, it is highly important that an accurate survey should be undertaken to correct these errors in the coast line, and enable ship captains unacquainted with the navigation of these parts, to enter James Bay with a certain degree of safety, a thing impossible with the present charts.

Importance of an accurate survey being made.

The general coast line of the west and south sides of James Bay is low and flat, with shallow water, deepening very slowly outwards all along, except where the rivers have cut out channels in the mud.

Although the average rise and fall of the tide does not exceed five feet, at the time of low water, only mud flats, strewn with large boulders, can be seen to seaward from high water mark. The shore is, in most places, marshy, covered with grasses and willows, with numberless small brackish ponds and lakes for a considerable distance behind high-water mark, while beyond, on slightly higher ground, is a dense growth of dwarfed black spruce and tamarac; it is often several miles from low-water mark to where the first really dry ground may be found.

Tides.

Shoals and mud flats.

Hannah Bay is so shallow that, with the exception of the river channels, it is almost completely dry at low water, and when a canoe is left by the tide, the sensation experienced by its crew is anything but pleasant, as they have to debark and stand in the mud, often beyond sight of the low fringe of bushes on the high water line, awaiting the return of the water. Rupert Bay is not quite so shallow as Hannah Bay, and has a channel up its centre to the mouth of the Notaway River.

Character of the coast on east side of the bay.

Along the east side of the bay the character of the coast changes, the low unbroken, muddy shores being replaced by higher rocky and sandy banks, deeply indented with small bays and fringed with innumerable rocky, shingle and sand islands as described by Dr. Bell (Report of Progress 1877-8.) The waters are much deeper and, although not free from danger on account of many hidden shoals, can be easily navigated in small craft, the islands and bays affording abundance of good shelter. The country inland from the bay varies similarly to the coast line. To the west and south it is almost flat, with its soil overlying nearly horizontal beds of

Silurian and Devonian limestones.

Silurian and Devonian limestones for about one hundred and fifty miles inland to the Archæan country, so that the general level rises slowly and evenly towards the interior. The soil along the rivers appears to be good, and as the climate to the southward is probably

Good soil.

favorable for the growth of cereals and root crops, nothing prevents future settlement in this region after the filling up of the north-west, except that without an extensive system of drainage, the lands remote from the rivers will be found too wet for successful farming, as it is said by the Indians, that with the exception of lands close to the rivers, the greater part of the country for a long distance inland from the bay is a mossy swamp.

Inland from the east coast the country is of a different character. The interior of this part is a rough table-land having an elevation of about seven hundred feet above sea level near its edge, and slowly rising inland to over two thousand feet at its highest.

Character and elevation of the interior table-land.

The edge of this table land leaves the coast to the north of Cape Jones, and runs in a S.S.E. direction, so that to the southward there is an interval varying from ten to thirty miles between it and the coast. In this portion the general level is not much over one hundred feet above the sea, and the soil is of Post-Pliocene clays and sands, with alluvium, affording good land for cultivation but as the climate is colder than on the west side, it is doubtful if it would allow the successful growth of any but the hardiest cereals, good crops of potatoes, however, and other roots could be and are grown as far north as the mouth of Big River. The land is rolling and broken by low rocky

Archæan hills which make up about one-third of the entire area, all of which would make excellent grass land. The best portion of it is along the river bottoms, and on the islands and banks. Root crops, Good grazing land.

Eleven large and many smaller rivers flow into James' Bay; on the west side are the Equan, Attawapishcat, Albany, and Moose rivers; on the south, Hannah Bay or Harracanaw, and the Nottaway rivers; on the east, the Rupert, East Main, Old Factory, Big and Bishop Roggan rivers. Rivers.

The water-shed of the country on the west side runs in a south-west direction from Cape Henrietta Maria, and consequently the rivers to the southward, having greater drainage areas, are the largest and longest.

The first river to the south of Cape Henrietta Maria is Raft River, an inconsiderable stream, the outlet of Raft Lake; it reaches the sea in lat. 54° 04′.

The next river is the Equan, a much larger stream, which takes its rise 300 miles to the westward, at the watershed between it and the Winesk River, flowing north; it enters the bay at lat. 53° 38′.

About lat. 53° 24′ are the two mouths of the Attawapishcat River, which rises over four hundred miles inland, near the source of the east branch of the Severn River. It flows north, and drains an extensive area of unexplored country between the Equan and Albany rivers.

The Kapiscow River is a smaller stream entering the Bay at lat. 53° 05′.

The next important stream to the southward is the Albany River, the longest and largest on the west side of James Bay.

This river, one hundred and forty miles in a straight line south-west from its mouth, divides into two branches. The north or main branch comes from the west; it takes its rise a short distance from the head-waters of the English River, in Cat or Cat-fish Lake, about one hundred miles north-west of Lake St. Joseph, through which it flows, and which flows into Lake Winnipeg. The south or Kenogami Branch flows from Long Lake, thirty miles from the north shore of Lake Superior. At its mouth the Albany spreads out and flows between a number of low, swampy islands, forming a delta twenty-three miles long and ten miles broad between the mouths of its channels, the most southward of which empties into the sea in lat. 52° 12′.

At the south-west angle of the Bay is the wide mouth of Moose River, whose branches drain all the country to the south-west and south, from the rivers flowing into the eastern portion of Lake Superior and the headwaters of the Ottawa. The western or Missinaibie branch flows out of Missinaibie Lake, at the head of the Michipicoten River, within fifty miles of Lake Superior; the middle or Metagami branch flows from the south, and drains the country north of the

watershed to Lake Huron; the eastern or Abitibbi branch flows out of Lake Abitibbi, a short distance from Lake Temiscamingue on the Ottawa River.

Varying character of the rivers.

All the rivers flowing into the west side of James' Bay present the same physical characters; on their headwaters and upper parts, while flowing over Archean rocks, they alternate between long lake-like expansions with little current, and short contracted portions accompanied by heavy rapids and falls, thus affording good stretches of navigable water with portages between. On their lower courses, for a distance of one hundred and fifty to two hundred miles from their mouths, where they pass over the flat Devonian and Silurian limestones, the fall is uniform, and consequently the character changes, so that in ordinary low water during the summer and early autumn, owing to this uniformity of fall and to the rivers having too great a breadth for the amount of water discharged at this period, they present an almost unbroken succession of small shallow rapids, full of boulder and gravel bars, and only navigable for canoes of light draft.

Navigation.

For three or four weeks after the ice leaves the rivers, during the spring freshet, and again after the autumn rains, the higher water flattens out these numerous rapids and covers all obstructions, so that navigation with large boats, and even small steamers, is then possible; but at these times the current has a uniform rate of between five and six miles an hour, and therefore comparatively powerful steamers would be required to ascend the streams, the boats at present used being tracked up by men along the banks.

Near the head of Rupert Bay the Little Nottaway River enters. It is a small stream draining the country to the south between Hannah Bay and Nottaway River. This was called formerly Onengham Creek and was used as a winter harbour by the first voyageurs to the bay in the Company's service.

The mouth of the Nottaway River is directly at the head of Rupert Bay. This is a large river, one of whose branches rises in Lake Chibougamoo, a short distance to the westward of Lake Mistassini, and to the northward of the headwaters of the Asbouapmouchouan River, which empties into the Saguenay by way of Lake St. John; the other branch comes from a more southerly direction and rises near the heads of the Gatineau and St. Maurice rivers. In its lower parts the Nottaway River is so rough and rapid that instead of using it as a route to Waswanippi, a post on its upper waters, the Hudson Bay Company's canoes ascend the Rupert River, itself a very bad route, for one hundred miles to Lake Nemiscow, and thence pass by a portage route through small lakes and streams to the Nottaway.

On the east side of Rupert Bay, about half way between the mouths of the Rupert and Nottaway rivers, a small stream called Fish River enters.

In lat. 51° 30′, on the east side of Rupert Bay and near its mouth, the Rupert River flows in. This large body of water flows from Lake Mistassini, which is fed by several comparatively large streams, the longest and largest of which is the Temiscamie River, which rises to the north-east of the lake, near the headwaters of the Peribonka River flowing into Lake St. John.

Portages on Rupert River route.

The Rupert River, for one hundred miles from the sea, is very rough, and in ascending it canoes with their loads are forced, on account of its heavy rapids and falls, to make portages aggregating over ten miles in length.

Continuing up the east side of James Bay, the next river flowing in is the East Main or Slude River, whose mouth is in lat. 52° 15′. This is a very large river, rising fully five hundred miles inland at the central water-shed of the Labrador Peninsula, which divides the waters running north into Ungava Bay, from those flowing west and south into Hudson Bay, and the Gulf of St. Lawrence respectively.

As has been previously stated, the course of the East Main River was roughly laid down by Mr. Clouston In 1824, who made a track survey to near its head. A copy of his map was obtained at Little Whale River last year and it is now in the office of the Geological Survey. The Hudson Bay Company use the upper part of this river as a route to their post of Nitchicoon, situated on a lake a short distance beyond the height of land on the head of one of the rivers flowing north into Ungava Bay. The route followed from Rupert House is by the Rupert River to a short distance beyond Lake Nemiscow, where a northern branch is taken, and passing thence through a chain of lakes, the East Main is reached, about two hundred miles from its mouth, and then ascended to its head through several more lakes. The lower part of the river is broken by a number of heavy rapids and falls, entailing long portages, and therefore the Rupert is taken in preference, thus obviating the long coast journey in open canoes, with its attendant delays and dangers. The present route to Nitchicoon is so difficult that the Hudson Bay Company have tried to find an easier one by the Big River to Fort George, but this was ascertained to be longer and harder than the one used at present. The difficulty of the trip can be appreciated when it is learned that the large canoes leave Nitchicoon with the first open water in the spring and are often dragged over the frozen lakes to the river, they thus reach Rupert House about 1st July; where, unloading their furs, they embark the trading outfit for the ensuing year and start immediately inland, only

Falls and rapids.

reaching Nitchicoon at the close of open water, and frequently they have been frozen in before reaching their destination, in which case the outfit has had to be hauled to the post on sleighs after the snow had fallen.

About lat. 52° 33′ the next large stream, called Old Factory or "Isonglass" River enters the bay. This is the river on which the company had a small post in 1685, and attempted to work a mica mine, but abandoned it as unprofitable. The only information obtainable concerning this stream is that it is a much smaller river than the East Main, and that its mouth is obstructed by sand and shingle shoals. To the northward of this are several small streams before the mouth of Big River is reached in lat. 53° 53′.

Mica mine.

Big River.

Big River is the largest river flowing into James Bay on the east side, and discharges probably a larger volume of water than the Albany, and therefore is the largest river entering the bay. In the latter part of this report it is more fully described.

Other rivers.

Between the Big River and Cape Jones are the mouths of several rivers of considerable size, the largest is the Bishop Roggan, the other important ones being the Little Bishop Roggan, Seal and Salmon rivers. These drain a large area of country between Big and Great Whale rivers.

The rivers entering James' Bay from the east for their entire length, pass, so far as known, through Archæan country, and consequently present physical characters somewhat different from those on the west side. On their headwaters they flow on the general level of the country and are nothing but a succession of lakes connected by short stretches of rapid rivers. After they have attained considerable volume and as they approach the margin of the interior table-land they begin to assume a true river character; they flow, with a moderate current, broken by sharp falls and heavy rapids, in old river valleys cut below the general level. Near the margin of the table-land the valleys become deeper, and the rivers are almost a constant succession of heavy rapids and falls until they reach the lower country, where they flow with a moderate current, with but few small rapids, in a distinct river valley between clay and sand banks of Post Pliocene age.

General character.

Harbours.

Settlement.

In relation to the future settlement of the country around James Bay and to the possibility of its use as a highway for future commerce between western Canada and Europe, the question of its harbours and their terminal facilities for railways is of the greatest importance. It is to be regretted that the natural harbours at the mouths of the

different rivers in the southern part of the bay meet the requirements of modern shipping only to a very moderate degree, and that to improve them sufficiently to admit of their being used as ports by large ocean steamers would entail an expenditure hardly likely to be warranted by the trade development of the future in this region.

Mouth of Moose River.

The most important harbour in this part of the bay is that at the mouth of Moose River. A description of it is given in Capt. Coate's notes on the geography o Hudson Bay, 1727-51, and as it has changed but little since then, his sailing directions may here be quoted: "From the Gaskitt fifty-eight miles S. by W. you come to Moose River Road, eight miles from Sand Heads, North Point W.N.W. six miles in lat. 51° 34′, where you wait for the tide to go into that wide mouthed river which is not less than twelve miles over from North Point to the opposite side; which opens with three channels, but the north and east are so choked with banks and shoals, there is no using them; the mid channel will admit of a ship of twelve feet. Observing the tide over a bar one mile broad and one mile within Sand Heads is a little place which affords water for a ship to be afloat, called Little Ship Hole, to distinguish it from another four miles above Sand Heads, called Ship Hole, in three fathoms low water, where we moor and do our business. Eight miles below the factory on Roberson's Islands from Middleborough (Island) another island runs a shoal within half a mile of the ship, which cuts the river and prevents the ship going to the factory, which has plenty water all above that place."

From this it will be seen that a ship while awaiting the tide to cross the bar, has to lie six miles from the mouth of the river, in a very dangerous position with a north-east gale. The channel on the bar is not over four hundred yards wide, and the Hudson Bay Company's ship, drawing fourteen feet of water, last summer, ran aground while crossing it, and had to remain in that exposed place until the next high tide.

Railway terminus.

The eight miles from the Ship Hole to Moose Factory is in places very shoal, and is rapidly filling in its upper part, so that the Company's schooner, drawing eight feet of water, can only come within about two miles of the Factory, whereas a few years ago her cargo was discharged close alongside that place. If a railway should be built to this harbour its terminus will need to be at Ship Hole; and to reach it a long and expensive line of embankment will have to be built from the South Shore, across sand and mud flats, partly bare at low water, and, owing to its exposed position, it would need to be correspondingly strong to withstand the force of water during the late fall gales. If approached from the north side, a large bridge will be required to cross the channel to the "Ship Sands," a low, flat, muddy island, partly cov-

ered with water at high tide, and lying close to the Ship Hole; in either case the terminus will have to be built largely on made ground.

As the present anchorage, six miles without the bar, is in only thirty-six feet. and as the water gradually shoals toward the river's mouth to a depth of fourteen feet at high water on the bar, and is only eighteen feet at low water at the Ship Hole, with a less depth of water for the four miles between it and the bar, it will be seen that to fit this harbour for the entrance of moderate-sized steamers, with a draft up to twenty feet, extensive dredging operations will be necessary for almost the entire distance from the outer anchorage to Ship Hole.

Poor harbours.

Unsatisfactory as are the natural conditions of Moose Harbour, those at the Albany and Rupert rivers are worse. Off the mouth of the Albany, for fifteen or twenty miles, the bottom is very flat and the deepest water not over twenty-five feet, slowly shoaling to twelve feet at the mouth, with numerous obstructive shoals and bars, the whole rendering it impossible for deep draft vessels to use it. The country around the mouth of the river is so low and swampy that it is hard to say where the land ends and the sea begins, and is totally unfit for the purpose of a railway terminus. To reach the mouth of the Rupert a narrow channel in Rupert Bay must be followed, with water from thirty to twenty-five feet deep, after which it shoals to eighteen feet for seven miles to the junction of the Nottaway and Rupert River channels, and then eight miles of water varying from ten to fifteen feet, with dangerous shoals, must be passed to enter the river proper. From this it will be seen that this harbour can only be approached by small vessels of light draft, and can never be used by the large-sized steamers engaged in modern ocean transportation. The mouth of the East Main River is broad and consequently shoal, with not more than eight feet of water on the sand bars at its entrance; while for more than twelve miles from its mouth, on all sides, are innumerable boulder and sand shoals, and small rocky islands, some of which are partly bare, the whole rendering an approach to the river so highly difficult and dangerous that the Hudson Bay Company's schooner does not call there.

Big River harbour.

The mouth of Big River is the only good natural harbour on James Bay, and, with a small amount of dredging, would afford capital accommodation for large vessels. A ship entering the river has to pass a few low islands lying off its mouth, but as there is good water and plenty of sea room between them, they occasion little danger. Within four miles from the mouth of the river a good harbour is formed by two rocky islands lying close to the north or main channel; this is called Stromness Harbour, and, having a good anchorage, with plenty of water, well sheltered on all sides, is a convenient place to await a suitable state of tide to enter the river.

Good anchorage.

At the mouth of the river the channel is divided by a sandy shoal, partly bare at low water; the north channel is the deeper, and is used by the Company's schooner, chiefly owing to its proximity to Stromness Harbour, as there is a sufficient depth of water in either channel to float that craft. From Stromness Harbour the channel runs eastward directly towards the shore for two miles, when it turns sharply southward, one mile along the shore, to the mouth proper of the river, which can then be ascended about two miles to Fort George, where large vessels can be moored close to shore. From Stromness Harbour to Fort George at high tide the least water in the channel is eighteen feet. Fort George being situated on an island, there is another channel on its south side, but this is very small and obstructed by shoals, navigable only by small boats.

The island would afford excellent ground for a railway terminus but the difficulty of building a line along the east coast from the south end of James Bay, a distance of 180 miles, with the large bridges required to cross the Nottaway, Rupert, East Main and Old Factory rivers, would entail an expenditure hardly warranted by the amount of trade to be developed.

Fisheries of inland waters.

The development of Big River harbour will come with that of the immense and excellent fisheries of the inland lakes of this region and to the northward, as well as the coast fisheries, which, after the failure of the present sources of supply, will be of great importance and value.

From Big River to Cape Jones the bay is obstructed by many low islands and shoals for several miles from the coast, and as the bottom is uneven and the water not deep, large vessels cannot approach the mouths of the rivers flowing into this part. To the northward of Cape Jones the character of the coast soon changes, becoming higher and more rocky, with bold water close in shore. The mouth of Great Whale River would make an excellent harbour if a channel were cut through the sand-bar that at present obstructs its outlet, and over which the Company's schooner cannot pass at low tide.

Little Whale River is also obstructed at its mouth by a dangerous bar, which can only be crossed by small craft, and is impassable when the wind blows freshly from the north to west, at such times being covered with tremendous breakers.

Other harbours suitable for small craft occur at frequent intervals among the islands and bays along the whole eastern coast, but are all too small and shoal for large vessels, except one at Cape Hope Islands, about twenty miles north of East Main River.

Islands.

Three groups of islands.

The islands of James Bay, from their geographical position and physical character, may be conveniently divided into three groups. The first consists only of the large island of Agoomski, lying off the western shore; the second includes the high drift islands, situated to the eastward of a line drawn through the middle of the bay, and separated from Agoomski on the west by a deep water channel; the third is composed of the rocky islands and sandy shoals along shore on the east coast.

Agoomski.

The Island of Agoomski, or Omer's Island, as it was called by Governor Bayly in 1673, is the largest in James Bay, being seventy-five miles long, with an average breadth of ten miles.

Its south end lies about thirty-five miles N. E. from the mouth of the Albany, and is consequently about twenty-five miles directly east from the coast.

The eastern shore of the island runs N. N. W. for thirty-five miles from its south end, and then bending more to the westward runs W.N.W. to its north end, which is in Equan Bay, and distant about eight miles from the main land, so that the position of the island is inaccurately laid down on the present published maps, which show it lying roughly parallel to the coast and about fifty miles distant from it. Indians coming from the northward to Albany on the ice, in the winter, when travelling in a straight line from Equan Point to the mouth of that river, cross the north end of Agoomski, showing that part to lie well in shore. The island closely resembles the adjoining main land in physical character, being very low and swampy. The shore line above high-water mark is made up of muddy flats covered in

Vegetation.

part with grasses and sedges, followed farther inland by thick growths of small willows, these in turn giving place to small black spruce and tamarac as slightly higher ground is reached. The line of these trees is often over two miles inland from high-water mark, itself a long distance from the sea at low water. As far as the tree line and in places beyond it, are numerous small lakes and ponds of brackish water; good fresh water being only obtainable in a few places well inland.

The shore between high and low water mark is composed of a stiff slimy mud. Scattered over it are many boulders of gneiss, large and small. At the various points the boulders are often piled together, forming higher elevations than the surrounding flats.

The water around the island is very shoal for several miles out, and as the bottom is uneven, being broken by numerous boulder shoals and bars, it is very dangerous to approach even with small boats owing to the dirty state of the water. In fine weather the first

notice given of these shoals is the bumping of the boat upon them. On the west side, between the island and the main land, the water is shallower than on the east side, so that at low tide the distance between shore and shore is reduced in some places towards the north end to not more than one mile. This is taken advantage of by the Indians, several families of whom hunt on the island, crossing from the main land to the island in their small canoes. They start from shore at high tide and follow the retreating water out to its lowest point, cross the narrow channel and reach the high water line on the opposite shore with the rising water. From its close resemblance physically to the western mainland, it is probable that Agoomski is underlaid by the nearly horizontal beds of Devonian limestone found on the rivers near the coast. If this is the case, the rocks are covered with drift material on the lower half of its east side, which is the only part of the island that has yet been examined geologically.

Animals.

The fresh and brackish lakes and ponds on the island are favorite breeding places for ducks and geese, which congregate here in countless numbers in the autumn to feed on the grasses growing along the low shores. The snow goose is reported to breed here when delayed on its passage north in the spring. Rabbits and cariboo are reported to be numerous, white bears frequent its shore, and the fur of the otters killed here is remarkably good and dark. Owing to the shoal character and muddy state of the water around the island, few fish are caught along its shore.

The principal islands composing the second group are Charleton, Danby, Cary, Woods, Little Charleton, Struttons, Weston, Solomon's Temples, Twins, Spencer, Walter and Grey Goose islands, along with the Bear Islands, lying more to the westward. These have a close resemblance to one another, both in formation and physical appearance, being composed wholly of sand, clay and boulders, with no bedded rocks in place. They all rise to considerable elevations above the sea level, present sharp escarpments, composed of clay and sand, along their margins, and the formation of all was probably due to the same causes, as shown later on in this report.

Sand, clay and boulders.

Charleton, the second largest island in James Bay, lies about twenty miles north of Point Comfort, the end of the peninsula separating Rupert from Hannah Bay, and about one-third of the distance across the bay from the east coast, its north-east point being in lat. 52° 2′ 13″. In shape it is an oblique parallelogram, having diagonals eighteen miles long from north-east to south-west, and twelve miles long from north-west to south-east. As before stated, this island, like the others of the group, is composed of unstratified sand, clay and boulders, without any rock in place.

Charleton Island.

The interior is a rough, rolling plateau, varying in elevation from 50 to 200 feet above sea level. On the south and east sides it ends in an abrupt escarpment, highest on the south; on the west and north the high interior land descends with an unbroken slope to a low shore. Starting from South-east Point, this escarpment runs westward at an angle of twenty degrees to the shore, consequently, on its west side it is a considerable distance inland. At the east end it has an elevation of seventy-five feet above sea level. This increases for four miles, where the maximum elevation of 200 feet is reached, fifty feet above the general level of the interior plateau, and standing above it with a cut bank that height on the north side, one-quarter of a mile from the southern margin of the escarpment, beyond which it decreases slowly westward, and is lost in the general low level of the west side. The face of the escarpment was examined at several points along its length, and found to consist of a moderately fine, light sand, with some clay, coarser gravel and small boulders mixed through the mass, the whole showing no signs of stratification. Going north from the south-east point for one mile, the escarpment averages sixty feet in elevation, with its base within a few yards of high water mark. Behind this, at a distance of 200 yards, is a second escarpment, thirty feet higher than the first. These, on their face, have the same composition as the southern escarpment. At the end of this course, and for one mile and a-half beyond to House Point, the descent from the interior is less precipitous, the land rising in three terraces—the first, ten feet, the next, forty feet, and the highest one, a quarter of a mile inland, 100 feet above the sea.

From House Point, for half a-mile, the face of the twenty-foot terrace is made up of sandy clay, with much gravel and boulders, rising out of deep water. From here the escarpment turns N. 30° W. for five miles, and then east five miles and a-half, passing inland around the head of a low, muddy bay, and reaching the shore again one mile south of the north-east point.

Terraces.

Here, on the east side, two distinct terraces are visible, the lower being fifteen and the higher seventy-five feet above the sea. The face of the inner terrace is chiefly sand, mixed with a considerable quantity of clay, and with many boulders scattered through the mass. To the westward of the north-east point, along the shore, the lower terrace is soon lost in the upper one, which, a mile beyond the point, shows a face of forty feet, composed of an unstratified sandy clay matrix, holding large quantities of boulders and coarse gravel.

Further to the westward the cut bank gradually loses its elevation, and two miles beyond the last described place is only about ten feet high; from here to the south-west point no banks occur, the shore line being

low, and formed of sand and mud, with many loose boulders scattered over it. At frequent points along this part of the shore the boulders are heaped up together, thus rising a few feet above and breaking the monotony of the general level of the shore.

Most of the boulders are of Laurentian and Huronian gneisses and schists, associated with light yellow fossiliferous limestones of Devonian and Silurian age, non-fossiliferous, light and dark limestones similar to those found at Lake Mistassini and along the coast to the north of Cape Jones, and also masses of the dark green traps found associated with the latter rocks. Character of boulders.

From the base of the escarpment on all sides, numbers of clear, cold springs of excellent water issue at all seasons. Following the shore from the south-west point, the course is due east for half a mile along a sandy beach, about fifteen feet above high water, covered with many boulders near the point; then turning N.N.E., a similar sandy shore covered with coarse grass and low willows is passed over for one mile and a-half to a flat muddy bay; this bay, with another on the west side, leaves at high tide only a low narrow neck joining the south-west portion of the main island. From this bay the course of the shore changes to S. 70 E., and runs in this direction seven miles to South-east Point. Between the escarpment on the south side of the island and the shore is a considerable area of low swampy land not rising over ten feet above high water mark, where a low embankment averaging twenty feet broad, composed chiefly of boulders bedded in clay, has been pushed up by the floating ice, and forms a natural dyke to the lower land behind, which is very swampy and partly covered with long narrow fresh water lakes lying parallel to the escarpment and shore. Between high and low tide on this side, is a wide mud flat strewn all over with a great number of boulders. Beyond low tide mark the water is very shoal for a long distance out; with the exception of the stretch of coast on the east side, from South-east to half a mile beyond House Point, the above description of the shore applies to the whole of Charleton Island. To the westward and northward sand and boulder shoals, bare at low water, extend out for miles from the island, rendering it impossible for ships to approach from those directions. Good water.

The bay on the east side with the escarpment passing around it, already mentioned, is two miles and a half wide and one mile deep; at low water it is completely dry and exposes a broad mud flat, with many large boulders upon it.

The land between the water and the escarpment, like that on the south side, is very low and swampy, with over one-half its area covered by small shallow lakes, formed or enlarged by numerous beaver dams, upon the three small streams that flow into this bay.

Danby and Cary Islands

To the eastward of Charleton lie two small islands; the southern, called Danby, being two-thirds of a mile distant; the northern or Cary, two miles from Charleton.

Between these islands and Charleton is a deep channel, through which the tide runs, with a current varying from three to five miles an hour. At House Point the water is deep close along the shore, and it was here that Captain James wintered his ship in 1631; here, also, in 1675 the Hudson Bay Company's ships discharged their cargoes from England, and took in the furs brought from the different forts on the Bay in sloops. In 1695 this depot was abandoned, and the anchorage has since been used only by the Company's ships when obliged to winter in the Bay, as it is the only moderately safe place in the southern part of James Bay where a ship may winter and allow the crew to obtain good water and fuel. The last ship wintered here in 1884; remains of the low huts, partly built in the ground for the officers and crew, are to be seen about one-quarter of a mile south of House Point on the first plateau island, near a fine large spring of clear water, which never dries or freezes, and is consequently available throughout the year. On the point is the frame of a large shed, formerly covered with sails, in which the ship's cargo was stored. The only drawback to this place as a wintering ground is that the strong current setting up and down the channel causes it to open early in the spring, and it then carries large masses of ice forward and backward, which striking the ship are a source of great damage and danger.

Wintering place for ships.

Trees.

The soil of the high interior land being light and sandy, the rain readily soaks in, and consequently no lakes or streams are found on the surface, which is partly covered with moss. The trees growing in the interior are chiefly small white and black spruce, with a few aspen and balsam poplar, growing much thicker to the northward than on the southern parts, where they form open glades, the intervening spaces supporting a growth of small birch (*Betula pumila*) from one to two feet high. About one-half of the south-eastern portion of the plateau has been burnt over, leaving nothing but the bare sandy plain with small patches of moss growing on it, and presenting a very barren appearance. Between the escarpment and the shore, also on the low swampy lands on the west side, the trees are almost wholly made up of black spruce, with a few tamarac and balsam poplar. Fringing the shore are extensive areas of low willows, beyond which grasses and sedges alone grow over these portions at or near high water mark, where the shore is frequently overflowed by the tide. Cariboo and black bears in small numbers are found on the island; white bears often land after heavy gales on its northern shores; rabbits are very plentiful, but the island is chiefly noted for the beavers that abound in all its

Rabbits and other animals.

small lakes, being preserved by the Hudson Bay Company, who claim to have introduced them, and only allow them to be hunted every third or fourth year. The small lakes are favourite breeding places for ducks and grey geese, which find good feeding grounds on the low grassy flats along the shore, ptarmigan also breed on this island, it being their southward limit around Hudson Bay.

Danby Island, as before mentioned, is distant two-thirds of a mile from the southern portion of the east side of Charleton Island. It is roughly triangular in shape, each side having a length of two miles; one side lies parallel to Charleton, with its middle directly opposite House Point. Its shores are low and made up chiefly of sand and boulders, with muddy stretches between the points, and a raised bar of sand and boulders formed by ice, similar to that on the south side of Charleton, runs around the island near high water mark. Shoal water extends out from the north, east and south sides for long distances. The interior of the island is low and swampy, covered with a thick growth of small black spruce and tamarac, with a few balsam poplar.

Cary Island.

Cary Island lies two miles north-east of Danby and three miles east from the north-east point of Charleton. It is four miles long from north to south, with an average breadth of one mile. On the western side the island is low and swampy, gradually rising inland. On its south, east and north sides are escarpments rising in the highest parts seventy feet above the sea. On the east side a raised beach of some fifteen feet in elevation runs along the shore, and extends inland from one to four hundred yards to an escarpment fifty feet higher, which has a face and top almost wholly composed of water worn boulders, averaging nine inches in diameter, and without glacial striae; they are packed tightly together in a condition similar to that shown by boulders on shoals at present, acted upon by the grounding and shoving of large masses of ice over them.

On the north and south sides, the face of the escarpment is largely composed of sandy clay with large numbers of boulders scattered through the mass. The island on its lower parts is wooded with black and white spruce and a few white birch and poplar, the top of the boulder escarpment is devoid of trees, and has a very barren appearance.

The Strutton islands.

Lying N. 65° E. seven miles from the north-east point of Charleton is the western end of two small islands called the Struttons.

The western or larger island is five miles long from east to west, one mile and a-half broad in the middle, and tapering to a point at either end; the smaller island is nearly round, with a diameter of one mile and a-half. The deep channel with its strong current that passes through the Sound between Charleton, Danby, and Cary islands con-

tinues across the open bay on a N.E. course and runs between the Strutton islands, and from these follows on the same course to near the mouth of the East Main River, where it turns northward and is lost along the coast. The channel between the Struttons is one-third of a mile wide, and is obstructed at its south entrance by a small low boulder island one-half mile in circumferance. The current, owing to the confined limits of the channel, rushes through at a higher rate of speed than in the Charleton sound, varying from four to six miles an hour.

The channel, between the Strutton Islands, has been tried as a wintering ground for a ship by the Hudson Bay Company, but it was found that the ice carried along on the strong current caused great damage to the vessel; the crew also suffered greatly from the ravages of scurvy, brought on it is said by the use of the stagnant water in the small lakes on the islands, where no running streams exist.

On all sides of these islands, with the exception of the above narrow deep channel, the water is very shoal, with an uneven bottom covered with sand and boulder shoals, some of which are bare at low water, but the greater number coming within a few feet of the surface, only show their presence by the breakers upon them during gales.

The highest point of the interior of the larger island is seventy-five feet above the sea. On the south side the slope from the highest level is very gradual and is broken by low rounded hills of boulders lying transverse to the shore line, where they terminate in short points: to the westward a raised beach twenty-five feet high, formed chiefly of boulders thickly packed in clay with sandy patches, extends back about one-quarter of a mile to a second abrupt bank of packed boulders thirty feet higher. On the lower beach is an immense rounded boulder of red Laurentian gneiss fully ten feet cube, and consequently weighing over eighty tons.

Raised boulder beaches.

On the east side along the sound and partly on the north side tightly packed boulder banks rise almost perpendicularly ten to forty feet from deep water and resemble, when examined closely, a built, dry stone wall, while at a short distance they have the appearance of an exposure of solid rock. Along the remainder of the shore and inland are immense numbers of boulders in sandy clay, showing that the greater part of the island is made up of them.

The smaller island is low, being formed chiefly of boulder clay with sandy shores covered with boulders on all the points. Both islands are scantily wooded on their lower parts with small white and black spruce and willows; numerous fresh and brackish ponds are situated on these parts also.

Little Charleton Island.

Bearing N.N.W. fifteen miles from the western point of the Strutton's is the eastern end of another small island, at present called Little

Charleton or False Charleton, but named Trodiley Island in Capt. Coates' notes.

This island is very similar in composition and size to the larger Strutton Island, except that it is made up of finer material and fewer boulders than that island. Its greatest length from east to west is five miles and a-half, with an average breadth of one mile. The north-east part of the island is the highest, and rises fifty feet above the sea. On the eastern half of its south side is a raised beach of sand and gravel ten feet high, extending from the water inland from one to three hundred yards, to a steep sloping bank of sand and boulders twenty feet higher, after which the land gradually rises towards the interior. The western part of the south shore is low and sandy and gradually rises inland towards the east, with no cut banks; the western extremity ends in a low, narrow boulder point half a mile long. The north shore is covered with boulders or coarse gravel, except short stretches in the bottom of the small bays which are sandy. Beyond the middle of the north shore, and from there to the east point the island rises abruptly inland, having banks of thirty to forty feet, composed almost wholly of small and large boulders mixed with quantities of clay and sand, from the base of which issue small streams of clear cold water. Springs.

The western end of the island is devoid of trees, and shows a barren, sandy soil covered with low arctic plants, with numerous large boulders strewn over the surface. The south-eastern portion is covered with small white spruce trees, not more than ten inches in diameter at the base and less than forty feet in height, which grow in open glades, the sandy soil here being covered with deep moss.

About half way between the Struttons and Little Charleton are two small low islands composed of sand and boulders, with low willows growing on their highest parts, many sand and boulder shoals also are to be seen in this part of the bay.

Twenty-two miles distant, on a N. 35° W. course from the east point of Little Charleton Island, is the next high island, with its north end in lat. 52° 30′ 32″, called Weston Island on the present chart of the Hudson Bay Company; this island is named Solomon's Temple in Capt. Coats' notes, while four low islands a few miles to the northward, at present marked Solomon's Temple, he calls Lord Weston's Islands; it is proposed to return to the old names, and call the large bold island Solomon's Temple and the low islands Weston Islands. Weston Island.

Solomon's Temple is a narrow island eight miles long from north to south in the form of a crescent, convex on the west side, and terminating in long, narrow points made up of immense numbers of boulders packed tightly together. On the west side, rising gradually from Solomon's Temple.

either point, is a cut bank of sandy clay full of small boulders, having a face of fifty feet in its highest parts. Behind this bank the surface of the island is an undulating plain, covered with many boulders and dotted with small shallow lakes which fill every depression of its surface. With the exception of a few solitary stunted white spruce, no trees grow on the island, its surface being covered only with low arctic flowering plants, grasses, sedges and mosses. Two miles beyond the north point and seemingly an extension of it, is a small low boulder island about one mile in circumference.

On the northern end of Solomon's Temple great quantities of driftwood are heaped up from ten to twenty and occasionally thirty feet above ordinary high-water mark; on the shores of all the other islands similar piles of wood are found, most abundantly on their north sides; that on the higher levels is generally greatly decayed and composed chiefly of cedar. The presence of these piles of driftwood at such high levels has been taken as evidence of a rapid elevation of the land around Hudson Bay. Dr. R. Bell places the rate of upheaval of the land or "subsidence of the water" at from five to ten feet a century. Other evidence than that of the driftwood is required to sustain such a theory, as its presence at these high levels above ordinary tide may be accounted for in another manner than by a rapid elevation of the shores and islands. Owing to the shallow state of the water near the shores of the islands and mainland of James' Bay, the wind, when blowing on the land, has great effect in causing abnormal rises of tide by forcing the water from the deeper parts of the bay over the shallows; an instance in case was observed by the writer while anchored on the east side of Agoomski Island in a moderate gale from the north-west, August 8th, 1887. Here the ordinary rise of tide does not exceed five feet, yet after beaching his boat at 8 p.m., by midnight the water was twelve feet deep showing a rise of seven feet at least above the ordinary level. From this it is easy to believe that extraordinary gales in the late autumn at long intervals apart, would back the water into the bay to such an extent as to cause a rise of tide from ten to twenty feet above its ordinary level. These high tides, accompanied by great breakers, would necessarily throw the older and lighter wood, then on a high level, farther back, and pile newer wood in front and below it, thus forming a state of affairs as at present seen.

Dr. Bell on subsidence of sea level.

Other views.

Other facts tend to disprove a rapid elevation of land around James Bay, at least in its southern part. Capt. Coates, in his notes on the mouth of the Moose River, written one hundred and fifty years ago, describes it as it exists at the present time, with little or no change in the state of the channel or shoals; if a rise of five or ten feet a century

was occurring during this time, the mouth of the river would necessarily be greatly changed, and the shallow flats of Capt. Coates' time would be ten or fifteen feet above the sea. Another place where comparison between levels at different dates can be made is the isthmus connecting the peninsula at the end of the point dividing Hannah from Rupert Bay. At present it is a low muddy neck covered with willows nowhere five feet above high-water mark and distinct from the higher land on either side, which is covered with spruce and tamarac. Now if the change of level claimed were actually taking place, this peninsula two hundred years ago would have been an island with a considerable depth of water over the present isthmus, but on a map (Partie de la Nouvelle France, Hubert Jaillot, 1696) this very peninsula is marked, thus affording good evidence against a rapid change of level of this part of James' Bay.

Between Little Charleton and Solomon's Temple are seven or eight small low islands formed of sand and boulders and covered with low bushes on their higher interior parts; these islands are called the Tiders.

The Westons are four low drift islands thirteen miles N.N.E. from Solomon's Temple in lat. 53°. The largest is about seven miles long, and on its western end the Hudson Bay Company had a ship wrecked in 1724. Weston islands

Thirty-six miles N. 10° W. from Solomon's Temple, in lat. 53° 04′, is the south-east point of the South Twin Island. This island is pentagonal in shape, with its face to the southward; it is seven miles long from north to south, with an average breadth of five miles. Starting from the south-east point, the shore line for one mile and a half northward passes along the base of a steep cut bank of boulder clay, containing an admixture of sand, and varying in elevation from forty to sixty feet. From here the shore turns westward, passing around a bay, one mile and three-quarters wide by one mile and a half deep; the cut bank runs one mile farther inland; low mud flats, covered partly with small blackish ponds, occur between it and high water mark. Again approaching the shore on the north side of this bay the escarpment gradually changes to low rounded hills sloping inland, composed chiefly of boulders, with a shore line as far as the north point formed of numerous boulder points with low muddy bays between, covered with grasses. South Twin island.

Between the north and west points, four miles, is an escarpment, composed of boulder clay and gravel, forty feet high, running parallel to a shore, alternating between boulder points and sandy bays. From west to south-west point the shore line is low and of the same character as that above, with the ground rising slowly inland. Along the south

side, sand and clay greatly predominate; a cut bank one-quarter of a mile inland gradually rises to an elevation of forty feet near the south-east point, with a lower raised beach of ten feet in front, the latter composed of sand, the former of boulder clay.

The interior of the island rises gradually towards the centre, where it has an elevation of one hundred feet above the sea.

Surface.

Small lakes fill all the depressions on its surface. With the exception of some four or five stunted white spruce, less than ten feet high, no trees grow on the island, which is everywhere covered with mosses and arctic plants.

Ice action.

A fine example of the expansive power of ice may be seen half a mile inland from the south east point, where there is a small shallow lake, at present completely drained by a small stream, which has cut out a channel through the escarpment. This old basin is nearly round, with a diameter of five hundred yards, and had a depth of about six feet. Around the old shore line is a bank of boulders and clay, four feet high and eight feet wide at the base, overgrown with vegetation, and resembling the intrenchment of a fortified camp. This has evidently been pushed up by the total freezing of the lake and the expansion of the ice.

Scattered over the surface of the island are great quantities of small angular fragments of light yellowish fossiliferous Silurian limestone, the probable result of the breaking up of large boulders of the same.

North Twin Island.

Separated by a channel five miles wide, and lying four miles to the westward of this island, with its south-west point in lat. 53° 04′ is the North Twin. Like the other island, it has an abrupt escarpment on the east side, with a low shore line on the west rising slowly inland. From the south-west point along the south side, the low shore is composed of sand and gravel, with a wide margin of swampy land extending inland to the slowly rising interior. Low cut banks occur near the coast at the south-east point, where two terraces of ten and thirty feet elevation are seen, the lower formed of sand and gravel, the upper of boulder clay and sand.

On the east side is a wide shallow bay, with low swampy land from a quarter to a half a mile inland to the base of a boulder clay escarpment fifty feet high. On the northern part of the east side a low terrace, fifty feet high, composed of sandy clay, with a few boulders, rises near high water mark, and extends inland on an average a half mile to a second terrace thirty feet higher, and of similar composition. On the north side the land adjoining the shore is made up of sandy dunes dotted with boulders, rising slowly inland, with numerous boulder points along shore. Along the west side the shore margin is low and swampy, with sand and gravel beaches between boulder points, the

latter becoming more numerous to the southward. The banks on this side are generally sloping, with a few cuttings of sandy clay full of small boulders.

Inland, the ground rises irregularly towards the centre, where it is lower than the South Twins. The surface is dotted with many small lakes, and covered with a low arctic vegetation.

From the north-east point a low narrow bar of boulders, partly bare at low water, runs out in a north-east direction several miles towards Spencer Island.

The rising and falling tide rushing over this bar forms a strong rapid with heavy breakers. Another reef extends from the south-east point, five miles in a S. by E. direction; a ship was wrecked on it in 1732. On the north point is the wreck of a large sloop belonging to the Hudson Bay Company, lost here in 1886, while under the charge of some Esquimaux engaged in killing white bears on the islands. In the Bay on the east side a small ship's boat, painted white, was found, which must have been lost from some vessel engaged in the whale fishery in the northern part of Hudson Bay, as no such boat has been lost by the Hudson Bay Company.

Walter Island lies ten miles N. 40 E. from the north end of the South Twin. It is nearly round, with a circumference of two miles, and rises with steep banks to an elevation of sixty feet at the highest point. It is almost wholly made up of boulders, which are everywhere tightly packed by ice on the sides and top of the Island. Walter Island

Between Walter Island and the South Twin, six miles from the latter is a small bare knob of Laurentian gneiss, called Emily Rock, rising in the middle fifteen feet above high water mark, with a circumference of fifty yards. The gneiss is dark flesh red in colour, and made up of dark red orthoclase, with some quartz and black hornblende. It contains lenticular masses of hornblende. Strike N. 30° W. Emily Rock.

Spencer Island is fourteen miles distant from the north end of the North Twin on a N. 50° E. course. This island is one mile and a half long by three-quarters of a mile broad, with a generally steep shore line covered with boulders. On the south side is a sandy bay showing three areas of ten, twenty and fifty feet elevation, the two lower having cut faces of sand and gravel, the highest being formed of small rounded boulders tightly packed together, the same extending over a greater part of the southern interior. On the east side is another sandy bay, with a raised beach of that material fifteen feet in elevation. In this bay twenty-eight empty oil casks were found, which were probably from the same wreck as the boat on the North Twin, the Hudson Bay Company's people knowing nothing about them. To the northward the island is lower and the boulders fewer, with more intermixed sand. Spencer Island.

On the west side a wall of boulders rises directly from the water to elevations varying from twenty to fifty feet. All these islands are frequently visited by polar bears, who land to rest after heavy gales, and feed on the arctic berries that grow in great profusion everywhere; Arctic foxes are also quite plentiful.

The other islands of this group were not examined, but it is inferred from information obtained from the Hudson Bay Company's officer, and Capt. Coat's notes, that they are of similar origin and composition to those above described.

Islands of the third group.

The islands of the third group in James' Bay lie along the east coast, and have been described by Dr. R. Bell in the report of Progress of the Geological Survey, 1877-78, as follows: "The majority of the islands are rather low, and composed of boulders and shingle with few or no trees, but the solid rock occurs upon a large proportion of them. No regularity can be detected in the general arrangement of these islands. They present a kind of labyrinth which it would be very difficult to map with accuracy and which is not unlike that of the Georgian Bay, Lake Huron, except that on the east coast of James Bay the water is shallower, and shews evidence of receding rapidly, and the islands are, as above stated, mostly covered by boulders and shingle."

Meteorological notes.

From the meteorological observations taken during the summers 1887 and 1888, detailed in Appendix No. the following summary is compiled:

Three daily readings with the minimum temperature, taken on fifty-eight days in 1887, while on James' Bay, give a mean temperature of 55 degrees.

Similar readings on fifty-one days in 1888 give a mean temperature of 53 degrees. In 1887, there was fog on twenty and rain on fifteen out of fifty-eight days.

In 1888, fog occurred on twenty-eight and rain on twenty-four out of fifty-one days.

Of one hundred and fifty-three observations on the direction of the wind taken in 1887, twelve were from the N., sixteen from N.-E., four from E., twenty-two from S.-E., seventeen from S., twenty-five from S.-W., twenty-one from W., and thirty-six from N.-W., the resultant direction being due west.

Mean temperatures at Moose Factory.

Two hundred and twenty similar observations in 1888, give a resultant direction of S. 87° W. Three daily readings of the thermometer at Moose Factory during the months of June, July, August and September give the following mean temperatures: 1878, 61·7°; 1879, 54·3°; 1880, 56·2°. These taken with the mean temperatures given above would give an average mean summer temperature of

55·5°. This would be slightly higher than an average for the entire bay, as the mean temperature of Moose Factory is higher than many other places. Dr. R. Bell, in report of Progress 1877-78, places the average temperature of the sea along the east coast at 51°. This is much higher than the temperature of the main body of water, as the water of the east coast is warmed by the rivers flowing into the bay on that side, and being very shallow has its temperature raised by the action of the sun's rays. The difference in the vegetation growing on the outer islands and in the same latitude on the main land shows that the temperature of the former is much lower than that of the latter and this is due to the lower temperature of the main body of water, which is so cold that an immersion of the limbs for a few minutes at any time produces a numbness in the parts of the body so covered.

Big River.

The harbour and mouth of the Big, Kitchisipis, or Mistisipi River has already been described as far as Fort George. At this point the north channel of the river is one mile wide, and for two miles above to the head of Fort George island, it is obstructed by one large and several small islands. For the next four miles the river has an average breadth of three-quarters of a mile, is quite deep and flows with an even current, of about three miles and a half an hour with falling water, the course being N. 50° E. Here a small rocky island and reef stretches across the stream, forming a small rapid. From this point the river bends to the eastward, and for thirty-three miles, in a straight line, flows with a general course of N. 85° W. Three miles above the rapid is the lower of four large islands, which lie on the south side of the main channel, and extend upward six miles and a half past the head of tide. Big River.

Two miles above the upper island the river contracts in width to one hundred yards, and passes over and between a rocky barrier, which causes a fall of ten feet in the form of a low chute with heavy rapids below. Immediately above the chute is a low rocky island half a mile long. From here for nineteen miles the river has an average breadth of eight hundred yards, and flows with an average current of three miles an hour in a deep channel. Beyond this distance is a sharp bend to the north-east for one and a half miles, around the base of a rocky hill, when the former course is again followed for several miles. At the bend, the river is only two hundred yards wide, and consequently has a very swift current, up which canoes require to be tracked. Two miles beyond the bend a portage route of over one hundred miles in length leaves the river on the north side. The river from a few miles

beyond is greatly obstructed by falls and heavy rapids, while passing through a deep narrow gorge, where the rocky banks are so steep that portages cannot be made, thus rendering its navigation with canoes impossible.

Few tributary streams enter the river below the portage. Among the larger is a small river from the north, flowing in behind the islands, about two miles above Fort George. The next is on the south side behind the lowest island at the head of tide. One mile and a half above the chute is a small river, thirty yards wide at its mouth, coming from the south and called the A-che-gi River. Three miles and a half, and seven miles above the last on the same side, are two large brooks named respectively A-na-mis-cat and Ni-min-se-tat Rivers. Four miles below the bend a small river twenty yards wide at its mouth, called the Ne-co-pa-stick, also flows in from the south ; at the bend a large brook descends in a beautiful fall from the rocky hill to the eastward, while in the upper bend and at the portage two large brooks enter from the north. From its mouth to the portage the river flows in a valley cut out of stratified marine clays and sands of Post Tertiary age. The banks on the islands and shores near the mouth of the river are composed chiefly of bluish white clay overlaid by a thin deposit of yellow sand, showing cut faces on the islands and at intervals along the shore ranging from ten to thirty feet in elevation above the river. A few miles up the river the banks become higher with thicker deposits of sand on top. Just above the first rapid an exposure on the south bank gives thirty feet of clay and ten feet of sand.

Hay flats. On the islands at the head of tide the banks rise fifty feet above the river. At this place, on the north shore, are extensive low flats covered with marsh hay. This is cut and transported to Fort George in large boats and used to feed the cattle kept there during the winter. Above the chute, the banks are often over sixty feet high, with forty feet of stiff blue clay at the bottom, overlaid with sandy clay and sand.

Fossils. Everywhere the lower clay beds hold fossils, the following being the species found : *Tellina grænlandica*, Beck, *Saxicava rugosa*, L., *Mya arenaria*, L., *Mya truncata*, L., *Buccinum tenue*, Gray, and *Mytilus edulis*, L. The upper sandy clay and sand beds contain very few fossils, *Saxicava rugosa*, being only sparingly seen in them.

Boulder clay At the bend below the portage, on the east side of the river, is a deposit of boulder-clay, cut by the river, and showing a face of over seventy-five feet in height. This was evidently deposited by the glacier behind, and protected by the steep gneiss-hills seen a short distance to the eastward ; the boulder-clay forms a tail to those hills. The coun-

try on either side of the river, above its banks, is a slightly rolling plateau of sand and clay, rising slowly inland, and broken through by low, rounded knobs of gneiss. The greater part of this country has been burnt over, and in such places is covered with a small second growth of black and white spruce, aspen poplar and tamarac, with Banksian pine predominating on the sandy portions. None of these trees exceed fifteen inches in diameter three feet from the ground. On the unburnt portions and along the river valley the trees are larger, some being eighteen inches in diameter fifteen feet from the ground. Here are found white and black spruce, balsam and aspen poplar, small white birch, tamarac and a few balsam spruce. Timber.

On the lower stretches of the river occasional low exposures of gneiss outcrop from beneath the clays. As the stream is ascended these rise higher and higher, until, upon the upper part, they form bold hills, rising at intervals above the sands and clays. The following are the different exposures noted while ascending the river: On the north shore, opposite Fort George, and below to the mouth of the river, are a number of rock exposures, consisting chiefly of pink and grey fine-grained orthoclase hornblende-gneiss, along with a coarse pink hornblende-gneiss holding large porphyritic crystals of bluish-white triclinic felspar. Everywhere throughout these exposures are enclosures of lenticular and partly rounded masses of fine-grained rock, composed chiefly of black hornblende, probably segregations from the main mass. Strike N. 80° W. Rock exposures along river. Gneiss.

On the south shore, behind Fort George, near the head of the island, are finely-bedded bands of a dark fine-grained hornblende-gneiss, made up of black hornblende and buff-weathering felspar, with little or no quartz. Along with these are lighter bands, in which orthoclase predominates. Strike N. 85° W.

At the mouth of the south channel are exposures of a dark hornblendic rock, netted by veins of lighter fine-grained gneiss, forming a breccia; also coarse, greyish-pink gneiss, made up chiefly of large, pale crystals of orthoclase and dark hornblende, with very small quantities of quartz. Strike N. 72° W.

At the island in the first small rapid the rock is light-grey and pink orthoclase hornblende-gneiss, containing lenticular masses of fine-grained hornblende-schist. Strike N. 68° W.

On the south shore, at the chute, is coarse grey hornblende-gneiss, with thin bands and fragments of hornblende-schist, followed by thick beds of massive hornblende-schist, interfoliated with thin bands of light orthoclase-gneiss; then grey and pink gneiss, with a dark-red variety, made up of flesh-red orthoclase, black hornblende and quartz. Strike N. 75° W.

On the north side the rock is a dark, granitic, orthoclase hornblende-gneiss, associated with thick masses of dark-green hornblende-rock, containing grains of magnetite; the source of the colors of iron-sand frequently seen along the river shore.

At the chute are two dark-green trap dykes, weathering reddish-brown, which run S. 66° W. and S. 47° W., being respectively four feet and nine inches wide. On the north side, one-quarter of a mile below the chute, is a similar dyke, eighteen feet wide, running S. 75° W.

Three-quarters of a mile above the chute is an exposure of hornblendic schistose gneiss, composed of alternate laminæ of blackish, green hornblende and yellow weathering, grey felspar with patches of reddish orthoclase. In some parts the rock is a dark, fine-grained, hornblendic gneiss, with large porphyritic crystals of whitish felspar, the largest crystals being one and a-half inches long by one-half inch broad, with their longer axis always parallel to the plane of stratification. Strike S. 75° W.

Five miles beyond the last, on the south bank, is a fine-grained, bluish grey gneiss made up of dark hornblende and bluish felspar, with little or no quartz, containing enclosures of dark hornblendic segregations. Strike S. 60° W.

One mile and a-quarter above the last there are exposures of fine-grained dark-grey hornblendic gneiss, weathering greyish yellow, containing porphyritic crystals of white felspar, and traversed by veins of pink orthoclase also having hornblende segregations.

Three miles beyond was seen similar hornblende gneiss, with massive hornblende rocks like those at the chute, also light pink highly felspathic gneiss containing much less hornblende and more quartz than the darker grey rock. Strike N. 85° W.

One mile farther up is more of the dark grey hornblendic gneiss and black massive hornblende rock.

Three miles and a-quarter beyond the last are exposures of the porphyritic gneiss. Strike E. by W.

At the small rapid on the bend below the portage is a coarse red and grey gneiss, composed chiefly of red and grey orthoclase, crystals of which are perfectly developed, along with slightly altered dark-green hornblende and some mica and quartz. Strike S. 77° W.

Portage Route between Big and Bishop Roggan Rivers.

Big River to Bishop Roggan River.

Leaving Big River at the portage, the route passes overland, on a general course of N. 40° E. by a number of portages connecting small lakes, draining into Big River through a large lake on a river which flows into James Bay a few miles north of the mouth of Big

River, and thence by two portages into a large lake on the Bishop Roggan River.

The following details show the difficulty of taking canoes over this route.

The first portage from Big River is three miles and four chains in length, and passes almost directly north, ending in a small lake one-quarter of a mile broad, joined to another small lake by a brook five chains long; the second lake is thirty chains across.

From it the next portage, of five chains, was made to another small lake, half a-mile wide, followed by a portage of sixty-seven chains ending at a similar lake half a mile long, succeeded by a portage of seventy chains, then a lake of fifteen chains, followed by a portage of forty-six chains, a lake of ten chains, and another portage of seventeen chains, to a slightly larger lake called Wa-we-cho-to-chis, where the Indians, while traversing the portages, stop to fish. This lake is two miles long from the upper end to its discharge, a small sluggish brook obstucted by beaver dams. The route follows the winding course of this stream for half a mile to a portage three miles long, ending at a small lake three-quarters of a mile broad, followed in succession by a portage of thirty chains, a lake of twenty chains, a portage of forty-one chains, a lake of forty chains, a portage of forty chains, a lake of one mile, a portage of fifteen chains, a lake of fifteen chains, and a portage of twenty chains, to the banks of a small river tributary to Big River. This stream was ascended one mile and a quarter past three small rapids to Lake A-wi-chi-na-wi-ga-chi, a large body of deep clear water well stocked with fish, an abundant supply of pickerel, pike, white fish, and suckers being taken in the net here. This lake has two bays extending from its outlet, the western bay is several miles long, the northern one was followed three miles to its head, where a sluggish stream fifteen feet wide was ascended one-quarter of a mile to a lake thirty-five chains wide, followed by five portages of thirteen, thirty-six, eight, fifty-five, and eighty chains long, connecting lake traverses respectively of twenty, twenty-five, and one hundred and twenty-five chains to Pi-a-go-chi River, at this point a shallow rapid stream one hundred feet wide. This river empties into James Bay near Wasticoon, a high rocky island about eight miles north of the mouth of Big River. From the portage a short rapid, full of large boulders was ascended for half a mile and Pi-a-go-chi Lake entered near its western end. This is a long, narrow lake surrounded by low rocky hills in many places rising abruptly two hundred feet from the water. The route follows its eastern bay four miles and a half, and leaves it by a portage on the north shore several miles from its eastern end. The portage is fifty-five chains long and passes over two rocky

Succession of portages.

ridges, ending in a small lake fifty chains across, followed by another portage of forty-three chains to a large irregular body of water called A-pi-cho-ti-ne-chits Lake, which is drained by Bishop Roggan River.

Character of country on route.

Between Big and Bishop Roggan rivers the country is made up of ridges of low rounded gneissic hills rising from fifty to two hundred feet above the general elevation of the land, which is estimated from an average of the barometer readings taken, to be six hundred and seventy-five feet above sea level. These hills are partly covered with boulder sands and clays, while the intervening valleys are filled with deep mossy swamps and small lakes.

Timber.

The greater part of this region has been burnt over by frequent fires, which have in many places left the higher parts totally devoid of vegetation. The trees remaining are second growth black spruce, tamarac and banksian pine, never exceeding fifteen inches in diameter three feet from the ground. On the lower swampy lands and around the margins of the small lakes, where the fires have not destroyed the older trees, a dense growth of small black spruce and tamarac prevails with an occassional balsam spruce. On the portage leading from Pi-a-go-chi Lake, a few balsam poplars, four inches in diameter, were seen along with small red cherry trees, this being the northern limit of the latter.

Except in the immediate vicinity of Big River no stratified superficial deposits occur on this portion of the route. The sands and clays seen were unstratified and mixed with boulders. On the higher ground sand predominates, owing probably to the greater part of the clay being washed out of the thin deposits there overlying the rock, and carried down into the lower valleys, where the clay is greatly in excess.

Rocks along route.

On the first portage from Big River are exposures of pink and grey coarse-grained hornblende orthoclase gneiss. Strike S. 60° W. Similar gneiss, highly contorted, is seen on the second portage. Coarse pink hornblende orthoclase granitic gneiss, containing angular fragments of dark, fine grained hornblende schist was seen on the third portage. On the fifth portage similar gneiss occurs along with a pink micaceous variety. Strike E. and W. Highly contorted pink and grey hornblende and mica gneiss, having a general strike of S. 20° W., is exposed on the seventh portage. On the eighth and ninth portages the rock is more micaceous, with great numbers of barren quartz veins. On the latter portage, fifteen chains from the south end, is a dark green diorite dyke, weathering deep brown, with a fine-grained compact structure near its contact with the surrounding gneiss, but rather coarsely crystalline in the mass. This dyke is two hundred and thirty feet wide and runs N. 27° W.

Similar pink and grey hornblende mica gneisses were seen on all the portages to the fifteenth, where they occur associated with grey hornblende gneiss, holding porphyritic crystals of grey felspar, like that described on the Big River.

On the portage from Pi-a-go-chi Lake the rock is chiefly composed of a fine compact pink graphitic gneiss, made up of orthoclase and quartz, with very small quantities of mica and hornblende. The quartz and orthoclase are arranged in alternate laminæ averaging one-eighth of an inch in thickness. Strike N. 77° W.

On the next portage are similar rocks along with coarse-grained pink micaceous gneiss. Strike S. 87° W.

South Branch of the Bishop Roggan River.

The name Bishop Roggan is a corruption of the Indian word pi-chip-oui-an, meaning fishing weir, from the immense willow weirs, with basket sluices, built across the stream by the Indians to catch fish descending the river.

Description of route by south branch.

Lake Ab-pi-cho-ti-na-chits, as before stated, is a large irregular body of water, full of islands and indented with many deep bays, the shape and size of which can only be ascertained by surveys of each, taking more time than could be afforded on a hurried trip over so extensive an area of country. From the last portage the route passes northward one mile and a half down a narrow bay, to a long, low point, crossed by a portage of six chains in length. Thence an irregular course between islands is followed for four miles in a general N.E. course to the outlet, where the river, fifty yards wide, is descended three-quarters of a mile, past a small rapid to Lake Ko-tan-i-wau-an. This is another large lake covered with islands, the river flowing out of its north west end. Its south-eastern shore was followed, two miles and three-quarters to the mouth of a small branch stream. The country around these lakes is comparatively flat, with low rounded gneiss hills, rising at intervals from fifty to one hundred feet above the swampy low lands.

The route passes up the small branch on a directly east course for three miles and a quarter to a fall eight feet high, where the river is ten yards wide. Between the fall and the lake below, the river, with an average breadth of two hundred yards, flows between low rocky hills, which rise from the water's edge, forming an irregular shore line. Above the fall, the valley is wider, the river or lake, here averaging four hundred yards in width, is broken into a great number of small bays, by low narrow points extending out from the base of the rocky hills.

To Pi-mi-ga-ma-chi Lake, four miles, the course is N. 70 W. This lake is several miles long from east to west, by about one mile broad; the route leaves it by the river that flows in on its north side, two miles and three-quarters from the outlet, and passes N. W. up that stream three miles to Lake A-wah-a-gets, with two portages past small rapids. From here the river turns S. 78 E., for seventeen miles, to Lake O-ho-mi-chi-chits, passing through seven narrow lakes connected by small rapids, where the stream is too small and shallow to ascend with canoes. Lake O-ho-mi-chi-chits is cut into three bays by long rocky points; it was traversed in a general S. 50° E. course to its head, the distance being six miles. Here a low rocky portage, thirty-four chains long, crosses the height of land between Bishop Roggan and A-pa-chi-chits river, a tributary of Big River; the portage ends at a small lake forty-three chains long. Descending the small brook flowing out of it, for ten chains, another small lake, thirty chains long, is passed through to a portage of twenty chains, over a steep hill to a lake of one hundred chains. The discharge is full of small rapids and causes a portage of half a mile, at the end of which is a navigable stretch of forty chains, followed by more rapids and a portage of eighty-six chains, after which the crooked course of the river is followed for eighty-eight chains to Lake Ka-bun-ski-was, which is six miles long, with numerous deep lateral bays. From the outlet of this lake the river is again followed two miles and three-quarters, through two small lakes with rapids between, to a portage of one hundred and thirty-two chains, passing south over a ridge of hills and ending at Sha-tach-i-wan Lake, through which the Big River flows. The A-pa-chi-chits River, below the portage, passes through a deep gorge, and enters this lake one mile and a half east of the portage, by a fall sixty feet high.

Portages.

Character of country.

As the small branch stream from Lake Ko-tan-i-wan-an is ascended, the country becomes more and more rocky and rough, with long ridges of hills running parallel to the river valley, massed closely together, having but small areas of swampy valley land between. The elevation of the hills above the surrounding water level varies from fifty to one hundred and fifty feet, as far as the water shed. Beyond this the hills rise from one hundred to two hundred and fifty feet above the general level to Lake Sha-tach-i-wan. These hills have for the greater part been recently burnt over, so that nearly everywhere they present the scorched bare surface of the rock, partly covered with boulders, and scattered over with the standing blackened trunks of trees; the whole having a very desolate, barren look. On the unburnt portions small black spruce and tamarac predominate along the lower parts of the branch, but are in a great measure replaced by small banksian pine as Big River is approached. A few small white birch and aspen pop-

Timber.

lar grow along the hillsides near Lake Ka-tan-i-wan-an. The northern limit of the mountain ash (*Pyrus Americana*, DC.) was reached on Lake Pi-mi-ga-ma-chi, where a few low trees were observed. Everywhere in the depressions and valleys between the hills are deposits of boulder clay, while scattered over the hills are immense quantities of boulders. A curious ridge of packed boulders, forty feet wide, and rising from five to fifteen feet above the general level, was seen running N. 10° E. from the inlet of Lake Pi-mi-ga-ma-chi over a low hill. It was traced for a distance of one mile to the edge of a deep swamp and apparently continued over the hill on the other side of the swamp. Boulders.

The rock throughout is chiefly a red syenitic gneiss, often granitic in structure, composed of red orthoclase, black hornblende, with little or no quartz. Rocks.

At the fall above Lake Kotaniwanan the rock is a coarse pink hornblende orthoclase gneiss. Strike S. 77° W.

On an island in Lake Pimigamachi similar gneiss is exposed. Strike S 85° W. At the bend in Lake Awahagats is more of the same rock without signs of stratification. On the portages past the rapids of the seventeen mile stretch to Lake Ohomachichits are exposures of pink hornblende orthoclase granitic gneiss. On the height of land portage the rock is coarse and fine grained pink hornblende gneiss. Strike S 88° W. At the second rapid below Kabunskiwas Lake are exposures of fine grained, highly contorted, micaceous orthoclase gneiss, showing pink and grey bands. On the summit of the portage to Shatachiwan Lake is a coarse-grained grey hornblende gneiss, containing porphyritic crystals of pale pink orthoclase.

Upper Big River.

Shatachiwan Lake is about seven miles long from east to west, with a wide bay on the south side, out of which the Big River flows. For three miles from its eastern limit, the lake has been filled up by alluvium brought down by the river. This forms a delta of low islands covered with willows and separated from each other by narrow shallow channels. Route by the Upper Big River.

In ascending the river from the lake its courses are: First, N. 60° E. for ten miles and a half, then N. 30° E. for two miles and one quarter, bending then to north for two miles, then N. 30° W. for three miles and a quarter, followed by N. 60° E. for four miles and S. 60° E. for three miles and three-quarters; lastly N. 65° E. for fourteen miles, where the route leaves the river by a small tributary called Pa-ti-ta-wa-gau River which flows in from the north.

For the first few miles above the delta the river flows with an even

current of about three miles per hour, between low, muddy banks, and has an average breadth of four hundred yards.

Two miles above the lake is a low island three-quarters of a mile long, with two smaller islands at its head. One mile beyond the island is a rapid one-quarter of a mile long with three feet rise. Above the rapid is a broad quiet stretch of nearly a mile, to a chute of ten feet, where the river falls over horizontal ledges of gneiss. The portage past this chute is eleven chains long. Seventy chains above is another chute of fifteen feet, passed by a portage of thirteen chains, and followed by quiet water for three miles and a half to a small rapid one quarter of a mile long, with more good water for two miles to a chute and rapid of forty feet. Between the last two chutes the river is obstructed by a number of small islands, fourteen in all. The portage past the forty-foot chute is half a mile long and is followed thirty chains above by another of fifteen chains past a fall of thirty feet. From here around the western bend, a distance of four miles and a half, the river is easily navigable with canoes past four large islands to a fall of thirty feet. Beyond this no obstacle occurs in the navigation of the river to the Patitawagau branch, up which the route passes. According to the statement of the guide the river, for a great distance beyond, is free from rapids and is quite easily navigable with canoes. About the last portage the stream averages two hundred yards in width, is comparitively shallow, and flows with a uniform current of between two and three miles per hour.

Falls and portages.

Tributaries of Upper Big River.

The first large tributary of Big River above Shatchewan Lake is called the Man-i-wan River and flows in from the north one mile and three-quarters above the fifteen feet chute. It is fifty yards wide at its mouth. Two miles and a quarter above, another large branch called Wa-cha-ti-mi River enters from the eastward, and is seventy yards wide at its junction with the main stream. Several small brooks fall into the river on both sides between this point and the big bend to the east, where two small rivers, whose mouths are one mile apart, enter from the north; these are named Mes-ta-oh River and Fishing River, the former is ten and the latter twenty yards wide. Another northern branch called the Ka-o-chi-so-wi sto River flows in immediately above the thirty feet chute, this stream is forty yards wide at its mouth. Only one other river, the Ka-wa-chi-wan entered between the last and the Patitawagan. The Kawachiwan flows out of a large lake on the high lands a short distance to the north of Big River and enters the valley by a beautiful fall of fifty feet.

As has been already stated, in passing from the northward to Shatachewan Lake, a sudden fall of over one hundred feet takes place in the general surface of the country. The higher plateau with its rolling

hills trends from the lake towards the north-east, and forms a distinct wall to the wide, flat plains through which the Big River flows.

Above the lake the river has cut out a shallow channel through deposits of non-fossiliferous stratified sands and clays, which on the lower reaches sometimes show cut faces of pure sand, occasionally overlying thin deposits of clay without boulders. Beyond the river valley the country is almost flat, with a few isolated ridges of gneiss rising from fifty to one hundred and fifty feet above the general surface. At the chutes and rapids these ridges cross the river. Stratified sand clays.

Above the upper chute the river approaches the high rocky land on the north, along the base of which are two terraces rising twenty and fifty feet above the present river level. Where examined they were found to present faces of stratified sand and fine gravel in many places overlying beds of fine blue clay. Above Kawachiwan River the hills also approach the river from the south, and along their base similar terraces rise ten, thirty and fifty feet above the river. Terraces.

The deposits in which these terraces have been cut are of fluviatile or lacustrine origin. The river at the close of the glacial period was probably dammed in various places with drift barriers which caused it to cover the wide flat valley between the higher rocky hills with lake areas in which the clays, sands and gravels were deposited.

Where the terraces are close to the higher rocky hills, their surface and faces are strewn with boulders evidently rolled down from the higher elevations where they thickly cover the rocky surface; at points distant from the hills no boulders were observed on the terraces.

Along the river valley and on the islands, the trees are chiefly black and white spruce and tamarac, with some balsam poplar and balsam spruce. Many of these trees are eighteen inches in diameter, three feet from the ground. On the higher parts out of the river valley the trees are smaller, and are black spruce, banksian pine and tamarac. Timber.

The country composing the river plain is generally swampy. Just above the delta of Shatachewan Lake, on the south bank, is an exposure of coarse, grey, garnetiferous hornblende-gneiss, penetrated by numerous veins of pure red orthoclase. Strike N. 47° E.

At the first rapid above, the rock is a fine-grained grey mica-gneiss, followed by coarse-grained, grey hornblendic-gneiss, holding porphyritic crystals of pale-pink orthoclase. Rocks.

At the ten-foot chute is a very coarse-grained grey gneiss, with well developed crystals of hornblende and orthoclase; along with it are small bands of fine-grained, pink, orthoclase-hornblende-gneiss, penetrated by many large veins of quartz and orthoclase, holding red garnet and black tourmaline crystals. The bedding of these rocks is

apparently horizontal. On the portage past the fifteen-feet chute the same rocks were seen dipping S. $< 70°$.

At the rapids, three miles and three-quarters above, the rock is a fine-grained, grey hornblende-gneiss. Strike N. 40° W.

On the portage at the forty-feet chute are exposures of highly contorted, pink and grey, fine-grained hornblende-gneiss.

At the twenty-feet chute similar rocks were seen.

A micaceous hornblendic-gneiss, greyish-green in color, along with pink bands of the same, holding segregations of hornblende and cut by veins of pink orthoclase, occur at the thirty-feet chute. Beyond this, to Patitawagan River, no rock exposures are seen in the river valley.

Portage Route from Big River to the South Branch of Great Whale River.

Description of route.

Leaving the Big River by the Patitawagan River, the route passes up that crooked stream in a general north-west course for fifty chains to a portage of half a-mile over a sandy plateau, sixty feet above the river valley, past a shallow rapid. Thence the winding course of the river is again followed two miles and three-quarter, past small rapids, causing portages of four, thirty-six and twenty-seven chains, to a small lake called Ka-wa-cha-ga-mi-chits. The river winds through a valley half a mile broad, cut out of stratified sands, on the lower parts showing cut faces sixty feet high. As the rate of fall of the river is heavy, these consequently become lower as the stream is ascended, until, near the lake, they have disappeared, giving place to rocky hills, partly covered with a thin layer of boulder-clay.

Lake Kawachagamichits is two miles long, with an average breadth of half a-mile. It is separated from another small lake forty-five chains long by a portage of six chains, with a similar portage at its upper end to A-chē-wa-ma-ni-ka Lake, out of which the Patitawagan River rises. This last lake is two miles and a-half long, with an average breadth of one-quarter of a mile, and is very deep. The waters of these lakes and the following ones are remarkably clear and cold, and are plentifully stocked with large white fish, lake and river trout, pickerel and suckers. The next portage is fifteen chains long, and forms the watershed between Big River and the north branch of Bishop Roggan River. The course, in a straight line from the mouth of the Patitawagan River to the height of land, is N. 50° W.

Character of country.

The country about the lakes is very similar to that described on the south branch of the Bishop Roggan River; it is made up of low rounded ridges of hills, rising from fifty to two hundred feet above the water level, with the intervening valleys covered with small lakes or mossy swamps. Everywhere are immense quantities of rounded

gneiss boulders; these constitute about three-quarters of the loose material which covers the rocky surface of the hills, and fills the valleys.

From the height of land portage, Ni-a-wa-ta-wi-ga-chi Lake is followed seven miles and a quarter in a N. W. direction. This is a long narrow lake, with numerous small natural bays, branching at its western end into three deep bays. The route passes to the discharge at the head of the western bay.

Here a portage of thirteen chains passes a rapid on the small stream flowing out. Following down this stream three miles and three-quarters on the same course, crossing portages of five, seventeen and fifteen chains in length, past small rapids, Lake Ka hi-pi-ka-mow is reached. The eastern bay of this lake is followed for three miles, when the route turns northward up a narrow passage into a large bay, running north and south, and follows the north arm of this bay to its head, three miles from the main lake. Here a portage of five chains crosses to a small narrow lake, ten feet higher than the last, into which it discharges by a small stream. The route follows up this lake one quarter of a mile to a portage of eight chains, that ends in a small lake fifteen chains across. A portage of twenty-two chains leads thence to a larger lake one mile long, separated from another lake, one mile and a half long, by a portage of six chains. The portage out of the upper end of the last lake is on the height of land between Bishop Roggan and the south branch of Great Whale River. The country passed through, drained by Bishop Roggan River, is very similar to that previously described, with lower hills averaging from twenty-five to fifty feet above the level of the water, and never exceeding one hundred feet. Portages.

Much more swampy land lies about the various lakes. Everywhere the hills and valleys are covered with innumerable boulders often perched upon the very summit of the hills.

The trees continue to decrease in size; they average six inches and are never over twelve inches in diameter three feet from the ground. They are black spruce and tamarac, with fewer banksian pine; a considerable number of very small white birch were seen on the rocky hill sides about the lakes. Timber.

The rock at all the exposures examined on the portages and along the lake shores was everywhere found to be a moderately coarse-grained, pink, hornblendic orthoclase gneiss: often granitic in structure, and frequently holding segregations of hornblende. The general strike, when seen, was about N. 60° W. Granite gneiss.

Upper Great Whale River.

Description of route followed.

Great Whale River heads in a small lake, half a mile long, separated by a short portage of ten yards from Lake Ka-hi-pi-ta ni-cow, a large body of water covered with small rocky islands, and nearly divided by a long point running out from the east side. The route passes through this lake around the point, a distance of three miles and a half to a portage of twenty-five chains, which connects it with Ma-squa chi-wi Lake. This lake is divided by ridges of hills forming long points into three bays; these lie in troughs parallel to the strike of the rocks, here N. 50° W.

The route crosses the two western bays, and passes up the eastern one to its head, the distance being four miles and one-half. From here three portages of six, twenty-three and thirty-four chains, with connecting small lakes of fifty-eight and twenty-five chains were passed over to Mis-him-in-i-we-tau Lake. The descent on the last portage is one hundred and sixty feet.

This lake, like Misquachiwi, is divided by rocky ridges into several long narrow bays parallel to the strike of the rock.

The portage reaches it at the upper end of the north-east bay, near the inlet of the river, which falls into it through a deep rocky gorge. This bay, with an average breadth of half a mile, runs ten miles in a direct N. W. course, to a long point separating it from a similar bay on the north side. The hills on either side of the bay rise on an average three hundred feet above the water, with numerous peaks one hundred feet higher; those on the south side slope gradually to the water's edge, while on the north they rise abruptly in rocky cliffs directly from the lake.

Beyond the point the route runs more to the northward, and in two miles and a half crosses the second bay, passing along the shore of a large island, through a narrows, into another deep bay running towards the north-west. Following along the east side of this, one mile and three-quarters, the outlet was reached, and a rapid of fifteen chain descended into Ka-bi-ma-chi-wan Lake, entering it about the middle, one mile and three-qnarters from its outlet.

Leaving the north-east bay of Mishiminiwetau Lake the hills become lower, with the ridges farther apart, and consequently the amount of low swampy land is much greater.

A rapid, ten chains long, with a fall of four feet, connects Kabimachiwan with Ka-chin-wa-ste-gin Lake, the river here is thirty yards wide. The north shore of the latter lake was followed three miles and a quarter to a portage, which leaves the lake from the head of a small bay near its north-west end, where the river flows ont. This portage

is fifteen chains long, and crosses a low rocky ridge, ending in a small lake half a mile across to the outlet, where the river is again obstructed by heavy rapids, causing a portage of fifteen chains, to another lake partly covered with many islands.

Here an east course was followed for one mile and a quarter past a long narrow point projecting from its west side, then turning north two miles and a half, the outlet was reached, and the river, here forty yards wide, descended one mile and three quarters past small rapids to Pos-pis-ka-ga-mi Lake. One mile to the east of the entrance of the river another large stream called Ka-mo-chi-mo-pas-ti-quo River enters. This lake is four miles long from south-east to north-west, with an average breadth of a mile and a half. Its western shore was followed three miles to the river flowing out.

Beyond this the river passes through no more lakes and flows in a distinct valley.

The country surrounding the last lakes is nearly flat and very swampy, with a few low ridges of hills, littered with large quantities of rounded boulders. The trees continue to grow smaller, and are almost wholly confined to the valleys and low lands. Black spruce predominates with some tamarac, and a very few banksian pine. Timber.

On the portage to Masquachiwi Lake the rock is a coarse-grained pink hornblende gneiss. Strike N. 10° W. A fine grained compact pink hornblende mica gneiss, holding dark hornblendic segregations, striking N. 70° W., was seen on the portage to Lake Mishiminiwaten. On the large island in that lake a fine-grained reddish grey mica gneiss occurs strike N. 75° W. Exposures of red and grey fine grained mica gneiss are to be seen at the rapid above Kachinwastegin Lake strike N. 82° W. On the portage below the same lake, the rock is a grey fine-grained, mica hornblende gneiss, cut by large veins of light pink orthoclase. Strike N. 75° W. Rocks.

At a small island in Pospiskagami Lake is a dark red fine grained mica gneiss made up largely of flesh red orthoclase, strike N. 72° W.

Lower Great Whale River.

The river where it leaves Lake Pospiskagami is one hundred and fifty yards wide, is quite shallow, and for two miles and a half flows with a swift current between low rocky banks, cut by numerous small bays. Here a rapid of eight feet is passed by a portage of fifteen chains; followed by another stretch of swift water for two miles and a half to a fall of eight feet. Below this, the river is three hundred yards wide and very deep, passing N.W. three miles through a straight gorge with rocky hills on either side, which rise from two to three hundred Character of river.

feet above the water; these hills are bare on top, with small black spruce trees growing along their bases on the river bank, and in the small valleys between the hills. The rock surface on the hills is covered with blackish lichens (tripe de roche), which gives it a dark purple color when seen from a distance. Below this gorge are two falls fifteen and eight feet, half a mile apart; these are passed by portages of twenty-one and two chains respectively. Below these a similar quiet stretch of three miles is passed, when the river suddenly turns round the foot of a hill three hundred feet high, which stands directly in the course. In passing this hill the river contracts and is broken by a fall of thirty feet. The portage here is twenty-two chains long, and passes up a valley between the hill and the highland on the west side.

Below this fall the river turns N. 60° W., and flows three miles and three-quarters past a small branch from the west, called Ka-min-a-squa-ga-ma-stick River. At the end of this course another small branch from the west also enters. The Indians, when coming from inland by the river, to avoid the rough part immediately below, ascend this branch some distance, then pass by a portage route through several small lakes, and reach the river again seven miles below. For four miles and three-quarters from the last course the river runs north in a narrow valley between rocky hills, rising abruptly from 200 to 400 feet above the water. In this distance no fewer than seven portages, of fifteen, four, fifty-five, thirty, fifteen, seven and fifteen chains long, are made past falls and rapids of six, five, sixty, thirty, eight, thirty-five and twenty feet fall respectively.

Seven portages.

Immediately below these the river again turns north-west, and is a continuous, shallow rapid for two miles and a-half. This is very difficult to descend in canoes, on account of the great number of large boulders which block the channel.

At the foot of the rapid is the lower end of the Indian canoe route. From here the river, with an average breadth of 100 yards, flows along at the rate of four miles per hour, between slightly lower hills, for five miles on the same course, to its junction with the main or north branch, which is 400 yards wide, and was seen flowing directly from the west from the base of a range of hills upwards of ten miles distant. Below the forks the river is over 400 yards wide, and flows to the north for two miles and a-quarter. Here the stream contracts to about fifty yards in width, and passes down through a cañon, whose walls rise perpendicularly 400 feet above the water. The total descent in two miles is 230 feet. At the head of the cañon are two falls of thirty and sixty feet, with a third one of fifty feet one half mile below. The rest of the descent is gradual, and consequently the pent up water

rushes through the gorge in a mass of foam, with huge waves rising thirty and forty feet high, the whole forming a wonderfully wild and grand scene.

The portage past this obstruction passes over the hills on the west side, and is rather more than two miles long. Leaving this gorge, the valley gradually widens out to half a-mile, and the river again flows towards the north-west, with an even current of three miles an hour, for eight miles and a-half, where, again narrowing to 100 yards, it takes a short bend to the east, and again to the north for three-quarters of a mile, where it breaks through a range of hills rising 500 feet above it, and falls sixty-five feet over a sharp ledge. Turning westward, and again widening out to one-third of a mile, the river flows at the rate of four miles per hour in an uninterrupted course, ten miles, to its mouth. Portage two miles.

Below the forks the hills along the river rise from three to five hundred feet in elevation above its surface. They reach their highest altitude near the last fall and then gradually decrease towards the coast where they average about three hundred feet. No stratified drift deposits were seen along the sides of the river valley until the Indian portage route was reached. From here, stratified sands and gravels of fluviatile origin were observed on the hill sides up to elevations of one hundred feet; above this the small amount of loose material is wholly boulder till. The erratic boulders are not scattered so thickly over the bare hills as they are farther inland. From the forks along the valley to the cañon, stratified sand and gravel are deposited along the hill sides up to an elevation of one hundred feet where a marked terrace is observable.

Below the cañon the river has cut banks varying from twenty to fifty feet high. The lower parts of these are composed of about thirty feet of light blue clay overlaid with ten feet of sand, which in turn is in places capped with a thin deposit of gravel. No fossils were found in these beds, although they are probably of marine estuarine origin like those nearer the mouth of the river.

From the lower fall to the mouth of the river the channel is cut out of deposits of clay, capped with sand, which form a terrace of seventy-five feet elevation in the valley between the rocky hills. The clay beds are full of Post Tertiary marine fossil shells: the sand above holds no fossils. Between the rocky hills and the sea shore on the north side of the river is a sandy plain two miles broad and one hundred feet high at the base of the hills, it slopes away to the shore, is covered only with coarse grass and is wholly devoid of trees.

On the south side a like plain fills a broad valley between the inland hills and those forming the south point of the river. The head of tide

is eight miles above the mouth, the river is here obstructed by three small boulder islands, with two similar islands below.

The vegetation on the lower part of the river is almost arctic in character, the only trees are stunted black spruce and a few tamaracks, which grow on the terraces and in valleys and crevices between the rocky hills.

Snow and ice.

At the end of July many patches of snow and ice were seen on the north slope of the gorges in the hills facing the river. At the first portage below Pospiskagami Lake the junction between the coarse-grained pink hornblendic gneiss and a band of dark-green chloritic and altered hornblendic rocks of Huronian age was seen. Near the line of contact the Laurentian gneiss is highly twisted and shattered, so that fragments are seen embedded in the massive schistose, chloritic rock, lying at right angles to the line of contact. Offshoots from the green rock cut the gneiss and fill small cracks in it. The whole has the appearance of an igneous mass, which has broken through the gneiss cracking and twisting it along the contact, and injecting itself into all the small open fractures in the same.

Contact of Huronian and Laurentian rocks.

At the lower end of the portage are green chloritic or altered hornblendic rocks, highly schistose in structure, with light quartoze veins generally running parallel to the bedding, but seen in places to cut from one plane to another. Strike N. 10° W.

The next exposure on the river is three-quarters of a mile below, where the rock is composed of dark green altered hornblende, and a dark triclinic felspar, the whole resembling an altered diorite. Thirty chains farther down stream exposures of grey Laurentian hornblende orthoclase gneiss occur. A quarter of a mile beyond is a pink hornblende orthoclase gneiss. A fine grained pink syenitic gneiss, enclosing lenticular masses of dark hornblende was seen three-quarters of a mile below the last exposure. Strike N. 20° W.

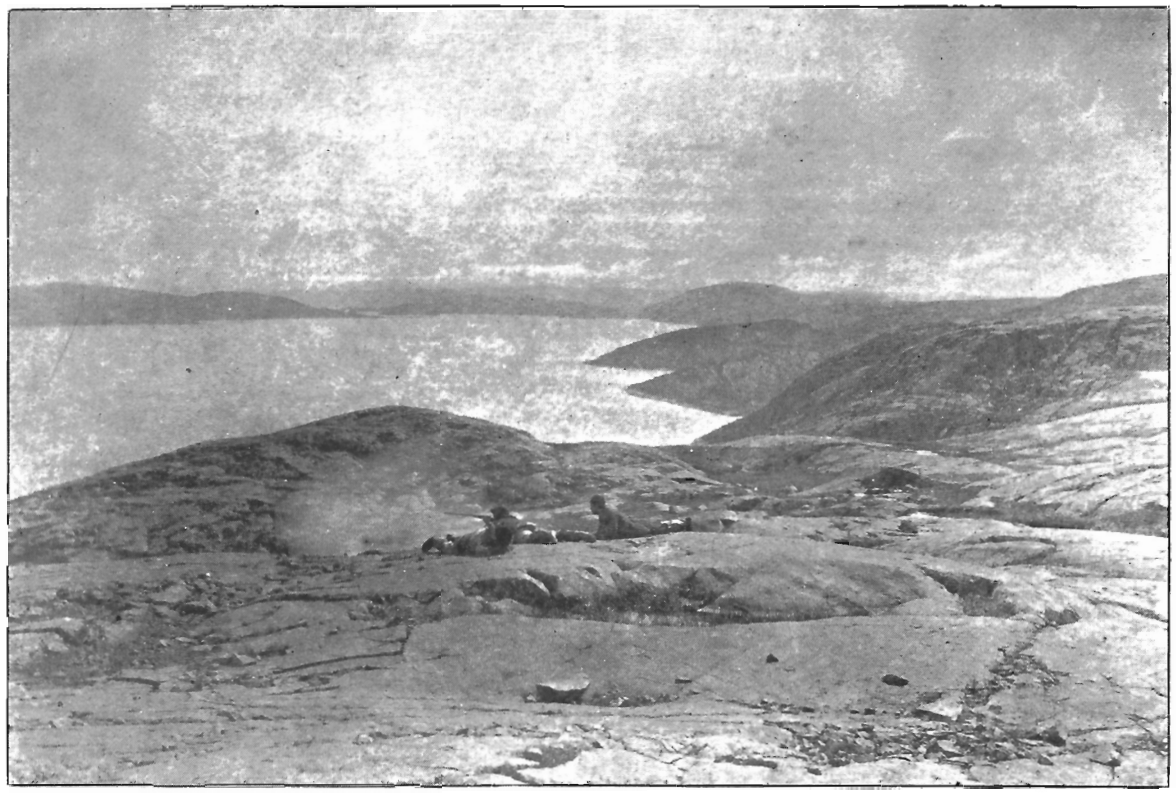
At the portage, past the eight feet fall, the rock is a greyish-pink hornblende orthoclase gneiss, highly contorted, with lenticular enclosures of hornblende.

For one mile along the upper part of the south side of the straight stretch below the fall mentioned above, the rock is composed of grey felspar, and light green felspar. This rock breaks into slabs about two feet thick, and dips S. 5° E. $< 65°$.

Enclosures in the gneiss.

Half a mile below the last exposures is a highly contorted pink hornblende orthoclase gneiss, containing large quantities of fragmented hornblende schist bands enclosed. Strike S. 35° W.

At the fifteen feet chute the rock is similar to the last, and from here to the mouth of the river all the exposures examined were made up of red and grey hornblende orthoclase gneiss, the red predominating.



A. P. LOW, PHOTO., 1888. THE DOMINION ILLUSTRATED PRINT, MONTREAL.

South shore of Richmond Gulf Lake. N. Lat. 56° 10′. W. Long. 77° 12′. looking East. from hill 450 feet above sea level.

Almost everywhere are enclosures of a greater or less number of lenticular masses of hornblende schist, with bands of the same sometimes highly shattered. The strike ranges from S. 30° W. to S. 80° W.

Route from Richmond Gulf to Clearwater Lake.

In latitude 56° 12′ 30″ a break in the sloping rocks of the Manitounuck group, described by Dr. R. Bell in Report of Progress, 1877-78, affords an outlet to a large salt water lake. This outlet, called Richmond or Hazard Gulf, is two miles long, and not over four hundred yards wide in its most contracted part. With the change of tide the water rushes in and out through it with great velocity, forming large whirlpools, a source of great danger in the navigation of the channel with small craft. The sides of the channel are very steep and rise from the seashore to over one thousand feet on the inner side. Richmond Gulf

The Gulf Lake or Artiwinipec, often erroneously called Richmond Gulf, has the form of an isosceles triangle. The base on the south is nineteen miles long, while the perpendicular from it to the northern apex is twenty-three miles. It is surrounded by high hills. On the west, sharp cliffs, formed by the broken faces of the Manitonieck rocks, which dip towards the sea, rise in places twelve hundred feet above the water. The south and east sides are bounded by lower rounded hills of Laurentian and Huronian rocks in part flanked by beds of limestone, sandstone and trap. These hills vary from four to eight hundred feet in elevation. The surface of the lake is broken by a number of high rocky islands, three of which are of considerable extent. Small black spruce trees grow along the base of the hills, in the low valleys between them and on many of the islands. Everywhere else the rocky surface is partly covered only with a low arctic flora. Gulf Lake.

On the higher parts of the hills numerous patches of snow were seen at the end of August.

The water of the lake is deep and clear, and probably abounds with fish, judging from the presence of large numbers of seals and gulls which feed upon them. In a small lake, which lies in a depression of the hills between the Gulf Lake and the coast and empties into the lake, the Esquimaux catch large quantities of a small species of salmon which never exceed ten pounds in weight. The rise of tide in the east bay is about twenty inches.

At the head of the east bay, directly opposite to the outlet of the lake, is a small stream called Wi-ach-ti-wan River. Wi-ach-ti-wan River.

Two miles from its mouth, on the north side of the bay, is the entrance of the Clearwater River, which descends with many rapids

Route to Clearwater Lake.

and falls, through a gorge in the Laurentian Hills. Owing to the difficulty in passing these, the route to Clearwater Lake ascends the smaller stream a short distance and then passes overland to that river, reaching it a point beyond the highly obstructed part. The

Portages and fall.

Wiachtiwan River, one mile from its mouth, has a sheer fall of three hundred and fifteen feet. To pass this, a portage two miles and twenty-five chains long is made over the hill on the north side. The highest point on the portage is five hundred feet above the sea level. One mile beyond, a fall of fifty-five feet causes a second portage of seventeen chains.

Above this the river averages forty yards in breadth, and winds through a valley half a mile wide between rounded gneiss hills which rise from three to five hundred above it.

The river was followed eleven miles and a-half in a general course of S. 80° E. Here a portage of one mile, fifteen chains, follows a small tributary stream to the north up from the valley to a small lake on the table-land above. The difference in elevation between the ends of the portage is three hundred and fifty feet.

This stream flows from the east two miles and three-quarters through five small lakes connected by five small rapids, past which small portages are made, to a height of land portage of forty-eight chains that ends in a lake drained by another tributary flowing into the Wiachtiwan River farther to the eastward.

The route passes down this lake two miles to its outlet, where a portage of eight chains is made past a small rapid to another lake one mile and a-half long, followed by a portage of thirty-five chains to a large lake seven miles long, the course from the height of land portage being directly east.

Four portages of four, ten, seventeen and twenty-three chains connecting lake traverses of twenty-eight, eighty and eighty chains lead, in a north direction, to a large lake which drains in the Clearwater River. This lake is five miles and a-half long from east to west, with an average breadth of half a mile; it is broken by a number of deep, narrow bays at either end, parallel to the general course of the lake.

The route crosses from the head of the most northward bay at the east end by a portage of twenty-eight chains over a low hill into the small stream which empties it. This stream was descended in a north-west direction two miles and a-half, and there left on the north side by a portage of twenty-four chains, up a steep hill to a small lake half a mile long, from which a portage of five chains was made to Clearwater River.

A quarter of a mile up the river, an island one mile and a-half long divides it into two channels, the north channel was ascended past three

A. P. LOW, PHOTO., 1888. THE DOMINION ILLUSTRATED PRINT, MONTREAL.

Clearwater River. N. Lat. 50° 12′, W. Long. 76° 05′, looking down stream, 40 miles inland from Richmond Gulf.

rapids where demi-charges were made. Above the island the river flows through a narrow valley for two miles and three-quarters, past two heavy rapids where small portages are made in ascending. From here the river widens out to half a mile, for seven miles and a-half into what is called Na-twa-ca-mi Lake; at the head of the lake is a heavy rapid passed by a portage of thirteen chains; beyond the rapid the current is sluggish for two miles and a quarter to the forks, where the two outlets of Clearwater Lake join.

Both streams are here obstructed by rapids, and the route follows up the south or smaller one one mile and a-quarter, and then crosses a portage of twelve chains from a small bay into a larger stream above the rapid.

From here the river, for one mile, is about one hundred yards wide and flows between high rocky banks to the outlet of Clearwater Lake, which is greatly obstructed by large high rocky islands.

The course from the point where the river was reached to the lake is due east.

A good view of Clearwater, or Ka-wa-cha-ga-mi Lake, was obtained from the top of an island, one mile east of the outlet, and two hundred and sixty feet above the water. The lake is surrounded by rocky hills which rise from two to four hundred feet above it. The greatest length from east to west appeared to be about thirty miles, while the average breadth was about ten miles. At its west end are a great number of high rocky islands, which continue along the south shore towards the east: about the middle of the lake many more islands appear to stretch across from shore to shore, so as to almost shut out a view of the east end. Clearwater Lake.

With the exception of a few clumps of stunted black spruce trees, that grow in protected valleys, the vegetation is wholly made up of low Arctic plants, which in part cover the bare rocks.

The water of the lake is very deep and remarkably clear; the Indians catch great quantities of large lake and river trout, white fish and suckers in the lake and the river flowing out.

From the north side of Clearwater Lake a short portage route through three or four small lakes, leads to Saal Lake, out of which the Nastapoka River flows. Saal Lake.

The Indians say that this is a much larger lake, surrounded by a low flat country totally barren.

From the Valley of the Wiachtiwan River to Clearwater Lake, the country traversed is a low plateau rising slowly towards the interior, and everywhere broken by roughly parallel ridges of low rounded gneiss hills, which rise from one to three hundred feet above water level; between the ridges are long narrow chains of lakes or mossy swamps.

Trees. Stunted trees of black spruce, with a few tamaracks grow on the low lands, around the margin of the lakes and in the swamps; none of these exceed thirty feet in height, nor are any over eight inches in diameter three feet from the ground.

Vegetation. The hill-tops are usually covered with a thin growth of white moss and arctic berries; on account of the absence of trees, fine views of the surrounding country may be obtained from any of the higher hills.

Terraces. Along the sides of the rocky hills, one mile up Clearwater River from Gulf Lake, five terraces were seen cut out of marine clays and sands, the highest reaching an elevation of over three hundred feet above sea level.

On the portage from the mouth of Wiachtiwan River, the road first passes up a rocky hill, partly covered with sand, and then along the top of a sandy gravel bank, fifty feet high, cut out of the stratified drift by a small stream. It then ascends an easy slope covered by coarse sand and gravel to a flat terrace fifteen chains wide and two hundred and thirty-five feet above sea level. This is covered with small bars and hummocks of coarse gravel, the remains of an old sea beach.

Ancient sea beach.

Beyond this the road again ascends an easy slope over sands and gravel to the edge of a flat plain four hundred and forty feet above the sea. Across the face of this plain, from the high hills on the north to a solitary rocky hill on the south, between the plain and the river valley, are a number of rounded knolls, in two rows. These average fifty feet in diameter and rise about five feet above the general level. They are composed of coarse gravel and small water-worn boulders, and were evidently formed in the shallow water of the old seashore line.

From here the road passes along the side of the hill on the south as the plain behind is swampy and covered with small spruce trees. At the east end of the hill is a narrow ridge of sand mixed with gravel and small boulders, one hundred feet above the river, with a sharp slope on either side. The portage follows the crest of the ridge and gradually descends from the hill towards the east to the level of the plain, where the valley of a small stream is followed to the river below. The sand and gravel of the ridge is nearly one hundred feet thick and overlies bedded clays, which form the cut banks along the small stream to the river edge. The origin of the ridge is probably due to the cutting action of the river, which at the earlier part of the period of upheaval of the land, evidently flowed to the north of the hill, and carried away about one hundred feet of sand and gravel from the top of the present plain. Later, it assumed its present course to the south of the hill, and cut away the deposits on that side leaving only the

Change in river channel.

ridge to mark the height of the old deposits. Along the valley of Wiachtiwan River, above the portage, terraces with faces cut out of stratified sand and clay are quite common, especially on the upper part. On the portage from the river valley, the first terrace is thirty feet above the river, the second, one hundred and sixty feet, and the third, a broad plain on the upper level, three hundred and ten feet, or six hundred and seventy-five feet above sea level.

The deposits out of which these are formed consist of stratified sands, with fine gravel on the top plain. Although no fossils were found in these beds, they are probably of estuarine origin and mark the amount of elevation of the land since the period of submergence subsequent to the period of glaciation.

Beyond this point, as far as Clearwater Lake, no stratified surface deposits were noted. The loose material is wholly made up of boulder till. The boulders are scattered over hill and valley in the utmost profusion. Often large rounded masses of rock of many tons weight were seen perched on the very summits of the hills and held in place by smaller boulders wedged underneath. In one place a boulder, over three feet in diameter, was seen perched upon another of twice the size. These boulders all appear to be derived from the immediate country rock and have not travelled far from their original place. The only example of a far-travelled erratic seen was a small boulder of white fossiliferous limestone, similar to that found in Hudson Straits and on the west side of Hudson Bay. This was found on the top of a hill two hundred feet above the outlet of Clearwater Lake. As the drift was here directly from the east, and as low flat land is reported by the Indians to occur about Seal Lake in that direction, it is highly probable that deposits of similar rock will be found in that neighbourhood, the boulder being carried from there by the ice. Distribution of boulders.

At the lower end of the portage, from the mouth of the Wiachtiwan River, is a small exposure of light green felspathic argillite, belonging to the Manitounuck group of Dr. Bell (see Report of Progress 1877-78.) Along the hillside, on the upper part of the portage, a cliff of the same rocks dip N. 60° E. $< 35°$, and gives the following section in ascending order: Manitounuck rocks.

(1.) Apple green silicious argillite, fifty feet.

(2.) Light yellowish grey sandstone, six feet.

(3.) Light grey crystalline limestone mixed with grains of quartz and shading into sandstone, with a calcite matrix, very hard and tough, thirty-five feet.

(4.) Bedded dark green amygdaloidal trap, one hundred feet.

Between this exposure and Clearwater Lake Archean gneisses only, were seen.

On the portage past the fifty-five feet fall, is a fine-grained pink micaceous gneiss, penetrated by large veins of pink orthoclase and quartz.

On the hill top, on the portage from the river valley, the rock is chiefly a dark red syenitic granite, holding small dark red garnets. Along with it are thin bands of highly contorted fine-grained pink micaceous gneiss. An immense dyke of dark green diorite, made up of moderately large crystals of dark green hornblende, and dark blue plagioclase. This dyke is over two hundred yards wide, and was seen cutting the hills on the opposite side of the river valley several miles away. Its direction is S. 35° E.

Dykes.

Another similar dyke, sixty feet wide, cuts the rocks in a N. 25° E. direction at the small lake half a mile north of the other, and may be an offshoot of the larger dyke.

On the portages between the small lakes to the height of land are exposures of pink mica-gneiss, associated with a dark-red variety, made up principally of dark-red orthoclase, with some quartz and small quantities of mica and a greenish hornblende. These rocks are often very much contorted; their general strike is S. 80° W. At the height of land portage are similar exposures, the hornblende showing signs of decomposition. Strike N. 63° W.

Gneiss.

The rocks examined along the lakes and portages of the next tributary were found to contain more hornblende, with little or no mica, and in places to enclose hornblendic segregations. General strike N. 57° W.

On crossing the height of land to the lakes draining into Clearwater River, the rocks contain larger quantities of hornblende, with more frequent hornblendic enclosures and schist bands.

On the portage from the small branch to Clearwater River are two dykes. The first one is on the hill, a short distance from the branch; it is olive-green in color, very fine-grained and compact in structure, and varies in width from five to fifty feet, with a direction of N. 70° E. The second dyke, near the Clearwater River, is coarser in texture, and composed of light-green plagioclase and dark-green hornblende; it is sixty feet wide, and runs N. 75° W. The rock cut by these dykes is a coarse-grained, pink hornblende-gneiss, containing broken bands of hornblende-schist. Strike N. 55° W.

Diorite dykes.

At the head of the island, a short distance from the portage to Clearwater River, another diorite dyke, thirty feet wide, was seen runinng N. 85° W.

All along the Clearwater River to the lake the rock exposures were found to be composed of a pink hornblende-gneiss, often granitic in structure, associated with a greater or less number of bands of dark hornblende-schist, and usually enclosing fragments or segregations of hornblende-rock. The average strike is north-west.

GLACIATION AND SUPERFICIAL DEPOSITS.

The hills everywhere inland to the east of Hudson Bay have been rounded off, planed and scratched by an immense glacier, which moved over the highest land, where the striæ and ice-grooves upon the rock surface attest it former presence. Ice grooving.

The following list of striæ show that the glacier moved in a uniform direction, a few degrees south of west, over all inequalities of the surface, except the deep valley of Great Whale River, where it was diverted and followed the course of the river valley.

On the Clearwater route the general direction is more nearly west than in the country to the south.

Everywhere the glacier appears to have followed the general slope of the country from the high interior gathering grounds.

From the evidence afforded by striæ and travelled boulders on the rivers falling into Hudson Bay from the west and south, collected by Dr. R. Bell it would appear that the continental glacier flowed down from the high land on the east side of the bay, crossed it, and had momentum and thickness sufficient to push itself in a direction south of west, up the west side over the wide margin of flat deposits of limestone, which extend inland from the present coast line some 200 miles, and then over the higher Archæan country that forms the watershed between Hudson Bay and the great lakes. Flow of great glacier.

LIST OF GLACIAL STRIÆ ON THE BIG, GREAT WHALE AND CLEARWATER RIVERS.

On an island in Big River seven miles above Fort George	S. 70° W.
At the chute in Big River	S. 75° W.
Seven miles above the chute	S. 80° W.
Eighteen miles above the chute	S. 70° W.
Twenty-two miles above the chute	S. 85° W.
On 1st Portage, from Big River to Bishop Roggan River (top of hill)	S. 80° W.
On 3rd Portage from Big River to Bishop Roggan River	S. 50° W.
On 5th Portage from Big River to Bishop Roggan River	S. 62° W.
Island in Piagochiwi Lake	S. 85° W.
On portage to Abpichotinachits Lake	S. 87° W.
Island in Pamigomachi Lake	S. 75° W.
Seven miles up Bishop Roggan River from Awagats Lake	S. 80° W.
Three miles above the last	S. 85° W.
Apachichits River near the portage to Big River	S. 78° W.
Big River, at the head of the Delta	S. 75° W.
Big River, at 1st ten feet chute	S. 78° W.
Big River, at fifteen feet chute	S. 85° W.
Big River, two miles and a-half above last	S. 76° W.

Big River at thirty feet chute	S. 86° W.
On portage to Kahipikamow Lake	S. 78° W.
On portage from Kahipkiamow Lake	S. 62° W.
Portage to Masquacuiwi (top of hill)	S. 60° W.
Portage to Mishiminewaten Lake	S. 63° W.
On Mishiminewaten Lake	S. 63° W.
At Rapid to Kabimichatiwan Lake	S. 85° W.
Portage to Pospiskagami Lake	S. 62° W.
Island in Pospiskagami Lake	S. 63° W.
1st Portage on Great Whale River below Pospiskagami Lake	N. 75° W.
Half a-mile below the last	N. 60° W.
Portage two miles below the last	N. 70° W.
One mile below the last	N. 70° W.
On Portage past eight foot fall in long gorge two and a-half miles below the last	N. 82° W.
On portage at rapid at head of Indian portage route	N. 80° W. & N. 35° W.
On portage past sixty foot fall	N. 70° W.
At Forks	N. 68° W.
On hill top, on two mile portage past canon	N. 77° W.
On lower end of two mile portage past canon	N. 68° W. & N. 50° W.
On last portage Great Whale River	N. 65° W.
At foot of portage from Gulf Lake up Wiachtiwan River.	S. 83° W.
On dyke at top of hill, on portage from Wiachitiwan River	N. 70° W.
On portage from 3rd lake above the last	W.
On the long lake of 2nd tribntary	S. 85° W.
At lower end of same lake	S. 80° W.
On height of land portage to Clearwater branch	S. 85° W.
On last portage to Clearwater River	S. 77° W.
At portage past upper rapid on large island in the Clear-water River	W.
At island in Natwagami Lake	S. 85° W.
On hill two miles below the outlet of Clearwater Lake	S. 78° W.
On top of island in Clearwater Lake 260 feet above the lake	S. 78° W.

Terminal moraine.

During some long period between the time of extreme glaciation and the close of the period of ice, the glacier did not extend beyond the middle of James Bay, and there, in a terminal moraine, deposited great quantities of sand, clay and boulders, part of which form the present unstratified drift islands, before described in detail in this report.

The evidence of stratified deposits of marine sands and clays along the valleys, near the mouths of the rivers on the east side of Hudson Bay, shows that a subsidence of the land of over five hundred feet (and probably nearly seven hundred feet) took place after the period of glaciation; since then the land has been slowly rising, with periods of quiet, as shown by the terraces cut out of the drift along the high land of the coast.

Terraces.

APPENDIX I.

List of plants collected on the Rupert and Moose rivers, along the shores of James' Bay, and on the islands in James' Bay, during the summers of 1885 and 1887, by J. M. Macoun.

The first column in the following list contains those species found growing along the Moose River, the second those growing along the Rupert River, and the third column those growing along the shores and on the islands of James' Bay:—

	Moose River.	Rupert River.	James' Bay.
RANUNCULACEÆ.			
Anemone parviflora, Michx	*	*	*
" dichotoma, Linn	*	*	*
Thalictrum dioicum, Linn	*	*	
Ranunculus aquatilis, Linn., *var.* trichophyllus, Chaix	*	*	
" Cymbalaria, Pursh			*
" affinis, R. Br., *var.* validus, Gr			*
" abortivus, Linn	*	*	*
" Pennsylvanicus, Linn	*		
" recurvatus, Poir	*	*	
Caltha palustris, Linn		*	*
Coptis trifolia, Salisb	*	*	
Actæa spicata, Linn., *var.* rubra, Ait	*	*	
NYMPHÆACEÆ.			
Nymphæa odorata, Ait, *var.* minor, Sims	*		
Nuphar advena, Ait	*	*	
" rubrodiscum, Morong	*		
FUMARIACEÆ.			
Corydalis glauca, Pursh	*	*	
" aurea, Willd	*		
CRUCIFERÆ.			
Nasturtium palustre, DC.	*	*	*
Cardamine hirsuta, Linn	*	*	*
" pratensis, Linn	*	*	*
Arabis humifusa, Wat., *var.* pubescens, Wat			*
" hirsuta, Scop	*		
" confinis, Watson	*		
" perfoliata, Lam	*		

	Moose River.	Rupert River.	James' Bay.
Erysimum cheiranthoides, Linn	*		*
Sisymbrium humile, C. A. Meyer			*
Draba incana, Linn., *var.* confusa, Poir			*
" aurea, Vahl			
VIOLACEÆ.			
Viola blanda, Willd	*	*	*
" cucullata, Ait	*	*	
" canina, Linn., *var.* Muhlenbergii, Gray	*	*	
" Canadensis, Linn	*		
POLYGALACEÆ.			
Polygala paucifiora, Willd	*		
CARYOPHYLLACEÆ.			
Silene acaulis, Linn			*
Arenaria verna, Linn., *var.* hirta, Wat			*
" Michauxii, Hook		*	*
" peploides, Linn			*
Stellaria longifolia, Muhl	*		
" borealis, Bigel. *var.* alpestris, Gray		*	
" longipes, Goldie	*	*	
" " *var.* Edwardsii, T. & G			*
" humifusa, Rottb		*	
Cerastium arvense, Linn	*	*	
" alpinum, Linn			*
LINACEÆ.			
Linum perenne, Linn			*
GERANIACEÆ.			
Geranium Carolinianum, Linn	*	*	
Impatiens fulva, Nutt	*		
RHAMNACEÆ.			
Rhamnus alnifolia, L'Her	*	*	
SAPINDACEÆ.			
Acer spicatum, Lam	*	*	
LEGUMINOSÆ.			
Astragalus alpinus, Linn			*
Hedysarum boreale, Nutt	*		
Vicia Americana, Muhl	*	*	
Lathyrus maritimus, Bigel			*
" palustris, Linn	*	*	
" ochroleucus, Hook	*		

	Moose River.	Rupert River.	James' Bay.
ROSACEÆ.			
Prunus Pennsylvanica, Linn	*	*	
" Virginiana, Linn	*		
Spiræa salicifolia, Linn	*	*	
Neillia opulifolia, Benth. & Hook	*		
Rubus Chamæmorus, Linn	*	*	*
" arcticus, Linn	*	*	*
" " *var.* grandiflorus, Ledeb		*	*
" triflorus, Rich	*	*	*
" strigosus, Mx	*	*	*
Dryas octopetala, Linn., *var* integrifolia, Cham. & Sch			*
Geum macrophyllum, Willd	*	*	
" strictum, Ait	*	*	
" rivale, Linn	*	*	
Sibbaldia procumbens, Linn			*
Fragaria Virginiana, Duchesne	*	*	*
" vesca, Linn	*		
Potentilla Norvegica, Linn	*	*	*
" Pennsylvanica, Linn		*	*
" maculata, Pour			*
" emarginata, Pursh			*
" palustris, Scop	*	*	*
" fruticosa, Linn	*	*	*
" Anserina, Linn	*	*	*
" arguta, Pursh	*	*	
" tridentata, Solander	*	*	*
Rosa Sayi, Watson	*	*	*
Pirus Americana, DC	*	*	
Amelanchier Canadensis, T. & G., *var.* oblongifolia, T. & G	*	*	
" *var.* oligocarpa, T. & G	*		
SAXIFRAGACEÆ.			
Saxifraga tricuspidata, Retz			*
" aizoides, Linn			*
" Hirculus, Linn			*
Mitella nuda, Linn	*	*	*
Parnassia palustris, Linn	*	*	*
" Kotzebuei, Cham. & Schlecht			*
Ribes oxycanthoides, Linn	*	*	*
" lacustre, Poir	*	*	*
" rubrum, Linn	*	*	*
" prostratum, L'Her	*	*	*
DROSERACEÆ.			
Drosera rotundifolia, Linn	*	*	
" intermedia, Drev. & Hayne, *var.* Americana, DC.	*	*	
HALORAGEÆ.			
Hippuris vulgaris, Linn	*	*	*
ONAGRACEÆ.			
Epilobium angustifolium, Linn	*	*	*
" latifolium, Linn			*

	Moose River.	Rupert River.	James' Bay.
Epilobium tetragonum, Linn	*	*	
" palustre, Linn., *var.* lineare, Gray	*	*	
Œnothera biennis, Linn	*		
Circæa alpina, Linn	*	*	
UMBELLIFERÆ.			
Sanicula Marilandica, Linn	*	*	
Cicuta maculata, Linn	*	*	
" bulbifera, Linn	*	*	
Sium cicutæfolium, Gmelin	*	*	
Archangelica atropurpurea, Hoffm			*
Heracleum lanatum, Mx	*	*	*
ARALIACEÆ.			
Aralia hispida, Vent		*	
" nudicaulis, Linn	*	*	
CORNACEÆ.			
Cornus Canadensis, Linn	*	*	*
" sericea, Linn		*	
" stolonifera, Mx	*	*	*
CAPRIFOLIACEÆ.			
Sambucus racemosa, Linn	*	*	
Viburnum pauciflorum, Pylaie	*	*	*
Linnæa borealis, Gronov	*	*	*
Lonicera cœrulea, Linn	*	*	
" involucrata, Banks	*	*	*
Diervilla trifida, Mœnch	*	*	*
RUBIACEÆ.			
Galium asprellum, Mx	*	*	
" trifidum, Linn	*	*	*
" triflorum, Mx	*	*	
" boreale, Linn	*	*	*
COMPOSITÆ.			
Eupatorium purpureum, Linn	*	*	
Solidago lanceolata, Linn	*	*	*
" Canadensis, Linn	*	*	*
" bicolor, Linn., *var.* concolor, T. & G	*	*	
" uliginosa, Nutt	*	*	
" macrophylla, Pursh	*	*	
" humilis, Pursh			*
Aster Lindleyanus, T. & G	*	*	
" puniceus, Linn		*	
" salicifolius, Ait			*
" umbellatus, Mill., *var*	*	*	
" nemoralis, Ait		*	
" macrophyllus, Linn	*		
" lævis, Linn	*	*	

	Moose River.	Rupert River.	James' Bay.
Erigeron hyssopifolius, Mx	*	*	*
" Canadensis, Linn	*	*	
" Philadelphicus, Linn	*	*	*
" uniflorus, Linn			*
" acris, L., *var.* Droebachensis, Blytt	*		*
Antennaria plantaginifolia, Hook	*	*	
" dioica, Gærten			*
" Carpathica, R. Br			*
Anaphalis margaritacea, Benth. & Hook	*	*	
Bidens frondosa, Linn	*	*	
" cernua, Linn	*	*	*
Achillea Millefolium, Linn	*	*	*
Chrysanthemum arcticum, Linn			*
Matricaria inodora, L., *var.* nana, Hook			*
Tanacetum Huronense, Nutt			*
Artemisia borealis, Pall			*
" Canadensis, Mx			*
Petasites palmata, Gray	*	*	*
" sagittata, Gray			*
Senecio aureus, Linn			*
" " *var.* obovatus, T. & G		*	
" " *var.* Balsamitae, T. & G	*		
" Pseudo-Arnica, Less			*
Cnicus muticus, Pursh	*	*	
Hieracium umbellatum, Linn	*	*	
" scabrum, Mx	*	*	
Taraxacum officinale, Web., *var.* lividum, Koch		*	
" " *var.* alpinum, Koch			*
Lactuca leucophæa, Gray	*	*	
Prenanthes alba, Linn	*	*	
" racemosa, Mx	*	*	
LOBELIACEÆ.			
Lobelia Dortmanna, Linn	*	*	
" Kalmii, Linn		*	*
CAMPANULACEÆ.			
Campanula rotundifolia, Linn		*	*
" " *var.* arctica, Lange			*
VACCINIACEÆ.			
Vaccinium Canadense, Kalm	*	*	
" Pennsylvanicum, Lam	*	*	
" uliginosum, Linn		*	*
" Oxycoccus, Linn	*	*	
" macrocarpum, Ait	*	*	*
Chiogenes hispidula, Torr. & Gray	*	*	
ERICACEÆ.			
Arctostaphylos alpina, Spreng			*
" Uva-ursi, Spreng	*	*	
Cassandra calyculata, Don	*	*	
Epigæa repens, Linn	*	*	

	Moose River.	Rupert River.	James' Bay.
Andromeda polifolia, Linn	*	*	*
Kalmia augustifolia, Linn	*	*	*
" glauca, Ait	*	*	*
Ledum latifolium, Ait	*	*	
Pyrola minor, Linn	*		
" secunda, Linn	*	*	*
" rotundifolia, Linn., *var.* asarifolia, Hook	*	*	*
" " *var.* pumila, Hook			*
Moneses uniflora, Gray	*	*	
Chimaphila umbellata, Nutt	*		
Monotropa uniflora, Linn	*		
PLUMBAGINACEÆ.			
Armeria vulgaris, Willd			*
PRIMULACEÆ.			
Primula Mistassinica, Mx	*	*	*
" farinosa, Linn	*	*	*
Trientalis Americana, Pursh	*	*	
Steironema ciliatum, Raf	*		
Lysimachia stricta, Ait	*	*	
" thyrsiflora, Linn	*		
OLEACEÆ.			
Fraxinus sambucifolia, Lam	*		
APOCYNACEÆ.			
Apocynum androsæmifolium, Linn	*	*	
GENTIANACEÆ.			
Gentiana serrata, Gunner	*	*	*
" Amarella, Linn., *var.* acuta, Hook., f	*	*	*
Pleurogyne rotata, Griseb			*
Halenia deflexa, Griseb	*		
Menyanthes trifoliata, Linn	*	*	
BORRAGINACEÆ.			
Mertensia maritima, Don			*
" paniculata, Don	*		
SCROPHULARIACEÆ.			
Mimulus ringens, Linn	*	*	
Veronica Americana, Schwein	*	*	
" scutellata, Linn	*	*	
" alpina, Linn			*
" peregrina, Linn	*		*
Castilleia pallida, Kunth, *var.* septentrionalis, Gray			*
Euphrasia officinalis, Linn	*	*	
Bartsia alpina, Linn			*
Pedicularis Grœnlandica, Retz			*

	Moose River.	Rupert River.	James' Bay.
Pedicularis Lapponica, Linn.			*
" palustris, Linn., *var.* Wlassoviana, Bunge.		*	*
" Canadensis, Linn.	*		
" flammea, Linn.			*
" hirsuta, Linn.			*
Rhinanthus Crista-galli, Linn.	*	*	*
Melampyrum Americanum, Mx.	*	*	*
LENTIBULARIACEÆ.			
Utricularia vulgaris, Linn.	*	*	
" intermedia, Hayne	*	*	
Pinguicula vulgaris, Linn.	*	*	*
LABIATÆ.			
Mentha Canadensis. Linn.	*	*	*
" " *var.* glabrata, Benth.			*
Lycopus sinuatus, Ell.	*	*	*
Dracocephalum parviflorum. Nutt.	*	*	
Scutellaria lateriflora, Linn.	*	*	*
" galericulata, Linn.	*	*	*
Brunella vulgaris, Linn.	*	*	
Stachys palustris, Linn.	*	*	*
PLANTAGINACEÆ.			
Plantago major, Linn.	*	*	*
" eriopoda, Torr.			*
CHENOPODIACEÆ.			
Chenopodium capitatum, Benth & Hook.	*	*	
POLYGONACEÆ.			
Polygonum amphibium, Linn.	*	*	
" lapathifolium, Ait, *var.* incanum, Koch	*	*	
" viviparum, Linn.	*	*	*
" cilinode, Mx.	*	*	*
Rumex salicifolius, Weinm.	*		
" verticillatus, Linn.			*
ELÆAGNACEÆ.			
Elæagnus argentea, Pursh.	*		*
Shepherdia Canadensis, Nutt.	*		
SANTALACEÆ.			
Comandra livida, Richardson.	*	*	
" umbellata, Nutt.	*		
URTICACEÆ.			
Urtica gracilis, Ait.	*	*	

	Moose River.	Rupert River.	James' Bay.
MYRICACEÆ.			
Myrica Gale, Linn	*	*	*
CUPULIFERÆ.			
Betula lenta, Linn	*		
" lutea, Mx., f	*	*	
" papyrifera, Mx	*	*	*
" pumila, Linn	*	*	*
" glandulosa, Mx	*	*	*
Alnus incana, Willd	*	*	
" viridis, DC	*	*	*
SALICACEÆ.			
Salix candida, Willd	*	*	
" desertorum, Rich	*	*	
" myrtilloides, Linn	*	*	
" glauca, Linn			
" discolor, Muhl	*	*	*
" arctica, R. Br			*
" cordata, Muhl	*		
" herbacea, Linn			
" lucida, Willd	*		
" rostrata, Rich	*		
" reticulata, Linn			*
" lanata, Linn., *var.* Macounniana, Bebb			*
Populus tremuloides, Mx	*	*	*
" balsamifera, Linn	*	*	*
EMPETRACEÆ.			
Empetrum nigrum, Linn			*
CONIFERÆ.			
Juniperus communis, Linn., *var.* alpina, Gaud	*		
" Sabina, Linn., *var.* procumbens, Pursh	*		
Pinus Banksiana, Lambert	*	*	*
Picea nigra, Link	*	*	*
" alba, Link	*	*	*
Abies balsamea, Miller	*	*	*
Larix Americana, Mx	*	*	*
HYDROCHARIDACEÆ.			
Elodea Canadense, Planchon			
ORCHIDACEÆ.			
Liparis Loeselii, Rich	*		
Calypso borealis, Salisb	*	*	
Microstylis ophioglossoides, Nutt	*		
Corallorhiza innata, R. Br	*	*	
Listera cordata, R. Br	*	*	
" convallarioides, Nutt	*	*	
Spiranthes Romanzoviana, Chamisso	*	*	

	Moose River.	Rupert River.	James' Bay.
Goodyera repens, R. Br	*	*	
Calopogon pulchellus, R. Br	*		
Pogonia ophioglossoides, Ker	*		
Orchis rotundifolia, Gray	*	*	*
Habenaria dilatata, Gray	*	*	
" hyperborea, R. Br	*	*	*
" obtusata, Rich	*	*	*
" Hookeri, T. & G	*		
Cypripedium acaule, Ait	*	*	
" pubescens, Swartz	*	*	
IRIDACEÆ.			
Iris versicolor, Linn	*	*	
Sisyrinchium mucronatum, Mx	*	*	
LILIACEÆ.			
Streptopus amplexifolius, DC	*	*	
" roseus, Mx	*	*	
Smilacina stellata, Desf	*	*	*
" racemosa, Desf	*		
" trifolia, Desf	*	*	
Maianthemum Canadense, Desf	*	*	*
Allium Shœnoprasum, Linn	*	*	*
Lilium Philadelphicum, Linn	*		
Tofieldia borealis, Wahlenb	*	*	*
" glutinosa, Willd	*	*	
Clintonia borealis, Raf	*	*	
JUNCACEÆ.			
Juncus filiformis, Linn	*	*	*
" effusus, Linn	*		*
" Balticus Dethard, *var.* littoralis, Engelm	*	*	*
" triglumis, Linn			*
" tenuis, Willd	*	*	*
" bufonius, Linn	*		
" alpinus, Villars, *var.* insignis, Fries	*	*	
" nodosus, Linn	*		
" Canadensis, J. Gray, *var.* coarctatus, Engelm	*	*	
Luzula spadicea, DC	*	*	
" spicata, Desv			*
" comosa, Meyer			*
" arcuata, Meyer			*
Typha latifolia, Linn	*	*	
Sparganium simplex, Huds	*		
" affine, Schnitzlein		*	
" hyperboreum, Laest, *var.* Americanum, Beeby			*
AROIDEÆ.			
Calla palustris, Linn	*	*	
Acorus Calamus, Linn	*		
ALISMACEÆ.			
Alisma Plantago, Linn., *var.* Americanum, Gray	*		
Sagittaria variabilis, Engelm., *var*	*	*	

	Moose River.	Rupert River.	James' Bay.
NAIADACEÆ.			
Triglochin maritimum, Linn			*
" " *var.* elatum, Gray	*	*	
Potamogeton natans, Linn	*		
" rufescens, Schreeder		*	
" amplifolius, Tuck	*		
" gramineus, Linn., *var.* graminifolius, Fries		*	
" " *var.* heterophyllus, Fries	*	*	
" praelongus, Wulfen	*		
" perfoliatus, Linn	*	*	
" zosterifolius, Schum	*		
" pauciflorus, Pursh	*	*	
" pusillus, Linn	*	*	
" rutilans, Wolfgang			*
" marinus, Linn		*	
" pectinatus, Linn	*	*	*
" Robbinsii, Oakes	*		
Naias flexilis, Rostk. & Schmidt		*	
ERIOCAULONACEÆ.			
Eriocaulon septangulare, With	*		
CYPERACEÆ.			
Eleocharis palustris, R. Br	*		*
" tenuis, Schultes	*		
" acicularis, R. Br	*		
Scirpus caespitosus, Linn			*
" sylvaticus, Linn., *var.* digynus, Boeckl	*		*
Eriophorum cyperinum, Linn	*		*
" alpinum, Linn		*	*
" vaginatum, Linn		*	
" capitatum, Host			*
" polystachyon, Linn	*		
Carex nardina, Fries			*
" pauciflora, Lightf	*		
" microglochin, Wahl			*
" polytrichoides, Muhl	*	*	
" teretiuscula, Good	*	*	
" stipata, Muhl	*		
" chordorhiza, Ehrh		*	
" tenella, Schk	*		
" canescens, Linn	*	*	
" " *var.* vulgaris, Bailey		*	
" echinata, Murray, *var.* microstachys. Boeck		*	
" scoparia, Schk	*	*	
" straminea, Schk	*		
" Buxbaumii, Wahl	*	*	
" atrata, Linn		*	
" alpina, Swartz			*
" aurea, Nutt	*	*	
" Œderi, Retz	*	*	
" flava, Linn	*	*	
" aquatilis, Wahl		*	*
" lenticularis, Mx	*	*	

	Moose River.	Rupert River.	James' Bay.
" maritima, Muller			*
" Magellanica, Lamarck	*	*	
" rariflora, Smith			
" limosa, Linn	*	*	
" vaginata, Tausch	*	*	
" concinna, R. Br		*	
" arctata, Boott, *var.* Faxoni, Bailey		*	
" flexilis, Rudge	*	*	
" capillaris, Linn	*	*	*
" riparia, W. Curtis			*
" filiformis, Linn	*		
" lanuginosa, Mx	*	*	
" Michauxiana, Bœckl		*	
" oligosperma, Mx		*	
" miliaris, Mx		*	
" saxatilis, Linn			*
" rotundata, Wahl			*
" rostrata, With			*
" " *var.* reticulata, Bailey	*	*	
" monile, Tuck	*	*	
" retrorsa Schw	*		
GRAMINEÆ.			
Beckmania erucæformis, Host, *var.* uniflorus, Scrib		*	*
Panicum dichotomum, Linn		*	
Hierochloa alpina, Rœm. & Schultz			*
" borealis, Rœm. & Schultz	*	*	*
Alopecurus alpinus, Smith			*
" geniculatus, Linn., *var.* aristulatus, Munro		*	
Stipa Richardsonii, Link		*	
Oryzopsis asperifolia, Mx	*	*	
Muhlenbergia glomerata, Trin	*		
Phleum alpinum, Linn			*
Agrostis scabra, Willd	*	*	*
Cinna pendula, Trin	*	*	
Deyeuxia Canadensis, Hooker	*	*	*
" Langsdorffii, Kunth			*
" neglecta, Kunth		*	*
" borealis, Macoun			*
Deschampsia atropurpurea, Scheele		*	
" " *var.* minor, Vasey			*
" cæspitosa, Beauv	*	*	
" " *var.* maritima, Vasey			*
" alba, Rœm. & Schultz	*	*	
Trisetum subspicatum, Beauv. *var.* molle, Gray	*		
Eatonia Pennsylvanica, Gray	*	*	*
Catabrosa aquatica, Beauv			*
Poa alpina, Linn	*		
" cæsia, Smith			*
" cenisia, Ait			*
" pratensis, Linn	*	*	
Glyceria arundinacea, Kunth			*
" Canadensis, Trin	*	*	
" fluitans, R. Br	*		
" maritima, Wahl			
" nervata, Trin	*	*	
Festuca ovina, Linn., *var.* brevifolia, Watson			*

	Moose River.	Rupert River.	James' Bay.
Bromus ciliatus, Linn	*	*	*
Agropyrum tenerum, Vasey		*	
Hordeum jubatum, Linn		*	*
Elymus mollis, Trin			*
EQUISETACEÆ.			
Equisetum arvense, Linn	*	*	
" palustre, Linn	*	*	
" scirpoides, Mx	*	*	
FILICES.			
Polypodium vulgare, Linn	*	*	
Pellæa gracilis, Hook		*	
Pteris aquilina, Linn	*	*	
Asplenium viride, Hudson	*	*	
" Filix-fœmina, Bernh	*	*	
Phegopteris Dryopteris, Fèe	*	*	
" calcarea, R. Br		*	
Aspidium spinulosum *var.* dilatatum, Gray	*	*	*
Onoclea sensibilis, Linn	*	*	
Cystopteris fragilis, Bernh	*	*	
" montana, Bernh		*	
Woodsia Ilvensis, R. Br	*	*	
" glabella, R. Br	*	*	
Osmunda regalis, Linn	*	*	
" Claytoniana, Linn	*	*	
Botrychium Lunaria, Swartz	*	*	*
" Virginicum, Swartz	*	*	
" ternatum Swartz, *var.* lunarioides, Willd		*	*
LYCOPODIACEÆ.			
Lycopodium annotinum, Linn	*	*	*
" dendroideum, Mx	*	*	*
" clavatum, Linn	*	*	*
" complanatum, Linn	*	*	*
" sabinaefolium, Willd		*	

APPENDIX II.

List of Diurnal Lepidoptera and Coleoptera

Collected by Mr. J. S. Cotter at Moose Factory in 1888, and by Mr. J. M. Macoun on the south coast and islands of James Bay in 1887. Determined by Mr. Jas. Fletcher, Dominion Entomologist.

Diurnal Lepidoptera taken at Moose Factory.

Papilo Turnus, L. (8 specimens.) 16 June–16 July.
Pieris Napi, Esp., winter form *Oleracea-hiemalis*, Har. (12 specimens.) 11–18 June.
Pieris Rapæ, L. (2 specimens.) 17–24 August.
Colias Scudderii, Reak. 17 August.
Colias Nastes, Bd. No particulars.
Argynnis Polaris, Bd. 18 June.
Phyciodes Tharos, Dru. winter form *Marcia*, Edw. 31 August.
Grapta Progne, Cram. 18 June.
Vanessa Antiopa, L. (2 specimens.) 11 June.
Vanessa Milberti, God't. (3 specimens.) 18–20 June.
Pyrameis Atalanta, L. (17 specimens.) 6–19 June.
Limenitis Arthemis, Dru., var. *Lamina*, Fab.
Cœnonympha Inornata, Edw. (3 specimens.) 31 August.
Lycæna Pseudargiolus, Bl., winter form *Lucia*, Kirby. (3 specimens.) 25 June.

Coleoptera taken on the south coast and islands of James Bay.

Cicindela 12-guttata, Dejean.
Calosoma frigidum, Kirby.
Chlænius sericeus, Forster.
Silpha Lapponica, Hlist.
Dicerca divaricata, Say.
Buprestis maculiventris, Say.
Asemum mœstum, Haldeman.
Criocephalus obsoletus, Randall.
Xylotrechus undulatus, Say.
Rhagium lineatum, Olivier.
Pachyta liturata, Kirby.
Acmæops proteus, Kirby.
Leptura chrysocoma, Kirby.
Monohammus scutellatus, Say.
Orsodachna atra, Ahr.
Adoxus vitis, L.
Lina Lapponica, L.
Lina scripta, Fabricius.
Gonioctena pallida, L.
Upis ceramboides, L.
Lepyrus colon, L.

APPENDIX III.

Notes on the Breeding Habits of certain Mammals, from Personal Observations and Enquiries from Indians.

By Mr. Miles Spencer, Fort George, Hudson Bay.

Rangifer Groenlandicus, L. Barren Ground Caribou.

These animals mate about the end of October, and the calves, one or two in number, are born about 1st July. The young at birth are the size of a small calf, red and white in color, very active, with open eyes. The female suckles the young for a period of two months.

Lynx Canadensis, Geoffroy. Canada Lynx.

The season of heat occurs about 1st March, when coition takes place as in dogs. The young, one to three in number, are born in holes lined with grass and moss. At time of birth they are slightly larger than the common adult red squirrel, of a grey color, helpless, with closed eyes. They are suckled by the female for three months, the male assisting in rearing them.

Canis lupus occidentalis, Richardson. Wolf.

Coition dog-like. It takes place about the middle of March, and the young, one to five in number, are born about the middle of June, in holes or under rocks. The young, when born, are about the size of an Esquimaux or Newfoundland pup, grey in color, with closed eyes and helpless. They are suckled for two months after birth by the female, who is assisted by the male in rearing them.

Vulpes lagopus, L. White or Arctic Fox.

These animals pair about the 1st March, and the young are born about the end of June. From one to seven are produced at a litter in holes under rocks. At time of birth they are somewhat larger than a squirrel, light grey in color, helpless, with closed eyes. The female suckles the young for two months, and is assisted by the male in rearing them.

Gulo luscus (L.), Sabine. Wolverine.

The wolverine mates about the middle of March, coition being dog-like. The young, one to three in number, are born about the middle of June. At birth they are about the size of an Esquimaux pup, reddish brown in color, helpless, with closed eyes. They are born in holes and under rocks, and are suckled for two months. The male assists in rearing the young.

Mustela Americana, Turton. Marten.

Coition is dog-like. It occurs about the 1st March, and the young are born, about the end of April, in holes, in rotten trees, lined with grass and moss. From one to five are produced at a birth, when they are the size of a new-born kitten, brown and black in color, helpless, with closed eyes. The female suckles the young for a period of five weeks, and is unassisted by the male in rearing them. Sometimes the female gives birth in a burrow in the ground.

Putorius vison, Brisson. Mink.

Coition dog-like. It takes place towards the end of February, and the young, one to three in number, are born about 1st May. At time of birth they are the size of a small mouse, very black in color, helpless, with eyes closed. The female makes a nest in a hole lined with grass, and suckles the young for six weeks. The male does not assist in rearing the young.

Mephitis mephitica, Shaw. Skunk.

Coition is dog-like, and takes place about 1st October. The young, one to three in number, are born in holes about 1st May. At time of birth they are the size of a large mouse, light brown in color, helpless, and eyes closed. The female suckles them for six weeks. The male does not assist in rearing the young.

Lutra Canadensis, Turton. Otter.

Coition dog-like. It takes place towards the end of February, and the young, one to three in number, are born, about 1st May, in holes, lined with grass. When born they are the size of a small squirrel, very black in color, helpless, with closed eyes. The female suckles them for six weeks, and is unassisted by the male.

Ursus Americanus, Pallas. Black Bear.

The period of heat occurs at the 1st of June, when coition takes place as in dogs. The young, one to three in number, are born at the end of October, in holes under rocks, lined with brush,

grass and moss. At the time of birth the cubs are the size of a squirrel, black in color, quite helpless, with closed eyes. They are suckled for five months, the male assists in rearing the young.

Thalassarctos maritimus, Linn. White Bear.

Coition, which is dog-like, takes place about the middle of April, and the young, from one to three in number, are born in holes under rocks lined with brush, grass, and moss, towards the end of October. At time of birth they are the size of a large rat, white in color, helpless, and with closed eyes. They are suckled for five months, the male assisting in rearing them.

Fiber zibethicus, L. Muskrat.

This animal mates about the middle of May, coition being cat-like, and the young, from one to six in number, are born about the middle of June. At time of birth they are the size of a small mouse, light brown in color, helpless, with closed eyes. The nest is built in a house or lodge, made of sticks and mud, in shallow ponds or quiet streams, and is lined with grass and moss. The female suckles the young for three weeks, and is assisted by the male in rearing them. The muskrat breeds twice subsequent to the first birth during the summer.

Erethizon dorsatus, L. Canada Porcupine.

Coition, which is cat-like, takes place about 1st October, and the young one is born unsheltered at the end of April. When born it is the size of a small rat, black in color, active, with open eyes. The female suckles it for two weeks, and is unassisted by the male in rearing it.

Castor fiber, L. Beaver.

At the end of February coition, which is cat-like, takes place, and the young, from one to nine in number, are born about the 1st June, in a house lined with brush and grass. They are then the size of a rat, light brown in color, helpless, with closed eyes. The female suckles the young for six weeks, and is assisted by the male in rearing them.

Arctomys monax, L. Woodchuck, Wenusk.

Coition, which is cat-like, takes place about the middle of October, and the young, from one to ten in number are born about the 1st May. At time of birth they are the size of a large mouse, yellow-

brown in color, helpless, with eyes closed. The nest is in a hole lined with grass. The female suckles the young for six weeks, and is assisted in rearing them by the male.

Delphinapterus catadon, L. White Porpoise.

Coition takes place under water. The two animals, with a noise as if they were rubbing hard against each other, rise to the water until nearly the whole body is visible, then come in sudden contact, and fall asunder. The time of mating is about the middle of June, and the young, one to two in number, are born towards the end of July, when they are from two to four feet long, of a lead color, very active, with open eyes. The female suckles them for at least three months.

APPENDIX IV.

(1) Meteorological Observations on James Bay in 1887, by A. R. Cunningham, and on the east coast of Hudson Bay in 1888, By C. H. Macnutt.

The barometer used was a small aneroid, but the readings have been corrected for instrumental error, and are believed to be nearly exact.

The Temperature is stated in degrees Fahrenheit. The force of the wind is estimated according to a scale from 0 to 10.

The proportion of the sky covered by clouds is estimated by a scale of 0 to 10, 0 being a cloudless sky, 10 a completely clouded sky. The character of the clouds is denoted by the usual letters or combination of letters referring to Howard's classification.

PLACE.	Date.	Hour.	Barometer corrected.	Ther. corrected. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1887.			°	°							
Missinaibie Station	May 25	7.00 a.m.	28.46	....	....	42.	0.	0	2	K S.	Fair.	Fair.
" "	" 25	2.00 p.m.	28.40	....	....	....	S. W.	1	5	K S.	Dull, part cloudy.	Passing showers.
" "	" 25	9.00 p.m.	28.35	....	....	....	S. W.	2	8	S.	Passing showers.	Passing showers.
" "	" 26	7.00 a.m.	28.28	....	....	44.	S. W.	1	10	S.	Light rain.	Light rain.
" "	" 26	2.00 p.m.	28.32	....	....	....	S. W.	2	10	S.	Rain and gloomy.	Light rain.
" "	" 26	9.00 p.m.	28.45	....	....	....	S. W.	2	10	S.	Rain.	Rain.
" "	" 27	7.00 a.m.	28.69	....	....	46	N. W.	2	2	K C.	Fair.	Clearing.
" "	" 27	2.00 p.m.	28.70	....	....	....	N. W.	2	0	0.	Fair.	Very fair.
" "	" 27	9.00 p.m.	28.71	....	....	....	N. W.	1	0	0.	Very fair.	Very fair.
" "	" 28	7.00 a.m.	28.69	....	....	29.	N.	1	0	0.	Very Fair.	Very fair.
H. of L. Portage to Missinaibie River	" 28	2.00 p.m.	28.65	....	....	....	N.	2	4	K S.	Fair.	Very fair.
Portage to Missinaibie Lake	" 28	9.00 p.m.	28.62	....			N.	1	0	0.	Very fair.	Very fair. squally.
" " "	" 29	7.00 a.m.	28.59	....	....	40.	N.	1	0	0.	Very fair.	Very fair.
Missinaibie Lake	" 29	2.00 p.m.	28.58	....	....	....	S. E.	1	3	K S.	Fair.	Detached clouds.
" "	" 29	9.00 p.m.	28.54	....	....	....	0.	0	8	S.	Gloomy.	Detached clouds.
" "	" 30	7.00 a.m.	28.58	....	....	48.	N. E.	1	2	K C.	Fair.	Fair.
Keg Portage, Missinaibie River	" 30	2.00 p.m.	28.59	....	....	....	N.	2	10	S.	Thunder showers.	Thunder *from* 1 p.m.
Keg Portage " "	" 30	9.00 p.m.	28.63	....	....	....	E.	1	6	K S.	Banked clouds.	Cleared at 8 p m.
Head of Swamp " "	" 31	7.00 a.m.	28.75	....	....	47.	S.	1	9	S.	Gloomy.	Light showers during night.
Island Portage " "	" 31	2.00 p.m.	28.82	....	....	....	S.	1	10	S.	Heavy thunder storms.	Thunder showers.
Green Hill Portage " "	" 31	9.00 p.m.	28.93	....	....	....	0.	0	10	S.	Overcast.	Passing showers.
" " " "	June 1	7.00 a.m.	28.86	....	....	48.	E.	1	10	S.	Overcast.	Passing showers.
St. Peter	" 2	7.00 a.m.	28.86	....	....	....	N. E.	1	9	S.	Overcast.	Light showers at 4 a.m.

St. Paul, Missinaibie River	"	2	2.00 p.m.	28.82	....	....	....	N. E.	1	8	K S.	Cloudy, dull.	Overcast.
" "	"	2	9.00 p.m.	28 82	..	....	....	0.	0	7	K S.	Banked clouds.	Passing showers.
Two Portage,	"	3	7.00 a.m.	28.85	....	..	58.	N. E.	1	8	K S.	Gloomy.	Light showers at 4.30 a.m.
"	"	3	2.00 p.m.	28.82	....	....	....	0.	0	9	S.	Gloomy.	Passing showers.
Pond Portage,	"	3	9.00 p.m.	28.82	.	....	....	0.	0	0	0.	Fair.	Fair.
"	"	4	7.00 a.m.	28.89	...	....	45.	0.	0	1	K C.	Fair.	Fair with light passing showers.
Devil's Rapids,	"	4	2.00 p.m.	28.88	..	....	....	S. E.	2	6	K S.	Light showers.	Detached clouds.
Albany Rapids,	"	4	9.00 p.m.	28.88	....	....	....	0	0	5	K S.	Detached clouds.	Fair.
"	"	5	7.00 a.m.	29.28	....		47.	N. E.	2	4	K S.	Detached clouds.	Fair.
Beaver Portage,	"	5	2.00 p.m.	29.27	....	..	....	N. E.	1	0	0.	Very fair.	Very fair.
"	"	5	9.00 p.m.	29.24	..	....	....	0.	0	0	0.	Very fair.	Very fair.
"	"	6	7.00 a.m.	29.28	..	....	49.	N. W.	3	2	K C.	Very fair.	Very fair.
Sharp Rock Portage,	"	6	2.00 p.m.	29.16	....	..		S. W.	1	1	C.	Very fair.	Misty.
Sandy Bay Portage,	"	6	9.00 p.m.	29.06	....	....		0.	0	1	C.	Misty and smoke.	Smoke.
"	"	7	7.00 a.m	28.78		....	54.	S. W.	1	2	K C.	Smoky.	Smoke.
Crow Rapid,	"	7	2.00 p.m.	29.01		....	....	S. W.	3	9	K S.	Gloomy, showers.	Passing showers.
Black Feather Rapid,	"	7	9 00 p.m.	29.00	....	.	....	0	0	1	C.	Fair.	Passing showers.
"	"	8	7.00 a.m.	29.13	....	. .	57.	N. W.	3	10	S.	Drizzling rain.	Light rain during night.
Kettle Portage,	"	8	2 00 p.m	29.22	56.	....	....	N. W.	3	10	S.	Cold rain.	Cold rain all morning.
"	"	8	9.00 p.m.	29.25	47.	....	....	N. W.	1	10	S.	Cold showers.	Cold rain, with fog.
"	"	9	7.00 a.m.	29.30	58.	....	47.	N.	3	0	0.	Fair.	Fair.
"	"	9	2.00 p.m.	29.28	64.	.	....	N. W.	1	0	0.	Very fair.	Very fair.
"	"	9	9.00 p.m.	29.32	54.	....		0.	0	0	0.	Very fair.	Very fair.
"	"	10	7.00 a.m.	29.38	68.	..	36.	N. W.	1	0	0.	Very fair.	Very fair.
"	"	10	2.00 p.m.	29.32	73.	..	....	N. W.	2	0	0.	Very fair.	Very fair.
"	"	10	9.00 p.m.	29.30	59.	....	....	0.	0	0	0.	Very fair.	Very fair.
"	"	11	7.00 a.m.	29.32	63.	....	44.	S. E	2	0	0.	Very fair.	Very fair.
"	"	11	2 00 p.m.	29.28	80.	....	..	S. E	3	0	0.	Very fair.	Very fair.
"	"	11	9.00 p.m.	29.23	70.	....		S. E	1	10	S.	Overcast.	Light showers.
"	"	12	7.00 a.m.	29.12	63.	....	57.	S.	2	10	S.	Gloomy.	Overcast.
"	"	12	2.00 p.m.	29.14	72.	....	....	S.	2	3	K S.	Fair.	Light rains in morning.
"	"	12	9.00 p.m.	29.22	64.	..	..	0.	0	5	K S.	Passing showers.	Passing showers.
"	"	13	7.00 a.m.	29.44	52.	....	47.	N. E.	3	10	S.	Gloomy, overcast.	Cloudy.
"	"	13	2.00 p.m.	29.41	58.	....		0.	0	2	K.	Fair.	Fair.
"	"	13	9.00 p.m	29.46	47.	....	....	0.	0	0	0.	Very fair.	Very fair.
"	"	14	7.00 a.m.	29.34	60.	....	37.	0.	0	0	0.	Very fair.	Very fair.
"	"	14	2.00 p.m.	29.32	79.	....	..	S. W.	1	0	0.	Very fair.	Very fair.
"	"	14	9.00 p.m	29.22	68.	....	....	0.	0	5	K S.	Banked clouds.	Passing showers.
"	"	15	7.00 a.m.	29.13	67.	....	57.	S. W.	1	1	K.	Fair.	Fair.
"	"	15	2.00 p.m.	29.07	85.	....	....	S. W.	2	2	K.	Fair.	Thunder showers.
"	"	15	9.00 p.m.	28.97	63.	....		N. W.	2	10	S.	Overcast, gloomy.	Showers.
"	"	16	7.00 a.m.	29.15	52.	....	52.	N. E.	3	10	S.	Overcast.	Overcast.
"	"	16	2.00 p m	29 20	62.	....	..	N. W.	3	7	K S.	Detached clouds.	Clearing.
"	"	16	9 00 p.m.	29.27	63.	....	....	N W.	1	0	0.	Very fair.	Fair.
"	"	17	7.00 a.m.	29.24	50.	....	33	N. E.	2	8	K S.	Fair.	Fair.
Skunk Id., " "	"	17	2.00 p.m.	29.22	70.	....	..	N. W.	1	9	K S.	Overcast.	Banked clouds.
Rapids above C. H. Portage, Missinaibie River.....	"	17	9.00 p.m.	29.16	58.	....	....	N. W.	2	0	0.	Fair.	Fair.
Rapids above C. H. Portage, Missinaibie River.....	"	18	7.00 a.m.	29.12	48.	....	35.	S. E.	1	8	K S.	Detached clouds.	Fair.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1887.			°	°	°						
Riverside Portage, Missinaibie River	June 18	2.00 p.m.	29.05	72.	.....	.....	S. E.	1	4	K S.	Banked clouds.	Passing showers.
Conjuring Ho. Portage, Missinaibie River	" 18	9.00 p.m.	29.01	60.	.....	.....	0.	0	5	K S.	Banked clouds.	Passing showers.
" "	" 19	7.00 a.m.	29.02	48.	.....	44.	0.	0	10	S.	Overcast.	Passing showers.
" "	" 19	2.00 p.m.	29.02	68.	.....	.....	0.	0	10	S.	Rain.	Light rain.
" "	" 19	9.00 p.m.	29.07	58.	.....	.....	0.	0	10	S.	Overcast.	Light rain.
" "	" 20	7.00 a.m.	29.12	68.	.....	48.	S. E.	2	2	C.	Fair.	Light showers.
" "	" 20	2.00 p.m.	29.10	77.	.....	.....	S.	3	2	K.	Fair.	Fair.
Store Portage, "	" 20	9.00 p.m.	29.05	74.	.....	.....	S. W.	1	10	S.	Overcast.	Cloudy.
" "	" 21	7.00 a.m.	28.80	58.	.....	56.	S. W.	1	10	S.	Overcast.	Light rain.
" "	" 21	2.00 p.m.	28.76	80.	.....	.....	N. W.	2	8	K S.	Banked clouds.	Passing showers, heavy.
Long Portage, "	" 21	9.00 p.m.	28.83	62.	.....	.....	S. W.	1	8	K S.	Gloomy.	Gloomy.
" "	" 22	7.00 a.m.	28.84	51.	.....	50.	S. W.	3	10	S.	Gloomy.	Rain during night.
" "	" 22	2.00 p.m.	28.92	56.	.....	.....	N. E.	6	10	S.	Overcast.	Overcast.
" "	" 22	9.00 p.m	28.95	53.	.....	.....	0.	0	10	S.	Overcast.	Overcast.
" "	" 23	7.00 a.m.	28.95	53.	.....	42.	0.	0	10	S.	Overcast.	Shower early in a.m.
" "	" 23	2.00 p.m.	29.02	66.	.....	.....	0.	0	10	S.	Light rain.	Showers all morning.
" "	" 23	9.00 p.m.	29.10	55.	.....	.....	0.	0	10	S.	Light showers.	Showers.
" "	" 24	7.00 a.m.	29.42	50.	.....	45.	0.	0	10	S.	Gloomy.	Passing showers.
Popular River, "	" 24	2.00 p.m.	29.52	60.	.....	.....	N. E.	1	10	S.	Overcast.	Light rain.
" Bubbling Water," "	" 24	9.00 p.m.	29.64	55.	.....	.....	0.	0	10	S.	Light showers.	Overcast, with light showers.
" "	" 25	7.00 a.m	29.83	54	.....	50.	N. W.	1	10	K S.	Overcast.	Passing showers.
" "	" 25	2.00 p.m.	29.96	61.	.....	.....	N. E.	2	10	K S.	Overcast.	Overcast.
7 m. above Metogami River	" 25	9.00 p.m.	30.06	58.	.....	.....	0.	0	9	K S.	Clearing.	Overcast.
" " "	" 26	7.00 a.m.	30.22	58.	.....	54.	S. E.	2	10	K S.	Detached clouds.	Clearing.
Gypsum Rapid, Moose River	" 26	2.00 p.m.	30.18	69.	.....	.....	0.	0	1	C.	Fair.	Fair.
Forks of Abbittibi River	" 26	9.00 p.m.	30.12	57.	.....	.....	0.	0	3	K.	Fair.	Fair.
" "	" 27	7.00 a.m.	30.16	59.	.....	55.	S. E.	4	2	C.	Fair.	Fair.
Head of Tide, Moose River	" 27	2.00 p.m	30.49	88.	.....	.....	S.	6	1	K.	Fair.	Fair.
Moose Factory	" 27	9.00 p.m.	30.48	72.	.....	.....	S. E.	2	0	0	Very fair.	Very fair.
"	" 28	7.00 a.m.	30.47	61.	.....	59.	S.	1	2	K.	Fair.	Fair.
"	" 28	2.00 p.m	30.46	85.	.....	.....	N. W.	6	3	K.	Fair.	Fair.
"	" 28	9.00 p.m.	30.47	75.	.....	.....	N. W.	1	1	K.	Very fair.	Very fair.
"	" 29	7.00 a.m.	30.54	68.	.....	60.	0.	0	4	K C.	Fair.	Fair.
"	" 29	2.00 p.m.	30.49	93.	.....	.....	S. W.	3	5	K S.	Fair.	Fair.
"	" 29	9.00 p.m.	30.23	80.	.....	.....	S. E.	4	5	K S.	Fair.	Fair.
"	" 30	7.00 a.m.	30.25	66.	.....	58.	N. W.	7	5	K S.	Fair.	Fair.
"	" 30	2.00 p.m.	30.08	83.	.....	.....	N. W.	7	2	K S.	Very fair.	Very fair.
"	" 30	9.00 p.m.	29.98	70.	.....	.....	S. E.	5	8	K S	Passing showers.	Passing showers during night.

Moose Factory	July	1	7.00 a.m.	29.93	71.	....57.	S. E.	6	9	K S.	Thunder shower.	Thunder showers.
"	"	1	2.00 p.m.	29.80	80.	.....	N.W.	4	8	K S	Thunder clouds.	Thunder showers.
"	"	1	9.00 p.m.	29.94	70.	.....	N.W.	6	10	S.	Rain.	Thunder showers.
"	"	2	7.00 a.m.	30.04	62.	....56.	N.W.	3	10	K S.	Overcast.	Gloomy.
"	"	2	2.00 p.m.	30.18	67.	.....	N.W.	5	9	K S.	Overcast.	Overcast.
Mouth of Moose River	"	2	9.00 p.m.	30.28	62.	.....	N. E.	5	6	K S.	Detached clouds.	Detached clouds.
"	"	3	11.00 a.m.	30.39	61.	.....	E.	5	5	C.	Misty.	Overcast.
Hannah Bay	"	3	8.00 p.m.	31.21	59.	.....	E.	4	9	K S.	Overcast, gloomy.	Overcast, gloomy.
E. Coast of Hannah Bay	"	4	8.00 p.m.	30.09	65.	.....	S. E.	2	10	K S.	Overcast.	Gloomy, misty.
"	"	4	3.00 p.m.	30.12	74.	.....	N.	1	8	K S.	Gloomy, mist.	Overcast.
"	"	5	3.00 a.m.	30.15	60.	.....	N.	4	5	K S.	Fair.	Fair.
Charleton Islands	"	5	9.00 a.m.	30.10	62.	.....	E.	5	10	K S.	Overcast.	Overcast.
"	"	5	1.00 p.m.	30.07	63.	.....	E.	4	10	S.	Dull, gloomy.	Dull.
"	"	5	9.00 p.m.	30.00	60.	.....	S. E.	4	10	S.	Foggy.	Foggy.
"	"	6	7.00 a.m.	29.98	60.	....52.	S. E.	2	8	S.	Thick fog.	Thick fog.
"	"	6	2.00 p.m.	29.92	72.	.....	S.	1	10	S.	Overcast.	Thunder storm.
"	"	6	9.00 p.m.	29.92	62.	.....	N.	1	5	K S.	Fog,	Gloomy with fog.
"	"	7	7.00 a.m.	29.99	63.	....51.	S. E.	1	10	S.	Overcast, with fog	Fog.
"	"	7	2.00 p.m.	30.08	67.	.....	N.	7	1	C.	Very fair.	Fog clearing.
"	"	7	9.00 p.m.	30.12	51.	.....	N.	2	10	C S.	Gloomy, fog.	Fair, with fog in evening.
"	"	8	7.00 a.m.	30.18	41.	....40.	S. E.	4	10	S.	Misty.	Clear
"	"	8	2.00 p.m.	30.09	61.	.....	0.	4	1	S.	Very fair.	Very fair.
"	"	8	9.00 p.m.	29.96	56.	.....	0.	0	10	S.	Overcast, misty.	Overcast in evening.
"	"	9	7.00 a.m.	29.74	58.	....52.	E.	7	10	S.	Thunder showers.	High wind with thunder storm.
"	"	9	2.00 p.m.	29.67	58.	.....	N. E.	8	10	S.	{ Heavy gale, with rain.	Heavy gale with rain.
"	"	9	9.00 p.m.	29.71	55.	.....	N. E.	6	10	S.	{ Gloomy, thunder squall.	Heavy gale with thunder storm.
"	"	10	7.00 a.m.	29.87	52.	....47.	N.	4	2	C S.	Fair.	Clearing to fair.
"	"	10	2.00 p.m.	29.97	57.	.....	W.	6	0	0.	Very fair.	Very fair.
"	"	10	9.00 p.m.	30.01	53.	.....	N.	3	2	K.	Detached clouds.	Partly cloudy.
Strutton Islands	"	11	7.00 a.m.	30.06	57.	....41.	S. E.	4	6	K S.	Detached clouds.	Partly cloudy.
"	"	11	2.00 p.m.	30.04	58.	.....	N. W.	3	10	S.	Dull, gloomy.	Overcast.
"	"	11	9.00 p.m.	30.14	57.	.....	0.	0	10	K S.	Fog, gloomy.	Fog, overcast.
"	"	12	7.00 a.m.	30.14	63.	....42.	S. E.	1	9	S.	{ Fog and light showers.	Overcast.
Little Charleton Island	"	12	2.00 p.m.	30.11	65.	.....	N. W.	4	4	C S.	Fog.	Fog with showers in a.m.
"	"	12	9.00 p.m.	30.00	57.	.....	0.	4	4	K S.	Fair.	Thunder storm in p.m.
"	"	13	7.00 a.m.	29.94	58.	....52.	N.	0	2	0.	Very fair, gale.	Clearing, strong wind.
"	"	13	2.00 p.m.	30.21	59.	.....	N. W.	7	0	K S.	Very fair, gale.	Fair, moderate gale.
"	"	13	9.00 p.m.	30.26	51.	.....	0.	7	2	K S.	Misty.	Misty, thunder storm.
"	"	14	7.00 a.m.	30.38	56.	....38.	N. W.	0	5	S.	Fog and mist.	Fog and wind.
"	"	14	2.00 p.m.	30.42	66.	.....	N. E.	4	10	K S.	{ Fair, with thin fog.	Fog, clearing.
"	"	14	9.00 p.m.	30.37	53.	.....	0.	3	2	S.	Fair.	Fair.
"	"	15	7.00 a.m.	30.27	56.	.....	S. W.	0	1	K S.	Detached clouds.	Cloudy.
Solomon's Temple Island	"	15	2.00 p.m.	30.10	57.	....44.	S.	2	6	K S.	Fair.	Fair.
South Twin Island	"	15	9.00 p.m.	29.92	50.	.....	S. E.	5	4	K S.	Overcast with fog.	Cloudy, fog.
"	"	16	7.00 a.m.	30.04	51.	....48.	N.	8	10	S.	Gloomy, foggy.	Overcast and misty.
"	"	16	2.00 a.m.	30.19	57.	.....	N. E.	8	10	S.	Misty.	Misty, heavy gale.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1887.											
South Twin Island	July 16	9.00 p.m.	30.24	42.	....	....	N. E.	8	10	S.	Overcast with fog.	Overcast with fog, heavy gale.
"	" 17	7.00 a.m.	30.37	42.	..	37.	N.	6	10	S.	Overcast with fog.	Gloomy.
"	" 17	2.00 p.m.	30.34	56.	..	....	N. E.	5	4	K S.	Fair.	Clearing to fair.
"	" 17	9.00 p.m.	30.30	41.	....		N.W.	2	2	K S.	Fair.	Fair.
"	" 18	7.00 a.m.	30 30	40.	..	40.	S. W.	6	1	C.	Fair.	Fair,
"	" 18	2.00 p.m.	30.30	78.	....	....	S. W.	4	1	S.	Fair.	Fair.
North Twin Island	" 18	9.00 p.m.	30.18	50.	....	....	S. W.	5	7	K S.	Gloomy, overcast.	Fair.
"	" 19	7.00 a.m.	80.06	49.	....	42.	S. E.	1	9	K S.	Overcast.	Heavy thunder storm in a.m.
"	" 19	2.00 p.m.	30.04	53.	....	....	S. W.	5	10	S.	Foggy.	Rain and fog.
"	" 19	9.00 p.m.	29.97	57.	..	....	S. W.	4	10	S.	Very foggy.	Thick fog.
"	" 20	7.00 a.m.	30.10	52.	..	47.	S. W.	5	10	S.	Fair.	Clearing to fair.
"	" 20	2.00 p.m.	30.15	52.	....	....	N.W.	5	3	K S.	Fair.	Fair.
Spencer Island	" 20	9.00 p.m.	30.18	47.	..	....	N.	2	5	K S.	Fair.	Fair.
"	" 21	7.00 a.m.	36.11	48	....	38.	S.W.	3	5	K S.	Detached clouds.	Overcast.
Comb Hills, East Const	" 21	2.00 p.m.	30.08	58.	....		S.W.	5	8	K S.	Light rain.	Light rain.
Near Mouth of Big River	" 21	2.00 p.m.	30.04	53.	....	....	0.	0	10	S.	Overcast.	Overcast.
"	" 22	7 00 a.m.	29.88	50.	..	43.	N. E.	6	9	S.	Banked clouds with thunder.	Overcast.
Fort George	" 22	2.00 p.m.	29 73	73.	....	....	N. E.	4	7	K S.	Overcast.	Overcast.
"	" 22	9.00 p.m.	29 76	55.	....	....	N.	6	10	S.	Overcast.	Overcast.
"	" 23	7 00 a.m.	29 92	43.	..	40.	N.W.	6	10	S.	Fair.	Fair.
"	" 23	2.00 p.m.	29 97	56.	..	....	S.W.	5	8	S K.	Very fair.	Very fair, brilliant aurora.
"	" 23	9 00 p.m.	30.14	48.	....		N.W.	3	0	0.	Overcast.	Light rain early in a.m.
"	" 24	7.00 a.m.	30.24	39.	..	32.	W.	0	10	S.	Overcast.	Overcast with fog.
"	" 24	2 00 p.m	30.28	58.	....		N.W.	3	10	S.	Very fair.	Clearing to fair.
"	" 24	9.00 p.m.	30.34	47.	....		0.	0	1	K.	Gloomy, overcast.	Overcast and misty.
"	" 25	7.00 a.m.	30.42	45.	....	41	N.W.	5	10	S.	Fair.	Clearing to fair.
Stromness Harbor	" 25	2.00 p.m.	30.47	59.	....	....	W.	3	4	K S.	Very foggy.	Dense fog in p.m.
"	" 25	9.00 p.m.	30.44	48	....	....	N.W.	4	....	....	Fair.	Fair, cleared early in a.m.
"	" 26	7.00 a.m.	30.45	53.	....	40.	N. E.	2	6	K S.	Very fair.	Very fair.
Grey Goose Island	" 26	2.00 p.m.	30 40	55.			S. E.	3	2	K S.	Fair.	Fair.
"	" 26	9.00 a.m.	30 28	49.		....	S. E.	1	5	K S.	Very fair.	Very fair, fog during night.
"	" 27	7.00 a.m.	30.22	49.	....	....	S. E.	1	2	K S.	Very fair.	Very fair, strong wind.
Near Cape Jones	" 27	2.00 p.m.	30.18	66.	....	....	N.W.	7	2	K S.	Very fair.	Very fair.
"	" 27	9.00 p.m.	30.24	49.	..	....	N.W.	4	1	K S.	Dense fog.	Dense fog.
"	" 28	7.00 a.m.	30 28	45.	....	39.	S. W.	3	....	....	Fair.	Cleared early in a.m.
"	" 28	2.00 p.m.	30.27	50.	....	....	S. W.	4	5	C K.	Very fair.	Fair.
Cape Jones	" 28	9.00 p.m.	30.17	46.	....	....	W.	5	0	0.	Misty.	Misty.
"	" 29	7.00 a.m.	30.05	59.	....	40.	S. W.	5	6	K S.	Gloomy.	Light rain.
Bear Island	" 29	2.00 p.m.	30.03	54.	....	....	S. W.	6	9	K S.	Heavy rain.	Overcast.

Cape Jones	"	29	9.00 p.m.	29.98	54.		S.W.	6	10	S.	Heavy rain.	Rain and fog.
"	"	30	7.00 a.m.	29.57	57.	50.	N.W.	1			Overcast, moderate gale.	Heavy rain and fog.
"	"	30	2.00 p.m.	29.67	55.		N.W.	7	10	S.	Overcast, moderate gale.	Overcast, moderate gale.
"	"	30	9.00 p.m.	30.00	49.		N.W.	7	10	S.	Overcast.	Overcast, wind falling during p.m.
"	"	31	7.00 a.m.	30.08	49.	36.	S.W.	4	10	S.	Fair.	Clearing.
15 m. N. of Big River	"	31	2.00 p.m.	30.07	47.		S.W.	5	3	K S.	Passing showers.	Overcast.
"	"	31	9.00 p.m.	30.08	49.		W.	6	10	S.	Detached clouds.	Showers.
"	Aug.	1	7.00 a.m.	30.22	51.	36.	N.W.	5	9	K S.	Fair.	Fair.
Grey Goose Island	"	1	2.00 p.m.	30 31	53.		S.W.	4	2	K S.	Fair.	Fair.
Wasticoon	"	1	9.00 p.m.	30 32	46.		W.	1	2	C S.	Passing showers.	Passing showers.
"	"	2	7.00 a.m	30.36	44.	41.	S.	3	7	K S.	Fair.	Passing showers
Loon Point	"	2	2.00 p.m.	30.32	65.		S.W.	3	5	K S.	Banked clouds, thunder.	Fair.
Fort George	"	2	9.00 p.m.	30.18	49.		0.	0	5	K C.	Misty.	Fair.
"	"	5	7.00 a.m.	30.17	48.	41.	S.	6	4	K S.	Fair.	Fair.
Stromness Harbor	"	3	2.00 p.m.	30.13	62.		S.W.	7	5	K S.	Overcast.	Heavy rain during p.m.
"	"	3	9.00 p.m.	30.09	56.		W.	2	10	S.	Overcast, misty.	Overcast.
"	"	4	7.00 a.m.	30.08	59.	53.	E.	1	10	S.	Overcast, misty.	Overcast, misty.
James Bay	"	4	2.00 p.m.	30.01	80.		E.	1	10	S.	Foggy.	Foggy.
Spencer Island	"	4	9.00 p.m.	29.84	56.		S.W.	1	9	S.	Light fog.	Light fog, strong wind.
"	"	5	7.00 a.m.	29.68	60.	41.	W.	6	5	K S.	Overcast, gloomy.	Overcast, heavy gale.
North Twin	"	5	2.00 p.m.	29.77	61.		N.W.	8	9	S	Gloomy.	Overcast, heavy gale.
"	"	5	9.00 p.m.	29.82	51.		N.W.	8	9	S.	Gloomy.	Rain during night, moderate gale.
"	"	6	7.00 a.m.	29.97	53.	48.	N.W.	8	8	K S.	Fair.	Clearing, moderate gale.
"	"	6	2.00 p.m.	30.08	56.		N.W.	7	5	K S.	Fair.	Fair, strong breeze.
"	"	6	9.00 p.m.	30.16	48.		N.	5	2	K S.	Fair.	Fair, strong breeze.
"	"	7	7.00 a.m.	30.24	55.	33.	S.	5	3	K S.	Fair.	Fair, strong breeze.
"	"	7	2.00 p.m.	30.11	58.		S.	6	5	C K.	Overcast.	Overcast.
"	"	7	9.00 p.m	30.06	53.		S.W.	4	9	S.	Misty.	Misty.
"	"	8	7 00 a.m.	30.04	53.	49.	S.W.	1	8	S.	Overcast, gloomy.	Thunder squall in a.m.
Agoomski Island	"	8	2.00 p.m.	30.11	60.		S.	2	10	S.	Overcast. ugly.	Overcast, strong gale.
"	"	8	9.00 p.m.	29.80	62.		S.	8	10	S.	Fair.	Very strong gale during night.
"	"	9	7.00 a.m.	30.19	50.		N.W.	8	5	K S.	Fair.	Wind moderating.
"	"	9	2.00 p.m.	30.37	52.		N.W.	4	3	K S.	Overcast, gloomy.	Fair.
"	"	9	9.00 p.m.	30.39	50.		S.	1	9	S.	Overcast.	Overcast, gloomy.
"	"	10	7.00 a.m.	30.31	57.	41.	S.	6	8	K S.	Fair	Clearing.
"	"	10	2.00 p.m.	30.13	57.		S.	6	2	K S.	Fair.	Fair.
"	"	10	9 00 p.m.	29.93	52.		S.	4	5	K S.	Fair.	Fair.
"	"	11	7.00 a.m.	29.78	58.	51.	W	4	5	K S.	Overcast, gloomy.	Strong breeze, foggy.
"	"	11	2.00 p.m.	29 98	48.		N.W.	6	10	S.	Very fair.	Fair.
"	"	11	9.00 p.m	30.05	47		N.W.	5	3	K S.	Very fair.	Very fair.
"	"	12	7.00 a.m	30.26	57.	45.	N.W.	2	2	K S.	Very fair.	Very fair.
"	"	12	2.00 p.m.	30.18	62.		S. E.	5	3	K S.	Overcast.	Fair.
"	"	12	9.00 p.m.	39.11	57.		S.	2	9	S.	Very fair.	Light rain during night.
"	"	13	7.00 a.m.	30.16	58.		W.	3	1	K.	Very fair.	Very fair.
"	"	13	2.00 p.m.	30.14	60.		S.	5	3	K.	Very fair.	Very fair, brilliant aurora.
"	"	13	9.00 a.m.	30.14	61.		S.	4	2	K.	Fair.	Fair.
"	"	14	7.00 a.m.	30.16	54.		N.E.	5	4	C K.	Fair.	Fair.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1887.											
Cockspenny	Aug. 14	2.00 p.m.	30.22	57.	....	....	N. E.	5	2	K. S.	Fair.	Fair.
Inner Ship Hole	" 14	9.00 p.m	30.16	57.	....	....	S. E.	2	5	K. S.	Fair.	Light showers and fog
"	" 15	7.00 a.m.	30.10	62.	....	....	S. E.	2	6	S.	Thunder showers.	Rain and fog.
Moose Factory	" 15	2.00 p.m.	30.14	57.	....	....	N. E.	3	8	K. S.	Overcast.	Clearing.
"	" 15	9.00 p.m.	30.89	59.	....	....	N. E.	2	4	K. S.	Fair.	Fair.
"	" 16	7.00 a.m.	30.28	55.	....	36.	N.	1	5	K. S.	Fair.	Overcast.
"	" 16	2.00 p.m.	30.18	60.	....	....	N. E.	2	10	S.	Rain.	Rain during afternoon.
"	" 16	9.00 p.m.	30.00	57.	....	....	E.	4	10	S.	Overcast.	Clearing.
"	" 17	7.00 a.m.	29.86	49.	....	50.	S. W.	5	0		Very fair.	Fair.
"	" 17	2.00 p.m.	29.73	73.	....	....	W.	5	5	K. S.	Fair	Light rain.
"	" 17	9.00 p.m.	29.65	69.	....	....	W.	4	10	S.	Light rain.	Light rain.
"	" 18	7.00 a.m.	29.88	65.	....	52.	W.	5	5	K. S.	Fair.	Clearing.
"	" 18	2.00 p.m.	29.87	69.	....	....	N. W.	6	8	K. S.	Overcast.	Fair.
"	" 18	9.00 p.m.	29.88	60.	....	....	W.	6	2	K. S.	Fair	Rain during night.
"	" 19	7.00 a.m.	29.88	42.	....	41.	S. W.	6	10	S.	Overcast.	Overcast.
"	" 19	2.00 p.m.	29.95	50.	....	....	W.	6	10	S.	Overcast.	Overcast.
"	" 19	9.00 p.m.	30.10	46.	....	....	W.	5	10	S.	Overcast.	Overcast.
"	" 20	7.00 a.m.	30.07	51.	....	45.	W.	5	10	S.	Overcast.	Overcast.
"	" 20	2.00 p.m.	30.04	53.	....	....	N. W.	5	9	S.	Overcast.	Overcast.
"	" 20	9.00 p.m.	30.02	48.	....	....	W.	5	8	S.	Overcast.	Overcast.
"	" 21	7.00 a.m.	30.02	52.	....	45.	W.	4	10	S.	Passing showers.	Passing showers.
"	" 21	2.00 p.m.	30.06	62.	....	....	W.	4	10	S.	Passing showers.	Passing showers.
"	" 21	9.00 p.m.	30.08	48.	....	....	W.	5	8	S.	Shower.	Passing showers.
"	" 22	7.00 a.m.	30.21	51.	....	47.	N. W.	3	8	S.	Overcast.	Passing showers.
Head of Tide, Moose River	" 22	2.00 p.m.	30.22	54.	....	....	N. W.	2	9	S.	Passing showers.	Passing showers.
Abbitibi Forks	" 22	9.00 p.m.	30.22	52.	....	....	0.	0	9	S.	Overcast.	Overcast.
"	" 23	7.00 a.m.	30.20	50.	....	....	0.	0	9	S.	Overcast.	Overcast.
Gypsum Rapid	" 23	2.00 p.m.	30.18	52.	....	....	0.	0	9	S.	Gloomy.	Overcast.
Metogami Forks	" 23	9.00 p.m.	30.17	56.	....	....	N. E.	6	10	S.	Overcast.	Overcast.
"	" 24	7.00 a.m.	30.20	46.	....	45.	N. E.	5	10	S.	Overcast.	Overcast.
Missinaibie River	" 24	2.00 p.m.	30.14	58.	....	....	E.	3	9	K. S.	Overcast.	Clearing.
Halfway Rapid, Missinaibie Riv	" 24	9.00 p.m.	30.13	54.	....	....	0.	0	1	C.	Fair.	Overcast.
"	" 25	7.00 a.m.	30.14	42.	....	37.	N. W.	5	10	S.	Light rain.	Clearing.
Missinaibie River	" 25	2.00 p.m.	30.14	50.	....	....	N. E.	5	8	K. S.	Detached clouds.	Fair.
Rabbit River, Missinaibie River	" 25	9. p.m.	30.11	50.	....	....	0.	0	2	K.	Fair.	Fair.
"	" 26	7.00 a.m.	30.11	41.	....	35.	0.	0	0	C.	Very fair.	Fair.
"	" 26	2.00 p.m.	30.08	55.	....	....	W.	3	4	K. S.	Fair.	Fair.
Cedar Island	" 26	9.00 p.m.	30.02	60.	....	....	0.	0	7	K. S.	Fair.	Very fair.
"	" 27	7.00 a.m.	30.08	53.	....	32.	E.	0	0	K.	Very fair.	Very fair.
"	" 27	2.00 p.m	30.03	85.	....	....		3	1		Very fair.	Very fair.

Wakagami Rv., Missinaibie Rv	"	27	9.00 p.m.	29.98	64.	....	....	0.	0	0	0.	Very fair.	Very fair.
" "	"	28	7.00 a.m.	30.03	33.	....	33.	0	0	1	K.	Very fair.	Very fair.
Long Portage, "	"	28	2.00 p.m.	29.49	69.	....	....	S.W.	3	5	K S.	Fair.	Fair.
" "	"	28	9.00 p.m.	29.84	65.	....	....	E.	1	2	K S.	Fair.	Passing showers.
" "	"	29	7.00 a.m.	29.93	40.	....	40.	0.	0	0	0.	Very fair.	Very fair.
Conjuring Ho. Portage, "	"	29	2.00 p.m.	29.65	68.	....	....	S.W.	3	1	K.	Fair, light fog.	Very fair.
10 m. below Kettle Portage	"	29	9.00 p.m.	29 52	60.	....	....	0.	0	0	0.	Very fair.	Very fair.
" "	"	30	7.00 a.m.	29.54	37.	....	37.	S.W.	1	0	0.	Very fair.	Hazy.
Kettle Portage	"	30	2.00 p.m.	29.47	74.	....	....	S.W.	3	1	K.	Very fair, smoky.	Hazy.
Black Feather Rapid	"	30	9.00 p.m.	29.44	69.	....	....	S.E.	5	1	K	Misty, fair.	Hazy.
" "	"	31	7.00 a.m.	29.49	51.	....	51.	S.W.	2	1	K.	Haze, fair.	Hazy.
Rocky Island Portage	"	31	2.00 p.m.	....	77.	....	....	S.E.	5	7	C K.	Haze.	Hazy.
Sandy Bay Portage	"	31	9.00 p.m.	....	65.	....	....	S.E.	3	10	S.	Overcast.	Rain during afternoon.
Beaver Portage	Sept	1	7.00 a.m.	....	54.	....	....	0.	0	10	S.	Overcast, gloomy.	Overcast, misty.
Albany Rapid	"	1	2.00 p.m.	....	69.	....	....	N.W.	4	10	S.	Overcast, gloomy.	Overcast, misty.
Devil's Rapid	"	1	9.00 p.m.	....	64.	....	....	N.E.	4	10	S.	" light rain.	Light rain.
Pond Portage	"	2	7.00 a.m.	....	47.	....	46.	N.E.	3	10	S.	Overcast.	Light rain during night.
"Two" Portages	"	2	2.00 p.m.	....	....	....	....	N.W.	4	7	K S.	Light rain.	Rained all morning.
Round Island	"	2	9.00 p.m.	....	....	....	....	0.	0	5	K S.	Fair.	Clearing.
Brunswick Portage	"	3	7.00 a.m.	....	....	....	....	0.	0	0	0.	Very fair.	Fair.
St. Paul Portage	"	3	2.00 p.m.	....	....	....	....	S.W.	1	4	K.	Fair.	Very fair.
Greenhill Portage	"	3	9.00 p.m.	....	....	....	....	S.W.	3	6	K S.	Fair.	Fair.
"	"	4	7.00 a.m.	....	....	....	....	0.	0	4	K.	Fair.	Fair.
Burnt Portage	"	4	2.00 p.m.	....	....	....	....	S.W.	2	2	K S.	Very fair.	Fair.
Keg Portage	"	4	9.00 p.m.	....	....	....	....	S.E.	1	2	K S.	Very fair.	Fair.
Lake Missinaibie	"	5	7.00 a.m.	....	....	....	....	0.	0	10	S.	Overcast.	Light rain during night.
	1888.												
Lake Missinaibie	June	3	9 00 p.m.	29.33	...	....	....	S.	3	8	S.		
Lake Missinaibie	"	4	7.00 a.m	29.36	52.	...	48.	S.	5	3	K S.	{Blue Sky, passing cloud.	Squally with rain.
Keg Portage, Missinaibie River	"	4	9.00 p.m	28 62	62.	05.	..	S.	3	0	0.	Fair.	Squally with passing clouds.
" "	"	5	7.00 a.m.	28.56	54.	....	53.	S.	3	5	C.	Haze.	Cloudy.
Green Hill Portage, "	"	5	9.00 p.m.	28.70	50.	....	..	S.W.	3	10	S.	Cloudy, rain.	Partly cloudy with thunder storm.
" "	"	6	7.00 a.m.	28.80	35.	....	34.	N.W.	3	10	S.	Overcast.	Thunder storms.
Brunswick Portage, "	"	6	9 00 p.m	29.19	39.	47.	....	N.W.	1	0	0.	Clear and fair.	Rain during a.m., cleared at 1 p.m.
" "	"	7	7.00 a.m.	29.30	33.	...	30.	0.	0	0	0.	Clear and calm.	Showers during the night.
Devil Rapid, "	"	7	9.00 p m.	29.13	49.	108.	....	S.W.	1	0	0.	Clear.	Fine bright day, cloudy in p.m.
" "	"	8	7.00 a.m.	29.16	45.	....	31.	0.	0	10	S.	Overcast, gloomy.	Overcast.
Crow Rapid, "	"	8	9.00 p.m.	29.06	49.	...	....	0.	0	10	S.	Overcast.	Overcast with light rain.
" "	"	9	7.00 p.m.	28 94	46.	....	44.	0.	0	10	S.	Rain.	Heavy rain all night.
" "	"	9	9.00 p.m.	28 90	53.	....	....	0.	0	10	S.	Raining heavily.	Continuous heavy rain all day.
" "	"	10	7 00 a.m	28.80	40.	...	36.	0.	0	10	S.	Heavy rain.	Steady rain all night.
Black Feather Rapid, "	"	10	9.00 p.m.	28.96	41.	....	..	0.	0	0	0.	Clear sky.	Stopped raining at 2 p m.
" "	"	11	7.00 a.m	29.10	50.	...	33.	N.W.	2	1	K.	Passing clouds.	Fair.
Conjuring Ho. Portage, "	"	11	9.00 p.m	29.15	47.	....	..	0.	0	0	0.	Clear.	Fine clear day.
" "	"	12	7.00 a.m.	29.21	68.	....	37.	N.W.	2	0	0.	Blue sky.	Fair.
Long Portage, "	"	12	9.00 p.m.	29.23	57.	70.	....	0.	0	2	K S.	{Passing, detached clouds.	Partly overcast, squally.
" "	"	13	7.00 a.m.	29.22	60.	....	47.	W.	4	3	K S.	Detached clouds.	Detached clouds, fair.
Cedar Island, "	"	13	9.00 p.m.	29.23	65.	....	....	N.	4	5	K S.	Detached clouds.	Detached clouds, fair.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1888.											
Cedar Island, "	June 14	7.00 a.m.	29.36	67.	....	55.	N.	2	5	K C.	Hazy.	Detached clouds, fair.
Abittibi Forks, "	" 14	9.00 p.m.	29.50	56.	....	....	N.	6	10	S.	Squally with rain.	Squally and overcast.
" "	" 15	7.00 p.m.	29.54	60.	....	50.	N.	2	1	K C.	Fair with haze.	Fair.
Moose Factory.....	" 15	9.00 p.m.	29.66	49.	.....	....	N.	4	4	K S.	Threatening, part cloudy.	Fine day.
"	" 16	7.00 a.m.	29.74	52.	.....	....	N.	5	....	.....	.....	.....
"	" 16	9.00 p.m.	29.70	60.	.....	....	N.	5	....	.....	.....	.....
"	" 17	7.00 a.m.	29.80	50.	....	...	W.	6	5	K S.	Passing clouds.	Part fair, squally.
"	" 17	9.00 p.m.	30.02	51.	75.	....	N.	2	0	0.	Clear sky.	Very fair.
"	" 18	7.00 a.m.	30.12	66.	.....	....	0.	0	1	K C.	Fair.	Fair with detached clouds.
"	" 18	9.00 p.m.	29.94	70.	81.	....	S.	2	10	S.	Rain.	Overcast with light rain showers.
"	" 19	7.00 a.m.	29.93	70.	73.	....	N. E.	2	9	K S.	Nearly overcast.	Squally with rain.
Mouth of Moose River.....	" 19	9.00 p.m.	29.98	64.	.....	....	N. E.	3	8	K S.	Misty and overcast.	Fair, partly cloudy.
"	" 20	7.00 a.m.	29.97	57.	...	....	E.	4	7	K S.	Haze with threateningsky.	Haze and much cloud.
Between Moose River and Charleton Island	" 20	2.00 p.m.	29.93	59.	...	....	E.	2	3	K C.	Haze and smoke.	Haze but fair.
S.W. Point Charleton Island..	" 20	9.00 p.m.	29.84	60.	..	....	N. E.	2	8	K C S.	Smoke and part cloud.	Fair day with much smoke.
"	" 21	7.00 p.m.	29.76	62.	.....	....	N. E.	3	5	K C.	Fair.	Fair.
"	" 21	2.00 p.m.	29.67	77.	.....	....	N. E	1	8	K C.	Detached clouds.	Fair.
"	" 21	9.00 p.m.	29.58	69.	.....	....	N. E.	2	8	K S.	Haze with detached clouds.	Haze and smoke, fair day.
E. Point Charleton Island.....	" 22	7.00 a.m.	29.50	66.	...	...	S. W.	7	7	K C.	Squally and threatening.	Wind changed at 4 a.m.
Carey Island.....	" 22	2.00 p.m.	29.69	55.	...	....	N.W.	8	9	K S.	Squally with some fog.	Overcast with fog and squalls.
"	" 22	9 00 p.m.	29.74	43.	...	....	N.W.	6	8	K S.	Heavy gale with fog.	Overcast with haze and high wind.
"	" 23	7 00 a m.	29.95	45.	.....	....	N.W.	5	10	S.	Overcast and foggp.	High wind with heavy squalls.
E. Coast 10 m. S. of East Main Rv	" 23	2.00 p.m.	29.98	47.	.....	....	N.W.	5	10	S.	Overeast and foggy.	Overcast and foggy.
" "	" 23	9.00 p.m.	29.98	49.	..		N.W.	6	10	S.	Overcast and squally.	Overcast and squally, strong high wind.
" "	" 24	7 00 a.m.	29.98	67.	....	47.	N.W.	4	10	K S.	Overcast and foggy.	Fog and cloud, squalls and high wind.
" "	" 24	2.00 p.m.	29.94	55.	....	..	N.W.	7	10	K S.	Squally, overcast and gloomy.	Squalls with strong wind.

E. Coast 10 m. S. of East Main River	"	25	7.00 a.m.	29.88	53.	....	N.W.	5	10	S.	Murky.	Showers at intervals.
H. B. Post, East Main	"	25	2.00 p.m.	29.82	65.	....	N. E.	5	10	S.	Fog, gloomy, overcast.	Overcast with fog.
6 m. S. of Cape Hope Island	"	25	9.00 p.m.	29.84	50.	....	N.	3	10	S.	Fog, gloomy, overcast.	Gloomy with fog.
"	"	26	7.00 a.m.	29.93	44.	42.	N.W.	6	6	K S.	Haze with detached clouds.	Overcast to clear.
6 m. N. of Cape Hope	"	26	2.00 p.m.	29.99	62.	....	N.W.	8	1	K.	Fair with heavy gale.	Smoky and fair, strong wind.
"	"	26	9.00 a.m.	30.12	42.	....	N.	3	0	0.	Fair with haze.	Fair with haze and smoke.
"	"	27	7.00 a.m.	30.28	43.	36.	N.	1	1	C.	Fair with haze.	Fair with haze and smoke.
Paint Hills	"	27	2.00 p.m.	30 22	58.	....	N.W.	2	3	C.	Fair.	Very fair.
5 m. N. of Paint Hills	"	27	9.00 p.m.	30.25	53.	....	0.	0	8	K S.	Detached clouds.	Fair with smoke.
30 m. S. of Big River	"	28	7.00 a.m.	30.30	73.	31.	S. E.	1	4	C.	Haze with detached clouds.	Fairwith detached clouds.
25 m. "	"	28	2.00 p.m.	30.19	67.	....	S. W.	2	3	K S.	Fair with haze and smoke.	Hazy.
20 m. "	"	28	9.00 a.m.	30.13	63.	....	0	0	10	K S.	Overcast with fog.	Hazy.
20 m. "	"	29	7.00 a.m	30.01	60.	35.	S. E.	2	10	S.	Fog.	Overcast and foggy.
Fort George, Big River	"	29	2.00 p.m.	29.96	65.	....	S. W.	3	8	K S.	Misty and overcast.	Overcast and misty.
"	"	29	9.00 p.m.	29.54	60.	....	S. W.	4	10	S.	Squally with showers.	Squalls with drizzling rain.
"	"	30	7.00 a.m.	29.95	45.	33.	N.W.	3	10	S.	Squalls and fog.	Squalls with rain and fog.
"	"	30	2 00 p.m.	30.18	52.	....	N.W.	5	9	K S.	Detached clouds with fog.	Very foggy.
"	"	30	9.09 p.m.	30.26	45.	....	N.W.	4	0	0.	No cloud, thin fog.	Very foggy, brilliant aurora.
"	July	1	7.00 a.m.	30.31	67.	....	N.W.	3	7	K.	Detached clouds.	Detached clouds, foggy.
"	"	1	2.00 p.m.	30 24	70.	....	N.W.	3	8	K S.	Overcast.	Overcast.
"	"	1	9.00 p.m.	30.18	46.	....	0	0	10	S.	Overcastand hazy.	Partly overcast, heavy dew.
"	"	2	7.00 a.m.	30.03	65.	46.	S. E.	2	8	K S.	Misty and dull.	Overcast.
"	"	2	2 00 p.m.	29.94	66.	....	S. E.	2	10	S.	Foggy and dull.	Overcast with fog.
"	"	2	9.00 p.m.	29.80	61.	....	S E.	2	10	S.	Squally with fog.	Very squally with fog.
"	"	3	6.00 a.m.	29.53	62.	57.	S. E.	3	10	S.	Very squally with fog.	Rain and fog.
Big River	"	3	2.00 p.m.	29.52	73.	....	S. E.	4	6	K S.	Fair and squally.	Clearing.
1st Portage, Big River	"	3	9.00 p.m.	29.50	68.	....	0.	0	9	K S.	Fair.	Fair and squally.
"	"	4	7.00 a.m.	29.42	61.	55.	S.	2	10	S.	Raining.	Overcast with light rain.
6 m. above 1st Portage	"	4	2 00 p.m.	29.32	68.	....	S.	3	10	S.	Heavy rain.	Heavy rain all morning.
"	"	4	9.00 p.m.	29 28	42.	....	0.	0	10	S.	Heavy rain.	Heavy rain.
"	"	5	7.00 a.m.	29.50	47.	40.	N.W.	3	10	K S.	Overcast and misty.	Stopped raining at 5 a.m.
At Big Bend, Big River	"	5	2.00 p.m.	29.68	64.	....	N.W.	3	1	C.	Squally fair and haze.	Cleared at 9 a.m.
On 3 m. Portage	"	5	9.00 p m	29.67	68.	....	0.	0	0	0.	Fair.	Fair.
"	"	6	7.00 a.m.	29.67	45.	25.	0.	0	3	K C.	Fair.	Fair.
"	"	6	2.00 p.m.	29.43	74.	....	S.	3	2	K C.	Very fair.	Very fair.
"	"	6	9.00 p.m.	29.24	65.	....	0.	0	9	S.	Showers.	Overcast with showers.
"	"	7	7.00 p.m.	29.28	43.	43.	S. W.	2	10	S.	Dull and foggy.	Rain during night, foggy,

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Max.	Thermometer. Min.	Direction of wind.	Force of wind.	Amt. of wind.	Kind of cloud.	Weather at time.	Weather during last interval.
	1888.										
On 3rd Portage to Bishop Roggan River	July	7 2.00 p.m.	29.41	71.	.....	S. W.	2	9	K S.	Dull.	Overcast.
On 5th " "	"	7 9.00 p.m.	29.45	45.	.....	S. W.	3	5	K S.	Fair.	Fair.
On 5th " "	"	8 7.00 a.m.	29.45	34.	.... 31.	S. W.	1	0	.....	Very foggy.	Overcast and foggy.
Wawichotochis Lake	"	8 2.00 p.m.	29.38	70.	70.	S. W.	1	9	K S.	Misty and dull.	Fair.
On 7th Portage to B. R. River	"	8 9.00 p.m.	29 24	60.	.....	0.	0	10	S.	Heavy rain.	Overcast with heavy showers.
" "	"	9 7.00 a.m.	29.82	40.	... 31.	N.W.	3	.....		Very foggy.	Raining all night.
" "	"	9 2.00 p.m.	29.19	61.	63. ...	N.W.	5	5	K S.	Squally and misty.	Fair and misty.
On 9th Portage to B. R. River	"	9 9.00 p.m.	29.20	51.	.....	N.W.	1	4	K S.	Detached clouds	Detached clouds.
" "	"	10 7.00 a.m.	29 09	40.	. 32.	S. E.	2	10	S.	Overcast.	Light rain.
Awichinawigamaehe Lake	"	10 2.00 p.m.	28.66	50.	.....	S. E.	1	10	S.	Heavy rain.	Heavy rain.
" "	"	10 9.00 p.m.	28.68	41.	.....	S. E.	1	10	S.	Dull and foggy.	Dull and foggy.
" "	"	11 7.00 a.m.	28.63	41.	.... 37.	S. E.	1	10	S.	Heavy fog.	Dense fog
" "	"	11 2.00 p.m.	28.64	51.	51.	S. E.	1	10	S.	Dull and foggy.	Dense fog.
17th Portage to B. R. River	"	11 9.00 p.m.	28.72	50.	.....	0.	0	10	S.	Overcast.	Clearing.
"	"	12 7.00 a.m.	28.82	51.	.... 41.	N. E.	4	3	K S.	Fair.	Fair.
Piagochiwi Lake	"	12 2.00 p.m.	28.92	72.	81.	E.	6	4	K C.	Fair.	Fair.
Abpechotenachits Lake	"	12 9.00 p.m.	29.04	49.	.....	N.	3	0	0.	Very fair.	Very fair.
"	"	13 7.00 a.m.	29.10	47.	.... 39.	N.	3	3	K.	Fair.	Fair.
8th Fall Bishop Roggan River	"	13 2.00 p.m.	29.10	61.	*90s	N.	5	2	K.	Fair.	Fair.
Awahagats Lake	"	13 9.00 p.m.	29.12	44.	.....	N.W.	3	0	0.	{Very fair and clear.	Clear.
"	"	14 7.00 a.m.	29 18	47.	108s 30.	N.W.	2	2	K C.	Fair.	Fair.
Upper River	"	14 2.00 p.m.	29.14	69.	.....	N.W.	4	1	K S.	Fair.	Fair.
H. of L. Portage from B. R. Rv	"	14 9.00 p.m.	29.10	49.	.....	0.	0	1	S.	Fair.	Fair.
"	"	15 7.00 a.m.	29.16	46.	112s 35.	0.	0	1	C.	Clear.	Clear.
Apachichits River	"	15 2.00 p.m.	29.19	71.	.....	S. E.	2	0	0.	Very fair.	Very fair.
Kabunskwao Lake	"	15 9.00 p.m.	29.18	63.	.....	0.	0	3	K S.	{Very clear and fair.	Very fair.
"	"	16 7.00 a.m.	29.18	59.	123s 47.	S. E.	1	6	K S.	Detached clouds.	Fair.
Chatachiwan Lake	"	16 2.00 p.m.	29.18	78.	.....	S.	1	5	K S.	Detached clouds.	Passing showers.
10 ft. chute, Upper Big River	"	16 9.00 p.m.	29.12	57.	.....	0.	0	8	K S.	Overcast.	Passing showers with hail.
"	"	17 7.00 a.m.	29.05	62.	91s 56.	S. E.	1	10	S.	Overcast.	Overcast.
40 ft. " "	"	17 2.00 p.m.	29.08	69.	.. ....	S.	4	6	K S.	Misty.	Misty, passing showers.
At Big Bend, "	"	17 9.00 p m.	29.00	69.	.....	0.	0	5	S.	Misty.	Misty.
" "	"	18 7.00 a.m.	29.02	59.	74. 54.	S.	1	8	S.	Misty and smoky.	Smoke and mist, thunder storm.
Upper Big River	"	18 2.00 p.m.	28.93	68.	.....	S. E.	2	9	K S.	{Overcast and misty.	Smoke,

* Maximum in the sun marked thus (s).

Patitawagan River	"	18	9.00 p.m.	28.79	58.	....	0.	0	5	K	S.	Smoke.	Overcast and smoky.
"	"	19	7.00 a.m.	28.66	59.	49.	0.	0	8	K	S.	Thunder storm.	Overcast with passing thunder storms.
"	"	19	2.00 p.m.	28.61	73.	*94s	S.	1	8	K	S.	Thunder storm.	Passing showers.
H. of L. Portage to W. Branch of B. R. River	"	19	9.00 p.m.	28.64	59.	....	W.	1	10		S.	Heavy rain.	Heavy rain.
" "	"	20	7.00 p.m.	28.64	57.	55.	N.W.	1	10		S.	Heavy rain.	Heavy rain.
" "	"	20	2.00 p.m.	28.68	61.	....	N.W.	4	10		S.	Overcast.	Stopped raining at 11 a.m.
Niawatawigachi Lake	"	20	9.00 p.m.	28.74	57	....	0.	0	8		S.	Overcast.	Passing showers.
"	"	21	7.00 a.m.	28.78	59.	54.	N.E.	1	6	K	S.	Detached, banked clouds.	Passing showers.
Kabipikamow	"	21	2.00 p.m.	28.78	72.	75.	N.W.	2	8		S.	Overcast.	Passing thunder showers.
Kabipitawicow Lake	"	21	9.00 p.m.	28.74	60.	....	0.	0	3		S.	Squally.	Passing thunder showers.
"	"	22	7.00 p.m.	28.62	59.	56.	S.	2	6		S.	Passing showers.	Passing showers.
Masquachi Lake	"	22	2.00 p.m.	28.70	64.	81s	S.W.	4	6	K	S.	Detached clouds.	Passing showers.
"	"	22	9.00 p.m.	28.92	55.	....	W.	2	5	K	S.	Detached clouds.	Overcast, clearing.
Mishiminewaten Lake	"	23	7.00 a.m.	28.98	50.	49.	S.	1	10	K	S.	Overcast.	Partly overcast.
"	"	23	2.00 p.m.	28.93	64.	108s	N.W.	1	5	K	S.	Banked clouds.	Passing showers.
"	"	23	9.00 p.m.	28.94	50.	....	N.E.	1	6		S.	Raining.	Overcast with light rain.
Pospishagami Lake	"	24	7.00 a.m.	28.94	53.	45.	N.W.	2	5	K	S.	Banked clouds.	Passing showers.
"	"	24	2.00 p.m.	28.95	62.	88s	N.W.	2	7	K	S.	Passing shower.	Passing showers,
8 ft. Fall Upper Gt. Whale Rv	"	24	9.00 p.m.	29.10	49.	....	W.	1	10		S.	Overcast.	Overcast.
Canoe Route,	"	25	7.00 a.m.	29.12	47.	44.	W.	2	9	K	S.	Overcast.	Overcast.
20 ft. Fall,	"	25	2.00 p.m.	29.25	60.	82s	N.W.	3	7	K	S.	Detached clouds.	Detached clouds.
2 m. Portage,	"	25	9.00 p.m.	29.38	45.	....	0	0	10		S.	Overcast.	Overcast, with fog.
65 ft. Fall,	"	26	7.00 p.m.	29.44	33.	32.	0.	0	5		K.	Fair.	Foggy early in morning.
H. B. Post Gt. Whale River	"	26	2.00 p.m.	29.73	59.	63.	N.W.	3	8	K	S.	Detached clouds	Fair.
Manitounuck Sound	"	26	9.00 p.m.	29.84	45.	....	E.	1	0		0.	Fair,	Fair.
"	"	30	9.00 p.m.	29.73	53.	50.	N.E.	2	10		S.	Overcast.	Overcast with showers.
"	"	31	7.00 a.m.	29.19	54.	52.	S.W.	1	10		S.	Rain and fog.	Heavy rain with fog.
"	"	31	2.00 p.m.	29.43	49.	....	S.W.	3	10		S.	Rain and fog.	Heavy rain with fog.
"	"	31	9.00 p.m.	29.62	52.	....	S.W.	3	10		S.	Dull and foggy.	Stopped raining at 6 p.m.
H. B. Post, Lt. Whale River	Aug. 1		7.00 a.m.	29.62	52.	49.	S.W.	2	10		S.	Thick fog.	Foggy.
"	"	1	2.00 p.m.	29.66	54.	....	S.W.	8	10		S.	Fog and rain.	Fog with rain after 10 a.m.
"	"	1	9.00 p.m.	29.88	56.	....	S.W.	7	10		S.	Fog clearing.	Squally with fog.
"	"	2	7.00 a.m.	29.94	53.	50.	N.W.	4	10		S.	Fog and rain.	Showers and fog.
"	"	2	2.00 p.m.	30.08	61.	96s	N.	1	2	C	S.	Fair.	Fair.
"	"	2	9.00 p.m.	30.01	48.	....	S.E.	3	2	K	S.	Fair.	Fair.
"	"	3	7.00 a.m.	29.92	57.	46.	E.	7	8	K	S.	Fair and squally.	Very fair and squally.
Richmond Gulf	"	3	2.00 p.m.	29.75	65.	....	E.	7	10	K	S.	Fair with squalls.	Strong wind fair.
"	"	3	9.00 p.m.	29.76	55.	....	E	4	8	K	S.	Passing showers.	Squally with passing showers.
"	"	4	7.00 p.m.	30.00	48	....	N.W.	2	9	K	S.	Misty.	Fog and light rain.
"	"	4	2.00 p.m.	29.97	63.	....	N.W.	4	5	K	S.	Fog clearing.	Foggy.
"	"	4	9.00 p.m.	30.03	51.	....	N.W.	1	7	K	S.	Fair.	Fair.
"	"	5	7.00 p.m.	30.05	49.	42.	N.W.	1	4	K	S.	Fair	Fair.
Top of Portage past 315 ft. Fall	"	5	2.00 p.m.	29 69	....	....	N.E.	2	10		S.	Overcast.	Cloudy.
55 ft. Fall	"	5	9.00 p.m.	29.59	52.	....	0.	0	10		S.	Overcast.	Part cloudy.
"	"	6	7.00 a.m.	29 59	53.	41.	N.E.	1	10		S.	Fog.	Fog.

* Maximum in the sun marked thus (s).

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of cloud.	Kind of cloud.	Weather at time.	Weather during last interval.
	1888.											
Wiachtiwan River	Aug. 6	2.00 p.m.	29.52	64.			N. E.	2	10	S.	Misty and overcast.	Cloudy.
Portage from River Valley	" 6	9.00 p.m.	29.10	57.			N. E.	3	10	S.	Overcast.	Passing showers.
"	" 7	7.00 a.m.	28.84	61.		54.	S. W.	6	9	K S.	Passing showers.	Passing showers.
H. of L. Portage	" 7	2.00 p.m.	28.92	66.			S. W.	6	9	K S.	Overcast.	Passing showers.
Portage to large lake on 2nd tributary	" 7	9.00 p.m.	29.03	55.			S. W.	2	9	K S.	Overcast.	Passing showers.
"	" 8	7.00 a.m.	29.04	54.		44.	0.	0	9	S.	Overcast.	Overcast.
On Large Lake	" 8	2.00 p.m.	29.05	67.			S.	2	8	S.	Cloudy.	Overcast.
On Large Lake on Clearwater Branch	" 8	9.00 p.m.	28.88	58.			S.	1	10	S.	Overcast.	Passing showers.
" "	" 9	7.00 a.m.	28.63	58.		55.	S. E.	2	10	S.	Overcast.	Overcast.
" "	" 9	2.00 p.m.	28.33	68.			S.	2	7	K S.	Fair.	Passing showers.
" "	" 9	9.00 p.m.	28.53	44.			S. W.	3	10	S.	Squally, dull.	Heavy rain in afternoon.
" "	" 10	7.00 a.m.	28.59	40.		35.	S. W.	2	10	S.	Dull and squally.	Heavy squalls with rain.
" "	" 10	2.00 p.m.	28.69	42.			S. W.	4	10	S.	Rain.	Rain.
" "	" 10	9.00 p.m.	28.88	42.			S. W.	2	10	S.	Squalls, foggy.	Fog and squalls.
" "	" 11	7.00 a.m.	29.19	40.		34.	S. W.	6	10	S.	Fog and high wind.	Squally high wind with fog.
Portage to Clearwater River	" 11	2.00 p.m.	29.30	55			S. W.	6	8	K S.	Misty, strong wind.	Squalls, overcast.
Above Large Island, "	" 11	9.00 p.m.	29.42	40.			S. W.	2	9	K S.	Fair.	Fair,
" "	" 12	7.00 a.m.	28.46	45.		37.	S. W.	2	3	K C.	Fair.	Fair.
Natwacami Lake	" 12	2.00 p.m.	29.41	61.			S. W.	3	2	K C.	Fair.	Fair.
Portage between outlets	" 12	9.00 p.m.	29.32	42.			S. W.	1	2	K S.	Fair.	Fair.
"	" 13	7.00 a.m.	29.21	50.		40.	W.	3	9	S.	Partly overcast.	Partly overcast.
Clearwater Lake	" 13	2.00 p.m.	29.19	53.			W.	3	10	S.	Rain.	Heavy rain after 10 a.m.
Above Island, Clearwater River	" 13	9.00 p.m.	29.22	52.			W.	1	10	S.	Heavy rain.	Heavy rain.
" "	" 14	7.00 a.m.	29.12	47.		41.	N. E.	1	10	S.	Overcast.	Rain all night.
Large Lake on Clearwater Branch	" 14	2.00 p.m.	29.07	51.			E.	1	10	S.	Overcast.	Overcast with rain.
H. of L. between Clearwater	" 14	9.00 p.m.	29.05	48.			E.	1	10	S.	Heavy rain.	Steady rain all afternoon.
"	" 15	7.00 a.m.	29.05	47.		32.	W.	1	1	K C.	Foggy.	Rain in earlier part of night.
Portage to Wiachtiwan Valley	" 15	2.00 p.m.	28.99	57.			W.	1	9	K C.	Overcast.	Clearing.
"	" 15	9.00 p.m.	29.04	53.			S. E.	1	3	K S.	Fair.	Fair.
2 m. Portage to Gulf Lake	" 16	7.00 p.m.	29.04	50.		47.	S. E.	1	5	K S.	Fair.	Fair.
"	" 16	2.00 p.m.	29.12	67.			S. E.	6	3	K S.	Fair.	Fair with strong breeze.
Gulf Lake	" 16	9.00 p.m.	29.63	63.			E.	6	8	K S.	Squally, clouded.	Fair with stronge breeze.
"	" 17	7.00 a.m.	29.85	43.		41.	W.	6	9	K S.	Very squally.	Rain during night.
"	" 17	2.00 p.m.	29.89	53.			W.	2	8	K S.	Passing showers.	Squally.

Richmond Gulf	"	17	9.00 p.m.	29.82	47.		S.	3	3	K S.	Fair.	Fair, brilliant aurora.
Coast N. of Lt. Whale River	"	18	7.00 a.m.	29.70	45.		S.	5	7	S.	Very squally.	Very squally.
"	"	18	2.00 p.m.	29.62	50.		S.W.	4	10	S.	Squalls with rain.	Rain all morning.
Little Whale River	"	18	9.00 p.m.	29.63	43.		S.W.	3	10	S.	Overcast.	Squalls with rain.
"	"	19	7.00 a.m.	29.62	42.	37.	W.	4	10	S.	Overcast.	Squalls with rain.
"	"	19	2.00 p.m.	29.63	42		W.	4	10	S.	Overcast.	Overcast, strong wind.
"	"	19	9.00 p.m.	29.75	43.		N.	6	10	S.	Rain shower.	Overcast.
"	"	20	7.00 a.m.	29.85	39.	36.	N.W.	5	10	S.	Foggy.	Rain and fog.
"	"	20	2.00 p.m.	29.83	40.		W.	5	10	S.	Foggy.	Foggy.
"	"	20	9.00 p.m	30.03	39		S.	7	10	S.	Overcast.	Overcast and foggy.
"	"	21	7.00 a.m.	30.09	39.	38.	S.W.	2	10	S.	Overcast.	Overcast.
Little River	"	21	2.00 p.m	30.18	44.		S.W.	2	9	S & K S.	Fog.	Fog.
"	"	21	9.00 p.m.	30.23	45.		N.W.	1	9	K S.	Heavy fog.	Heavy fog.
"	"	22	7.00 p.m.	30.24	40.	35.	0.	0	...	.....	Very dense fog.	Very dense fog.
Manitounuck Sound	"	22	2.00 p.m.	30.19	47.		W.	1	.	.....	Very dense fog.	Very dense fog.
"	"	22	9.00 p.m.	30.04	42		N. E.	1	1	K S.	Fair.	Fog cleared during afternoon.
"	"	23	7.00 a.m.	29.87	48.	38.	S.W.	2	9	K S.	Overcast.	Squally.
"	"	23	2.00 p.m.	29.77	49.		S.W	3	10	S.	Passing shower.	Overcast.
"	"	23	9.00 p.m.	29.76			W.	3	10	S.	Dull and foggy.	Dull and foggy.
Mouth of Gt. Whale River	"	24	7.00 a.m.	29.69	39.	39	W.	6	10	S.	Rain with fog.	Rain with fog. Heavy gale all night.
"	"	24	2.00 p.m.	29.63	39.		W.	7	10	S.	Rain and fog.	Heavy gale.
"	"	24	9.00 p.m.	29.63	38.		W.	7	10	S.	Rain and fog.	Heavy gale.
"	"	25	7.00 a.m.	29.82	40.	38.	N.W.	1	10	S.	Overcast and fog.	Rain and fog, wind fell at midnight.
20 m. S. of Gt. Whale River	"	25	2.00 p.m.	29.94	42.		N.W.	1	9	S.	Overcast with fog	Overcast with fog.
Black Whale Harbour	"	25	9.00 p.m.	30.02	39.		N W.	1	10	S.	Very foggy.	Foggy.
"	"	26	7.00 a.m.	30.18	41.	38.	N. E.	1	...	.....	Dense fog.	Dense fog.
Long Island	"	26	2.00 p.m.	30.21	45.		N.	4	9	K S.	Dull and misty.	Fog clearing.
Cape Jones	"	26	9.00 p.m.	30.20	42.		N.	4	3	K S.	Fair.	Fair.
"	"	27	7.00 a.m.	30.45	39.	37.	N.	3	...	.....	Dense fog.	Dense fog.
Fort George	"	27	2.00 p.m.	30.42	45.		N.	4	2	K S.	Foggy.	Fog clearing.
"	"	27	9.00 p.m.	30.33	40.		N.	1	4	K S.	Fair with fog.	Fog clearing.
"	"	28	7.00 a.m.	30.25	39.	36-	S.	2	8	K S.	Detached clouds.	Fair.
"	"	28	2.00 p.m.	29.93	51.		S.	3	10	S;	Overcast and foggy.	Squally.
"	"	28	9.00 p.m.	29.82	51.		S.	2	10	S.	Dull and foggy.	Light rain with fog.
"	"	29	7.00 a.m.	29.82	48.	40.	N.W.	1	10	S.	Very foggy.	Light rain with dense fog.
Mouth of Big River	"	29	2.00 p.m.	29.89	42.		N.W.	4	10	S.	Fog.	Fog.
25 m. S. of Big River	"	29	9.00 p.m.	29.93	41.		N.W.	3	10	S.	Dull with fog.	Fog.
"	"	30	7.00 a.m.	29.84	43	39.	S.W.	4	10	S.	Dull and foggy.	Fog.
Comb Hills	"	30	2.00 p.m.	29.75	50.		S.	5	9	S,	Overcast and misty.	Overcast.
"	"	30	9.00 p.m.	29.73	42.		N.W.	3	10	S.	Overcast.	Overcast with light rain.
"	"	31	7.00 a.m.	29.96	40.	38.	N.W.	7	9	K S.	Overcast, gale.	Strong gale.
"	"	31	2.00 p.m.	30.08	40.		N.W.	7	7	K S.	Strong gale, fair.	Strong gale.
"	"	31	9.00 p.m.	30.18	36.		N.W.	4	3	K S.	Shower.	Passing showers.
"	Sept.	1	7.00 a.m.	30.01	41.	36.	S W.	8	9	K S.	Strong gale.	Strong gale, overcast.
"	"	1	2.00 p.m.	29.85	43.		S.W.	8	10	K S.	Strong gale.	Showers of sleet.
"	"	1	9.00 p.m.	29.74	45.		S.	4	10	S.	Overcast.	Showers of sleet.
"	"	2	7.00 a.m.	29.94	44.	41.	W.	8	10	S.	Strong gale.	Showers, strong gale.
"	"	2	2.00 p.m.	30.23	42.		W.	8	7	K S.	Strong gale.	Strong gale, foggy.

PLACE.	Date.	Hour.	Barometer corrected.	Thermometer. Air.	Max.	Min.	Direction of wind.	Force of wind.	Amt. of wind.	Kind of cloud.	Weather at time.	Weather during last interval.
	1888.											
Comb Hills	Sept. 2	9.00 p.m.	30.35	37.		...	W.	4	5	K S.	Fair.	Clearing.
"	" 3	7.00 a.m.	30.32	38.	..	35.	S.	3	10	S.	Overcast.	Light rain.
Paint Hills	" 3	2.0 p.m.	30.06	40.	..	..	S. E.	4	10	S.	Squally.	Squally, overcast.
5 m. S. of Paint Hills	" 3	9.00 p.m.	29 84	39.	....	....	S. E.	6	10	S.	Dull, overcast.	Showers.
"	" 4	7.00 a.m.	29.83	40.	....	39	N.	3	10	S.	Fog.	Fog.
Cape Hope	" 4	2.00 p.m.	30.05	42.	....	....	N.	6	10	S.	Dull and foggy.	Fog.
East Main River	" 4	9.90 p.m.	30.14	41.	..	....	N.	7	10	S.	Rain and fog.	Rain and fog.
"	" 5	7.00 a.m.	30.35	35.	..	32.	N.E.	2	10	S.	Snow flurries.	Fog with snow flurries.
Strutton Island	" 5	2.00 p.m.	30 47	37.	....	....	N.W.	4	3	K S.	Snow flurries.	Snow flurries, squally.
S.E. Point of Charleton	" 5	9.00 p.m	30.54	38.	....	..	S.W.	1	9	K S.	Overcast.	Fair.
"	" 6	7.00 a.m.	30.53	37.	....	34.	S.W.	2	4	K S.	Fair.	Fair.
Ministickewaten	" 6	2.00 p.m.	30.53	50.	....	....	S.W.	1	1	K C.	Very fair.	Fair.
"	" 6	9.00 p.m.	30.43	44.	....	....	S.W.	1	3	K S.	Fair.	Fair.
"	" 7	7.00 a.m.	30.20	50.	....	47.	S.W.	4	5	K S.	Fair, smoky.	Smoke.
10 m. N. of Moose River	" 7	2.00 p,m.	30.05	59.	....	....	S.W.	6	3	K C.	Smoke, fair.	Squally and smoky.
5 m. "	" 7	9.00 p m.	29.93	60.	....	....	S W.	7	1	K S.	Fair.	Squally.
5 m. "	" 8	7.00 a.m.	29.74	54.	....	54.	S.	2	8	K S.	Misty.	Misty.
Moose River	" 8	2 00 p.m.	29.65	57.	....	....	S.	2	8	K S.	Misty.	Showers.
Moose Factory	" 8	9.00 p.m.	29.46	58.	....	....	S.W.	3	10	S.	Rain and fog.	Heavy thunder storm in afternoon.
"	" 9	7.00 a.m.	29.61	53.	....	51.	S.W	4	10	S.	Rain and fog.	Rain and fog.
"	" 9	2.00 p.m.	29 69	56.	....	...	W.	4	10	S.	Dull.	Overcast.
"	" 9	9.00 p.m.	29.77	55.	....	....	W.	2	9	S.	Overcast.	Overcast.
"	" 10	7.00 a.m.	30.02	54		52.	W.	2	9	S.	Overcast.	Overcast.
"	" 10	2.00 p.m.	30 10	63.	....	....	W.	2	10	S.	Overcast.	Overcast.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

SECOND REPORT

ON THE GEOLOGY OF A PORTION

OF THE

PROVINCE OF QUEBEC.

BY

R. W. ELLS, LL.D., F.G.S.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
WILLIAM FOSTER BROWN & CO.
1888.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., etc.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I have the honour to transmit herewith my second report on the Geology and Mineral resources of the Eastern Townships. It embraces the work of the past two years, and is intended to accompany the north-east quarter-sheet map of a part of the province of Quebec, which is the continuation to the northward of that published in 1886. Many miles of coast line have been surveyed, both along the shores of the St. Lawrence and on the islands lying in the channel, and a great extent of country has been traversed along the roads, many new ones having been opened up since the compilation of the map by Mr. Barlow in 1868. These have been plotted and reduced by Mr. N. J. Giroux, C.E., P.L.S., who has ably assisted me throughout the entire work, and these additions to the map render it much more complete and accurate.

Our thanks are due to many persons, more especially to the owners and managers at the various mining centres, for much kindness and for courteous assistance in furnishing statistics and other valuable information. The area north of the St. Lawrence has only been cursorily examined by us, collections of fossils having been made at several points.

I have the honor to be,

Sir,

Your obedient servant,

R. W. ELLS.

SECOND REPORT

ON THE GEOLOGY OF A PORTION

OF THE

PROVINCE OF QUEBEC.

By R. W. ELLS, LL.D., F.G.S.A.

Area described.

The work of the past two seasons has been for the most part confined to that portion of the province lying to the south of the St. Lawrence River and embracing the counties of Megantic, Dorchester, Bellechasse, Levis, Montmagny, and l'Islet. In its economic aspect it includes the Chaudière gold-field, the asbestus deposits of Thetford and Broughton, and the iron and copper deposits of Leeds. A great part of the district, viz., that lying to the north-east of the Chaudière River, was examined by Mr. James Richardson in 1868. His report is the latest official publication in detail on that section of the country. In view, however, of the many new facts pertaining to the structure and the age of the several rock formations of the Eastern Townships which have been obtained since, the statements put forward in that report now require considerable modification.

Surveys.

Along the St. Lawrence, our examinations of the south shore extended from Pointe au Platon, about thirty-five miles above Levis, to River du Loup. Of this section a carefully paced compass survey was made as far east as Ste. Anne de la Pocatière, while on the north side our examination extended from the mouth of the Jacques Cartier River to Cape Tourmente. The group of islands which occupy the central portion of the river between Quebec to opposite St. Thomas were also surveyed from Orleans Island to Crane Island, both inclusive.

The extension northward of the several geological formations described in the preceding report* was carefully traced. The extension of the anticlinal there, and previously in 1863† and in 1867,§ described as that of Sutton Mountain was found to continue, with a nearly direct course, to the rear of l'Islet, where our examination ended in this direction; displaying for a considerable part of the distance the series of crystalline schists, chloritic, talcose, and micaceous, which characterize

* Geol. Surv. Rep. 1886. Part J.
† Geol. of Canada, 1863, p.p. 247, 251.
§ Rep. of Geol. Survey, 1867-68, p.p. 7A and 8A.

it to the south-west. It is concealed at several points, however, by the overlap on the west of the black slate and quartzite series, regarded as of Cambrian age; while on the east it is flanked for a great distance by the volcanic portion of what is now described as Lower Cambrian. These rocks extend continuously to the north-east and constitute, in part at least, the gold-bearing series of the Eastern Townships. In this series there occurs a very considerable development of volcanic rocks, diorites, serpentine, &c.; but the areas of the latter, north of the great masses of Thetford, are comparatively limited. All the known areas of serpentine were carefully examined with a view to the presence of asbestus in workable quantity, and small veins were seen in nearly every locality; but the conditions for successful mining appear much less favourable in the smaller and detached masses than they are in those at the great mining centres of this industry, viz., at Thetford and Coleraine.

Objections to the term "Quebec Group."

The name "Quebec Group," which has for so many years been applied to much of the rocks of this portion of the province of Quebec, has become so misleading and unintelligible in view of the many new facts brought to light concerning its composition and structure, by the study of the past fifteen years and the many changes rendered necessary in consequence, that its further use appears not only undesirable but to a certain extent objectionable. It was applied by Sir W. Logan to a great series of sediments which were deemed to lie somewhere about the horizon of the Calciferous and Chazy formations. Dr. Selwyn and others, have, however, since 1876, pointed out that it has been found to embrace rocks ranging from the Pre-Cambrian to the Hudson R. or Loraine, both inclusive. An almost entirely new arrangement of the different formations which make up the group is therefore imperative. In the case of such portions of the original group, the horizon of which has been definitely determined, the proper name of the formation can be readily applied, while in the case of such portions, either distinctly fossiliferous, or closely related areas the exact position of which in the Geological scale may be doubtful, the terms Levis or Sillery, with their system classification, may be retained.

Various reports on the area in question, extending over a period of sixty years, have appeared from time to time, among which may be more particularly mentioned the following:—

Reports bearing on the subject.

Dr. J. T. Bigsby, 1827, Geol. Soc, London, Vol. I., p. 27. On the Geology of Quebec and vicinity.
Capt. Bayfield, R. N., 1845. On the Transition rocks, Canada.
Sir W. E. Logan, 1843., Geol. Rep., pp. 18-19.
" " " 1844., Geol. Rep., pp. 19-33.
" " " 1845-46., Geol. Rep., pp. 101-114.

E. Emmons, M. D., 1847. Am. Mag., Geology of the Montmorenci.

Sir W. E. Logan, Geol. Rep., 1849-50. Geology of South side of the St. Lawrence, between the Chaudière River and Temiscouata Road.

" " " Geol. Rep., 1850-51. On the gold of the Chaudière Valley.

" " " Geol. Rep., 1852-53. On the geology of the North shore of the St. Lawrence between Montreal and Cape Tourmente.

Logan and Hunt, 1855. Esquisse Geologique.

James Hall, 1858. Communicated 1855. Can. Nat., Vol. III., Notes on the genus Graptolites, etc.; also Geol. Rep. 1857.

E. Billings, 1860. Can. Nat., Vol. V., p. 301. On some new species of fossils from the limestones of Pte. Levis, opposite Quebec.

Sir W. E. Logan, 1860. Can. Nat., Vol. V., 1860, p. 472. Remarks on the fauna of the Quebec group, and the Primordial Zone of Canada, addressed to J. Barrande.

T. S. Hunt, 1861. Can. Nat., Vol. VI., p 91-95. On some points in American Geology—the Quebec group paralleled with the Taconic system of Emmons.

Logan, Barrande and Hall, 1861. Can. Nat., Vol. VI., p. 106. On the Taconic system, and on the age of the fossils found in the rocks of Northern New England and in the Quebec group.

Sir W. E. Logan, 1861. Can. Nat., Vol. VI., p. 199. Considerations relating to the Quebec group and the Upper copper-bearing rocks of Lake Superior.

E. Billings, 1861. Can. Nat., Vol. VI., p. 310. On some of the rocks and fossils occurring near Phillipsburg, Canada East.

E. Billings, 1861. Can. Nat, Vol. VI., p. 344. On the occurrence of graptolites at the base of the Lower Silurian.

Dr. T. S. Hunt, 1861. Can. Nat., Vol VI., p. 374. Mr. Barrande on the Primordial Zone in North America, and on the Taconic system of Emmons.

Dr. T. S. Hunt, 1862. Can. Nat., Vol. VII., p. 78. Note on the Taconic system of Emmons.

James Hall, 1865. Sec. II., Can. Org. Remains. Graptolites of the Quebec group.

E. Billings, 1861-65. Pal. Fos., Vol. I., p. 57. On some new species of fossils from the Quebec group, where their probable position from fossil evidence is stated.

" " " Pal. Fos., Vol. 1., p. 185. New species of fossils from the limestones of the Quebec group from Pt. Levis and other localities in Canada East.

" " " Pal. Fos., Vol. 1., p. 207. New species of fossils from the Quebec group in the Northern part of Newfoundland.

Jules Marcou, 1862. On the Taconic rocks of Vermont and Canada.

E. Billings, 1863. Can. Nat., Vol. VIII., p. 19. On the Parallelism of the Quebec group with the Llandeilo of England and Australia, and with the Chazy and Calciferous formations.

Sir W. E. Logan, 1863. Can. Nat., Vol. VIII., p. 183. On the Rocks of the Quebec group at Point Levis, letter addressed to Mr. Barrande.

T. Devine, 1863. Can. Nat., Vol. VIII., pp. 95 and 210. Description of a new Trilobite from the Quebec group.

Sir W. E. Logan. Geol. of Can., 1863, p. 225. The Quebec group.
" " " " p. 884. Supplement.
" " Geol. of Can., 1866, p. 3-5. Divisions and characters of the Rocks of the Quebec group.
Prof. H. Y. Hind, 1865. On the distribution of the Quebec group in New Brunswick.
James Richardson, 1866. Geol. of Can., p. 30-33. On the Geology of the Quebec group in the Eastern Townships.
" " 1866-69. Geol. of Can. On the region South of the St. Lawrence, between the Chandière River and the Temiscouata Road.
Dr. T. S. Hunt, 1878. Sec. Geol. Sur. Penn., Part I. Azoic rocks.
Dr. A. R. C. Selwyn, 1877-78. Geol. of Can., p. 2a, 9a. Observations on the Stratigraphy of the Quebec group and the older Crystallines of Canada, also 1881 Can. Nat., Vol. IX, p. 17.
Thos. Macfarlane, 1881. Can. Nat., Vol. IX, p. 91. Canadian Stratigraphy.
Dr. A. R. C. Selwyn, 1880-81-82. Notes on the Geology of the Eastern portions of the Province of Quebec.
R. W. Ells, 1881-82. Report on the Geology of the Gaspé Peninsula.
Dr. T. S. Hunt, 1883. Trans. Roy. Soc. Can. The Taconic question in Geology.
Dr. A. R. C. Selwyn, 1882. Trans. Roy. Soc. Can. The Quebec group in Geology.
Mr. F. D. Adams, 1880-81-82. Notes on the Microscopic Structure of some rocks of the Quebec group.
Sir Wm. Dawson, 1883. Appendix to Harrington's Life of Sir W. E. Logan, the Quebec group.
Dr. Selwyn, 1883. Reply to Sir Wm. Dawson.
Prof. Jules Marcou, 1884-88. Various papers on the Taconic question. and on Canadian geological classification.

It will be readily seen from the above list that the bibliography pertaining to the several formations found in the area under consideration is very considerable. Many of the reports have long been out of print, and are now inaccessible to the great majority of readers. In order that the subject may be more intelligible, we have thought it advisable, therefore, to present a short summary of the various opinions held by the great number of scientific workers in this field, and expressed, from time to time, in the publications above enumerated. More particularly is this thought to be desirable, in view of the great difference in the opinions stated in regard to the structure of the area in the report of 1863, and in sundry papers since 1877 by Dr. Selwyn, and which have reference more especially to that peculiar series of rocks known as the "Quebec Group." This term was first introduced by the late Sir Wm. Logan in 1860, and applied to a series of rocks, first particularly studied near the City of Quebec, and especially developed on the South side of the St. Lawrence opposite that city, which presented so many difficulties as to the correct interpretation of its structure

and position, as to warrant the giving of a special name to the rocks which composed it. The investigations of this group, which had been begun some years before that date, had always presented problems very difficult of solution, owing to the fact that it was held to embrace a great variety of rocks differing very widely in character from those in the immediate vicinity of the St. Lawrence, and to include both the fossiliferous shales near that river and the great series of crystalline rocks of the interior, or the prolongation of the Green Mountain Range of Vermont, which enters Canada near Sutton Mountain, and extends with some interruptions to the extremity of the Gaspé Peninsula. These were regarded as the equivalents of the fossiliferous series near Quebec, their different aspect being supposed to be due to a profound metamorphism by which not only the contained fossils were completely effaced, but their entire physical character altered from the ordinary shales, sandstones and conglomerates of the original deposits to the most highly altered schists, quartzites, dioritic and gneissoid rocks. The upper part of the series was also held to embrace sediments, which contained fossils of Utica or possibly Hudson River age, so that the curious anomaly was presented of one single group name which comprised rocks ranging from what has now been determined to be as old as the Huronian to the upper part of the Cambro-Silurian. An abstract of the views referred to will be presented under the latter heading.

The several geological systems recognized in the area examined during the past season are:— Systems recognized.

F. Devonian.
E. Silurian.
D. Cambro-Silurian.
C. Cambrian.
A. B. Pre-Cambrian.
Crystalline and Igneous rocks, volcanic and plutonic.
Superficial deposits.

F. Devonian.

In describing the distribution of the Gaspé series (see Geol. of Can., 1863, p. 427-29) allusion is made to an out-crop of fossiliferous limestone, which is found on the north bank of the Chaudière River, about midway between the Famine River and the village of St. George. The fossils from this locality were examined by Mr. Billings, who pronounced their aspect to be Devonian rather than Silurian.

During the past season, the extent of this outlier and its relations to the associated slates of the locality have been carefully ascertained. It was found to have a breadth along the face of the hill of about twenty chains, and to rest unconformably upon the black and grey slates and greyish sandstones of St. George, the basin-shaped synclinal, with the beds curving along the face of the cliff, being readily seen when viewed from the opposite side of the river. The underlying slates at this point dip south-east at a high angle.

Extent of the Devonian areas.

No fossiliferous rocks of a similar horizon appear on the south side of the Chaudière in any direction, in so far as yet observed, the outcrops of Silurian slates at the narrows of Lake St. Francis, decribed in Part J, Vol. II, Geological Survey, 1886, being the nearest in point of age. To the north-east the limits of the St. George basin could not be clearly determined, owing to the covering of soil and forest, but it is apparently of no great extent in this direction, as no indications of such rocks are seen on the road which extends for twelve miles up the east side of the Famine River, the rest of the country in this direction being an almost unbroken wilderness.

Further to the north-east, on the road leading to Ste. Justine, between the townships of Langevin and Ware, a very limited exposure of similar fossiliferous limestone rests on the black slates and hard grey sandstones. This is on lot 32, range IX, Langevin, at the summit of the ridge, midway between the crossing of the brook at the head of the Famine River and the corner of the road to Ste. Justine church. The breadth of this outcrop is not more than twelve to sixteen feet, and it is about the same in length.

These are the only areas of rock which may be said to belong to the Devonian system that are known to occur anywhere throughout the whole of the country to the south of the St. Lawrence, which is included in the north-east quarter sheet of the Quebec map. The exposures just described resemble patches which have escaped denudation. From the fossils collected in 1886 by Mr. Ami from the Chaudière locality the following species have been recognized :

Polypi.

Fossils.

1. *Favosites Gothlandicus*, Lamarck	Dev. and Sil.
2. *Favosites*, sp. indt	
3. *Syringopora Hisingeri*, Billings	Dev. (Cornif.)
4. *Diphyphyllum*	"
5. *Cyathophyllum* (?) sp	"
6. *Heliophyllum*, sp. indt	"
7. Crinoid fragments	

Brachiopoda.

8.	*Orthis*, sp. indt	
9.	*Strophomena rhomboidalis* Wilckens	Sil. and Dev.
10.	11. *Strophodonto*, 2 sp.	Devonian.
12.	*Productus* (?)	"
13.	*Spirifera duodenaria*, Hall, var. or N. sp.	
14.	*Spirifera gregari*, Hall, " "	
15.	*Spirifera*, sp. indt	
16.	*Atrypa reticularis*, Linn.....Dev. Some resembling *A spera*, Schl.	
17.	*Leptocelia flabellites*, Conrad	Dev.

Lamellibranchiata.

18.	*Paracyclas*, sp.	Dev.
19.	*Pterinea textilis*, Hall, var	Dev. and Sil.

Trilobita.

20.	*Proetus crassimarginatus*? Hall	Dev.
21.	*Phacops*, sp. indt	Dev. and Sil.

From the collection determined by Mr. Billings, in addition to the forms above enumerated we have :

Favosites basaltica, Goldfuss	Dev. (Cornif.)
Diphyphyllum arundinaceum, Billings	" "
Zaphrentis, sp. indt	Dev. and Sil.
Helsophyllum Oneidaense, Billings	Devonian.
Orthis seriatula, Hall	Dev.(Cornif.)
Chonetes, 2 sp.	
Productus, small form	Devonian.
Spirifera acuminata, Hall	Dev. (Cornif.)
Cyrita, like *C. rostrata*	" "

E. SILURIAN.

Areas of Silurian.

No rocks which could definitely be pronounced of Silurian age were seen in the area embraced in this quarter-sheet map. The red shales mentioned in the Geol. Can., 1863, p. 205, the horizon of which was regarded as probably about that of the Medina from the fact that they overlie the Hudson River shales on the Becancour River and at other places, were carefully but unsuccessfully examined along that stream for fossils. The most northern area, that in the seigniories of St. Jean des Chaillons and St. Pierre des Becquets, shews, in some of the smaller streams, the same character of red shales. From the known unconformity of the red shales of the Becancour to the underlying Loraine shale, it is probably safe to assume that they

represent some portion of the Silurian system. Owing to the general lack of exposures, however, the extent of the areas so occupied must be largely conjectural.

D. Cambro-Silurian.

Former views.

Many of the remarks in Part J, Vol. II., Geological Survey of Canada, 1886, on the character and distribution of the rocks formerly supposed to belong to the Upper Silurian system, will apply equally to the area at present under consideration. On the map of 1869, which is the latest published by the Survey of a large part of this district, the area occupied by rocks of Silurian age included all that portion of the province lying between the state of Maine and a line drawn from near the north-west end of Lake St. Frances to the intersection of the Quebec boundary by the North-West Branch of the St. John River, in the township of Talon, crossing the Chaudière a short distance west of the village of St. Francis, Beauce. From the point mentioned in Talon, the northern limit of the Silurian was thought to extend in a tolerably direct course to the north-east, keeping along the international line to the northern part of Lake Temiscouata; the area being regarded as forming the prolongation in this direction of what was then held to be the great Silurian basin, lying to the east of the Sherbrooke and Stoke Mountain anticlinal.

The statements in Geol. of Can, 1863, p. 427–29, relative to the structure and age of the strata along the Chaudière River, in which the great series of slates, quartzites and felspathic rocks, now regarded as in part constituting the lowest portion of the Cambrian, are classed as of Silurian age, cannot now be accepted as correctly interpreting the geological structure of this area, since it has been ascertained that no clearly recognizable Silurian rocks exist in this area at all, while, in the portion of the province lying to the south, such areas are confined to limited and at times closely infolded basins.

Two principal areas.

The formations pertaining to this system, and found in the area south of the St. Lawrence, range from the Hudson River downward to the Cambrian. The area may be readily divided into two portions, an eastern and western, the former including all that series which extends between the central anticlinal presently to be described and the United States boundary, the latter that situated between that anticlinal and the St. Lawrence River.

Eastern area.

The former portion has been briefly alluded to in the preceding report, 1886,* and is the prolongation to the north-east of the great Cambro-Silurian area which lies between the Stoke Mountain range

* Geol. Sur. of Can., Vol. II, Part J, 1886.

and the Cambrian rocks of Lake Megantic and vicinity. In their northward extension these sediments present characters very similar to those already described for the southern area, consisting largely of dark-grey and blackish, sometimes plumbaginous slates with greyish sandstones, the former sometimes ochre-spotted and displaying, on weathered surfaces, the characteristic striped or banded aspect already referred to. Calcareous rocks are, as a rule, absent, though on the Upper Chaudière they are occasionally seen, and they have been reported by Mr. A. Webster, formerly of the staff of the Geological Survey, as occurring on the North-West Branch of the St. John River, a short distance below the Lac de la Frontière. The western limit of the principal area of these rocks on the Chaudière is supposed to be the valley of the Famine River, whence they are well exposed on the roads leading up the Chaudière and Du Loup streams, extending in this direction along the Kennebec road to the vicinity of lots 37-40, Kennebec Road Range, Linière. The western boundary, north of the Famine, presumably follows the course of that stream to a distance of several miles beyond the crossing of the road to Langevin, whence curving round, the Cambro-Silurian rocks widen out towards the head waters of the Etchemin River, the line between these and the Cambrian crossing the road from Mailloux to St. Magloire, about half a mile west of the latter place. The country in this direction is entirely unopened, except by the road to St. Magloire, through Roux and Mailloux, and that through Cranbourne and Ware to Ste. Justine or Langevin. Further north, no waggon-road exists south of the Taché road, but in the northern part of Roulette and Montmagny an old foot-path extends through the northern part of these townships, past the south end of Lac au Crapaud, in the direction of Lac à la Frontiere, on the N. W. Branch of the St. John. On this path, about the line between ranges VI and VII of Talon, blackish clay slates, presumably of this series and similar in character to those described further south, appear. This outcrop probably marks the western limit of the Cambro-Silurian area in this direction, as the dark grey graphitic limestone already referred to as occurring on the St. John waters, is found a few miles further to the north-east, associated with similar slates. The country lying east from Ste. Justine and St. Magloire, in the valley of the Daaquam River, is generally low and apparently unbroken by any prominent ridges which might indicate the presence of areas of the metamorphic Pre-Cambrian rocks. Hay swamps are numerous and the banks of the stream are frequently lined with alders for some distance inland. From the notes of Mr. A. Webster, who descended the Upper St. John from Little Lake St. John, at the head of the South-West Branch, which stream forms the boundary between Maine and

Upper waters of the St. John River.

Observations of Mr. A. Webster

Quebec for about twenty-five miles, we learn that much of the country in that direction is also low and that rock exposures are rare, much of the water in the river being sluggish. Where observed, the ledges consisted of greyish sandstone and clay-slate, which from their description resemble very closely the rocks described as occupying the great Cambro-Silurian basin of the south-eastern part of the province. The Upper St. John is navigable for canoes only when the water is high. On both occasions, when we visited the Upper Chaudière, the water in the St. John was so low that we could not examine that stream. The route followed by Mr. Webster, in 1880, was by a road from Jersey to the new settlement of St. Zacharie de Metgermette, by way of Lake Abenaquis, which is at the head of the Abenaquis stream, an eastern branch of the Famine River. The land about this lake is stated by him to be generally good, the rocks in places being arenaceous slates and grey sandstones similar to those seen abont St. George and Jersey on the Chaudière River. Boulders of green chloritic, epidotic and quartzose rock, which may have been derived from the ridges in the adjoining state of Maine, were observed. About Little Lake St. John, crops of oats, wheat and potatoes seen at the end of August were reported excellent, a similar soil, with clay slates underlying, being noted as at the settlement further west. It is very probable that in the valley of the Upper St. John, as well as in that of its main branch, the Daaquam, on the west, the rocks and the soil are similar. East of St. Magloire, the rocks seen were fine cleaved clay slates, having a north-west dip. On the North-West Branch of the St. John, between Lac à la Frontière and the main river, hard, altered greenish-grey sandstones were observed, with bands of greenish-grey clay slates, all dipping S. E. $< 75°$–$80°$; and containing, a short distance below the lake, interstratified beds of argillaceous, bluish-black limestone much cracked and traversed by seams of calcspar. The specimens of limestone from this locality resemble very closely the Cambro-Silurian limestone of Cookshire and Eaton, in which microscopic fossils were found, and which have been described in the last Report.*

Central area.

Another area of somewhat similar rocks, separated from those just described by a ridge of Cambrian, is formed by the prolongation to the north-east of the St. Francis area, which, extending from the upper part of Lake St. Francis, through Lambton and Tring, reaches the Chaudière in a gradually narrowing band about midway between St. Francis and St. George. The rocks in this area consist for the most part of bluish-grey and blackish slates, at times ochre-spotted, with grey sandstones, presenting at times the characteristic banded

* Geol. Survey, 1886, Vol. II, Part J.

aspect on smoothed surfaces noted in the central basin to the south-east. What has been regarded as a narrow band of these rocks crosses the Chaudière and extends up the west side of the Gilbert River for a short distance, though its northern limit cannot be definitely ascertained, owing to the inaccessible wilderness character of the country in this direction. As a rule, these rocks are not so highly felspathic or quartzose as those of the underlying Cambrian system, although in places they carry quartz veins. An apparent unconformity between the rocks of this series and the harder quartzites which underlie them is seen at the south end of the lake in lot 3, range III, of Tring, the bluish slates dipping S. 35° W. $<$ 30°, while the underlying quartzite dips S. 20° E. $<$ 20°. Full descriptions of the rocks of this series have been already given in the Annual Report, 1886, Part J, and need not here be repeated. South of the Chaudière their structure is apparently that of a basin bounded on either side by well defined ridges or areas of Cambrian sediments, one of which is seen to cross that river just below the mouth of the Famine, while the other is well developed about the village of St. Francis, Beauce, and for several miles to the south-east. Its extension west of that village will presently be described. Certain areas of red and green slates and grey sandstones, which cross the Chaudière near the Colway River and extend to the north-east into Cranbourne, present features very similar to those found in the Sillery rocks of Quebec, and may indicate a synclinal of these sediments in this direction.

St. Lawrence area.

The second area of the Cambro-Silurian rocks above referred to as that in the vicinity of the St. Lawrence presents at several places many features differing from those in the area just described, and the formations are, forthe most part at least, presumably of a later age, as indicated by the abundance of fossils found at many points.

St. Nicholas, fault.

On the south side of the St. Lawrence, two miles above the wharf at St. Nicholas, which is about twelve miles above Lévis, the contact between the grey, sandy shales and sandstones of the Loraine and the red, green and black shales of the Sillery formation is well seen both on the beach and in the cliff. The beds along the line of fault for several yards are much crushed, but the general dip of the two series is S. $<$65°-90°. From the Loraine shales a small collection of fossils sufficient to show their horizon was obtained. These have been examined by Mr. H. M. Ami, who has recognized the following species :—

Fossils.

Columns of *Glyptocrinus*, prob. *G. decadactylus.*
1. *Arthrograptus quadrimucronatus.*
2. *Diplograptus*, sp. nov, (*D. Latior.*)

3. *Leptæna sericea*, Sowerby.
4. *Orthis testudinaria*, Dalman.
5. *Zygospira Headi*, Billings.
6. *Ambonychia radiata*, Hall.
7. *Orthodesma parallelum*, Hall.
8. *Modiolopsis*, sp. indt.
9. *Trinucleus*, sp., large form.

Utica-Trenton outcrop.

The rocks of this horizon occupy the shore continuously for nearly three miles and a half, the high dip, S. 10° E. < 50°-60°, being maintained. The strike of the strata being almost along the shore, no great thickness of beds is exposed. At the end of this distance a sharp overturn fold occurs in the grey beds, followed by a line of fault which brings up a series of highly bituminous black and brown limestones and dark shales, with hard, blackish or greenish cherty beds like those seen at the Marsouin, the dip of which is S. 15°-30° E. < 55°-80°. These contain fossils, among which were observed :—

1. *Dicranograptus ramosus*, Hall.
2. *Climacograptus bicornis*, Hall.
3. *Dicellograptus sextans*, Hall.
4. *? Corynoides calycularis*, Nicholson.
5. *Leptoboloid* shell. Too imperfect for specific and generic reference.

St. Antoine and Ste. Croix.

The peculiar bands of cherty and shaly rocks from which these fossils were obtained extend along the shore in the direction of St. Antoine de Tilly for nearly a mile and a half, and at their most southerly outcrop are underlaid by the usual grey shales and sandstones of the Loraine formation, there being probably a line of fault at this place. Above this the latter are well exposed in the cliffs and on the river flats at low tide, where they can be seen to run in straight lines obliquely across the river towards the north shore for nearly a mile in some places. The strike of the several beds to the vicinity of the St. Antoine wharf is quite uniformly to the S. W. < 50°–70°, though several well defined anticlinals are seen in this distance, but above the wharf, the angle of the dip begins rapidly to decline to 30°, whence the beds become more horizontal, till at St. Croix wharf the inclination is not more than 6°-8°, the direction of the dip being south and the river flowing past the basset edges of the strata. For several miles north of St. Croix wharf the flaggy sandstones are thickly covered with fossils, from which the following forms were obtained :—

1. *Discina*, sp.
2. *Leptæna sericea*, Sowerby.
3. *Strophomena alternata*, Conrad.
4. *Orthis testudinaria*, Dalman.
5. *Orthis emacerata*, Hall.
6. *Zygospira Headi*, Billings.
7. *Anazyga recurvirostra*, Hall.
8. *Bellerophon bilobatus*, Sowerby.
9. *Murchisonia gracilis*, Hall.
10. *Ambonychia radiata*, Hall.
11. *Orthodesma parallelum*, Conrad.
12. *Lyrodesma*, sp.
13. *Trinucleus*, sp. nov.
14. *Calymene senaria*, Conrad.
15. *Dalmanites* or *Encrinurus*, sp.

Above Ste. Croix, towards Pointe au Platon, the shores of Ste. Croix Bay are generally low and boulder-strewn, and but few ledges are seen. The more westerly trend of the shore as we ascend the river traverses the lower beds of the Loraine or Hudson River formation till near the extremity of the point, which forms the sharp angle of the river below and opposite Port Neuf, where the upper beds of the Utica formation proper appear. Pointe au Platon. These are highly bituminous, brownish-grey shales, with bands of hard dolomitic limestone, containing graptolites, and in character are like the rocks seen on the north side of the gorge below the Montmorency Falls. Only one fossil form was obtained from this point, viz., *Orthograptus quadrimucronatus*, Hall. These beds are very nearly flat or dip to the S. W. $< 2°$. They continue along the shore above the wharf for a mile, above which our measurements did not extend, as the next course of the river traverses the Loraine shales again, repeating the section seen at Ste. Croix. Pointe au Platon, therefore, and the cliffs in the immediate vicinity represent the only typical Utica rocks seen on the south side of the river in this direction. From the fault above St. Nicholas the line of contact there described between the Loraine and Sillery formations extends apparently in a direct line, as indicated on the geological map, 1866, to the Becancour River, where it is seen about fourteen miles above the mouth. Fault. Becancour River. On this river the rocks of the newer series are grey sandstones and shales, like those about Ste. Croix, and contain an abundance of fossils of like species, among which were found a *Diplograptus*, resembling *D. Hudsonicus*, a *Crania*, and a *Lingula*, *Orthis testudinaria*, *Zygospira Headi*, *Ambonychia radiata*, and a *Trinucleus* like that from Ste. Croix, besides a branching and frondose species of monticuliporoid coral.

These rocks are in contact by a fault, with the red, green and black shales and hard sandstones of the Sillery formation, which extend thence up the Becancour to the line of the Grand Trunk Railway at Lyster.

Jacques Cartier River to Pointe-aux-Trembles.

The country bordering the St. Lawrence on the north side from Portneuf, which is opposite Pointe au Platon, to Quebec is well described in the Geology of Canada, 1863. The paced section of the shore during the past season, from the mouth of the Jacques Cartier River eastward, passes over brownish and blackish bituminous shales, holding graptolites, with *Leptobolus insignis*, as far down as a point seventy-five chains west of the wharf at Pointe aux Trembles, where these sediments are immediately underlaid by grey nodular limestones of Trenton age. Throughout this distance the Utica beds are nearly horizontal or range in dip from 2° to 8°, but show several low anticlinals on either side of Ecureuil Point, with several local twistings of the strata. The Trenton beds of Pointe aux Trembles are also thrown into a series of low undulations, the dips ranging from 10° to 20°, but near the northern exposure these become more abrupt, reaching angles of 40°. The contact between the Trenton and the Utica to the east of Pointe aux Trembles is sixty-four chains from the wharf, and is well seen for several hundred yards along the beach, the direction being at this place almost with the course of the shore. The whole exposed breadth of the Trenton anticlinal of Pointe aux Trembles is therefore only 140 chains. The beds at this place are simply a mass of fossils, many of which are beautifully preserved. A few forms only were picked up in our traverse among which were:—

Trenton fossils from Pointe-aux-Trembles.

1. *Heterocrinus simplex*, Hall, var. *Canadensis*, Billings.
2. *Monticuliporoid corals*, several sp.
3. *Leptæna sericea*, Sowerby.
4. *Strophomena deltoidea*, Conrad.
5. *Strophomena alternata*, Conrad.
6. *Orthis testudinaria*, Dalman.
7. *Dalmanites callicephalus* (?), Green.
8. *Calymene senaria*, Conrad (= *C. Blumenbachii*, Brongn.).
9. *Asaphus platycephalus*, Stokes (large sp.).
10. *Ceraurus pleurexanthemus*, Green.

Pointe-aux-Trembles to Cape Rouge.

Below this, to near the contact above Cap Rouge, the shore is generally low and marshy, with great mud flats, strewn with Laurentian boulders, and with points every few hundred yards composed of the same. Occasional ledges of brown and black shales of Utica aspect are seen, which, at about two miles and a quarter above the Cape Rouge contact, shade upward into greyish shales, with beds of greyish sand-

stone of the usual Loraine aspect. These dip south-easterly $< 40°$-$50°$, and one mile above the contact, hard, cherty shales are seen, with beds of conglomerate, from the pebbles of which *Orthis testudinaria* and *Leptæna sericea* were collected. Near the contact the beds are black and greyish shales and grey sandstones, which along the line of fault, as above St. Nicholas, are much crushed. The line of fault at this place is beautifully seen on the beach at low tide.

Fault above Cape Rouge.

The rocks on the north side of the St. Lawrence, extending between Ancient Lorette and Cape Tourmente, were more particularly studied by Messrs. Giroux and Ami, who made careful collections of fossils at various points. Among these were Lorette, Charlesbourg, Templeman's Quarry, Montmorency Falls, Ste. Anne de Beaupré and St. Joachim. The distribution of the Trenton, Utica and Loraine formations, as given in the Geology of Canada, 1863, was found to be generally correct.

North side St. Lawrence River below Quebec.

At Ancient Lorette the Laurentian gneiss occupies the bed of the St. Charles River, below the bridge at the gorge, which is reached by a flight of steps from the west bank. The gneiss is here overlaid directly by the Trenton formation, the lower beds of which for several feet are made up of recemented *débris* from the underlying gneiss, and these gradually pass upward into the highly fossiliferous, dark-grey, bituminous limestone. These rocks dip south-easterly $< 10°$. To the east of the village the gneiss also shows along the north side of the road leading to Charlesbourg for a mile or more. The Trenton horizon of the Lorette limestone is well seen from the following list of fossils collected in a short time from the beds at the foot of the fall, and which have a Black River facies in their lowest portion :—

Ancient Lorette

Trenton rocks on Laurentian gneiss.

Fossils from Lorette.

1. *Prasopora lycoperdon*, Vanuxem (*P. Selwyni*, Nich.).
2. *? Batostoma Ottawaense*, Foord.
3. *Pachydictya acuta*, Hall.
4. Several other branching *Polyzoa*, indt.
5. *Discina Pelopea*, Billings.
6. *Lingula Philomela*, Billings.
7. *Leptæna sericea*, Sowerby.
8. *Strophomena alternata*, Conrad.
9. *Orthis testudinaria*, Dalman.
10. *Orthis*, sp. nov.?
11. *Skenidium ?*. sp.
12. *? Zygospira* or N. G.; This form occurs at Montmorency, both above and below the falls, and at Beauport, Charlesbourg, etc.
13. *Atrypa hemispherica*, Hall.
14. " " var. or n. sp., without plications along the

anterior margin, but marked by a few prominent concentric lines of growth.

15. *Bucania punctifrons*, Emmons.
16. *Bellerophon bilobatus*, Sowerby.
17. *Conularia Trentonensis*, Hall.
18. *Theca*, n. sp. This species occurs in the Black River limestone of St. Joseph Island, Lake Huron, and elsewhere.
19. *? Ctenodonta dubia*, Billings.
20. *? Pterinea Trentonensis*, Emmons.
21. *Ambonychia*, sp., with numerous fine flexuous lines radiating from the umbonal region to the anterior margin, where they are most prominent.
22. *Lituites undatus*, Emmons.
23. *Endoceras proteiforme*, Hall.
24. *Primitia Canadensis*, Jones, var. *nana*.
25. *Beyrichia*, sp. nov. ?
26. *Asaphus platycephalus*, Stokes.
27. *Ceraurus pleurexanthemus*, Green.
28. *Calymene senaria*, Conrad (= *C. Blumenbachii*, Brongn.).
29. *Encrinurus vigilans*, Hall.
30. *Dalmanites callicephalus*, Green.
31. *Trinucleus concentricus*, Eaton.
32. *Illænus Milleri*, Billings.

Lorette to Ste. Foye.

The road from Lorette to Ste. Foye shows but few ledges. After descending the slope of the ridge on which the former village is situated, the country is low towards the line of the Lake St. John Railway. A few outcrops of brown bituminous shale were, however, seen in ditches and cuttings, and these were of Utica aspect.

Lorette to Charlesbourg.

From Lorette to Charlesbourg no rocks are seen other than those of the Trenton and Utica formations, with the exception of the ledges of Laurentian gneiss north of the road already referred to. At a small brook about one mile west of Charlesbourg church brown bituminous shales contain *Leptobolus insignis* in abundance, with *Orthograptus quadrimucronatus* and a *Climacograptus*—all Utica forms. Similar rocks are seen fifty yards north of the church, dipping south-easterly at an angle of 40°, and striking almost directly across the road. From these

Fossils.

were obtained, in addition to the forms noted above, *Leptograptus flaccidus*, a *Strophomena*, a specimen like one from the Montmorency Falls, *Bellerophon bilobatus*, *Leperditia* (*Primitia*) *cylindrica*, *Triarthrus Becki*—all species of Utica age. About 500 yards north of the church, on the east side of the road, Templeman's quarry is situated in dark

grey limestone, the beds being nearly horizontal. The limestone strata, which are highly fossiliferous, are separated by thin partings of black shale, an occurrence common to this formation at other points. A natural pit, over eighty feet deep, in the bottom of the quarry, gives a good section of the strata, and the owner stated that the same character of rocks extended all the way to the bottom, or at least as far as he could ascertain, and that he did not know on what the limestone rested, as the bottom of the formation had not been reached. From the beds of the quarry the following species were obtained :— Templeman's quarry.

1. *Pachydictya acuta*, Hall.
2. *Ptilodictya falciformis*, Nicholson.
3. *Prasopora lycoperdon*, Vanuxem (= *P. Selwyni*, Nicholson.).
4. *Crania*, sp. indt., parasitic on *End. proteiforme*.
5. *Endoceras proteiforme*, Hall.
6. *Schizocrania*, or *Discina*, sp.
7. *Lingula riciniformis*, Hall.
8. *Leptæna sericea*, Sowerby.
9. *Strophomena alternata*, Conrad.
10. *Strophomena ?* n. sp., same species as at Montmorency.
11. *Orthis testudinaria*, Dalman.
12. *Calymena senaria*, Conrad.

South of Charlesbourg the slope of the hill to the flat country, as at Loretto, shows ledges of brown bituminous shales of the Utica, with south-easterly dip $< 45°$–$50°$. Beauport, Parent's quarries.

Near Beauport the Trenton limestone is seen in great ledges along the road leading to Montmorency, in a nearly horizontal position, while the Utica shales, somewhat highly inclined, occur a short distance south of the road. From Parent's quarries, at this place, Mr. St. Cyr, of Quebec, has obtained both Trenton and Utica forms, among the former of which may be mentioned :—

1. *Prasopora lycoperdon*, Vanuxem.
2. *Amplexopora discoidea*, James.
3. *Lingula obtusa*, Hall.
4. *Strophomena deltoidea*, Conrad.
5. *Camerella hemiplicata*, Hall.
6. *Conularia Trentonensis*, Hall.
7. *Orthoceras anellum*, Hall, or a closely allied sp.
8. *Calymene senaria*, Conrad.
9. *Ceraurus pleurexanthemus*, Green.
10. *Asaphus platycephalus*, Stokes.

From the beds of Utica at this place were obtained :—

1. *Schizocrania filosa*, Hall.
2. *Leptæna sericea*, Sowerby.
3. *Lyrodesma pulchellum*, Emmons.
4. *Endoceras proteiforme*, Hall.
5. *Asaphus Canadensis*, Chapman.

Montmorency Falls.

The rocks of the Montmorency Falls, near the junction of the Montmorency River with the St. Lawrence, eight miles below Quebec, have for many years been the subject of geological investigation. The contact of the horizontal beds of the Trenton with the Laurentian is well seen in the river at the brink of the fall and for several miles up the stream, while at the foot of the fall the Trenton beds are almost entirely absent, and the overlying Utica is brought against the face of the Laurentian cliff, which here has a vertical height of about 260 feet, but in a highly inclined position, having a dip of nearly 60°, a state of things which can only have been brought about by a heavy fault. This fault can be traced westward past Beauport, whence it trends to the north-west, and strikes just across the rear of Charlesbourg, the beds at which place have already been described. Carefully located collections of fossils have been made on several occasions, both from above the falls and below in the gorge, but no species known to be older than Trenton have been found, and it seems clear, from the evidence of the fossils and from the character of the sediments, that the conclusions stated by Sir Wm. Logan in the Geology of Canada, 1863, as to the structure at this place, and subsequently by Dr. Selwyn in sundry papers, are clearly maintained.

Contact of Trenton and Laurentian.

Fault.

River above the falls.

Above the falls the bed of the river is composed of true Laurentian gneiss, which is seen on the very edge of the cliff when the water is low, while the banks of the stream on both sides are made up of the Trenton limestone, which is highly fossiliferous. The lowest beds of the Trenton in places consist of a re-composed rock made up of the *débris* of the Laurentian gneiss, cemented with sand and calcareous matter. These beds rest directly upon the gneiss, and frequently fill up irregularities in its surface. They range from a foot to three feet or more in thickness, and shade upward into the fossiliferous limestone of the Trenton, from the lowest beds of which the following species were obtained :—

1. *Pachydictya acuta*, Hall.
2. *Prasopora lycoperdon*, Vanuxem.
3. *Solenopora compacta*, Billings.
4. *Lingula curta?* Hall.
5. *Leptæna sericea*, Sowerby.
6. *Strophomena alternata*, Conrad.

7. *Orthis testudinaria*, Dalman.
8. *Orthis pectinella ?* Conrad.
9. *Anazyga recurvirostra*, Hall.
10. " ? Form not recognized, but very common here and elsewhere, and often referred to *Zygospira modesta*, Say.
11. *Vanuxemia*, sp. indt.
12. *Conularia Trentonensis*, Hall.
13. *Bellerophon bilobatus*, Sowerby.
14. *Bucania punctifrons*, Emmons.
15. *Murchisonia gracilis*, Hall.
16. " *perangulata*, Hall.
17. *Orthoceras*, sp. cf, *O. anellum*.
18. *Harpes*, sp. portion of glabella and cephalon.
19. *Encrinurus vigilans ?* Hall.
20. *Asaphus platycephalus*, Stokes.
21. *Ceraurus pleurexanthemus*, Green.
22. *Illænus Milleri*, Billings.

Ravine below the falls.

In the beds in the cutting on the road west of the bridge and in the cliffs in front of Mr. Hall's house at the head of his steps, *Trinucleus concentricus* is very abundant.

Below the falls the Trenton limestones are almost entirely wanting in the section, the fault having obliquely cut the measures and brought the Utica shales with a thin band of the upper Trenton against the foot of the cliff. Occasional patches of hard sandstone or grit are seen in the lower part of the face of the cliff of Laurentian gneiss, but these appear to be portions of the lowest bed of the Trenton mentioned above, rather than the remains of any older formation, while the cliff is for the most part flanked by the thin limestones and black or brown bituminous shales of the lower part of the Utica. A ravine makes in on the east bank from the front of the fall for some distance, and marks the line of division between the Laurentian and the fossiliferous sediments. From these latter a good collection was made, both from the bottom and the east side of the ravine, among which are recognized :

1. *Hyalostetia*, or similar spongo spicules.
2. *Diplograptus*, sp.
3. *Climacograptus*, sp.
4. *Reteograptus Eucharis*, Hall ; small form.
5. *Orthograptus quadrimucronatus*, Hall.
6. Plate of a *cystidean* or *crinoid*, resembling *Glyptocystites* or *Glyptocrinus*.
7. *Lingula curta*, Hall.

8. *Leptobolus insignis*, Hall.
9. *Leptæna sericea*, Sowerby.
10. *Orthis testudinaria*, Dalman.
11. " ? A form apparently new and occurring in the Trenton and Utica from the Falls to Lorette.
12. *Serpulites dissolutus*, Billings.
13. *Illænus*, sp.
14. *Calymene senaria*, Conrad (= *C. Blumenbachii.*).
15. *Triarthrus Becki?* Green.
16. *Primitia*, sp. Apparently undescribed.

Mr. Ami remarks that the above fauna is pre-eminently Utica in facies, with an evident admixture of a few Upper Trenton species obtained from the lowest calcareous beds which crop out in the ravine. From the presence of certain typical Utica forms, no doubt can exist as to the exact horizon to which the strata there seen belong.

Section from foot of fall to mouth of river.

The section of brown bituminous shales which extends along the north side of the gorge between the foot of the fall and the mouth of the river shows a probable repetition of the Utica beds near the outer extremity, and here the fossils found indicate a Utica horizon similar to that found on the east side of the ravine. These beds are, therefore, repeated by folding or by fault, indications of which latter are seen nearly midway between the foot of the steps and the mouth of the stream. It is also probable that both faults and folds occur in the space between this shore and the Island of Orleans, occupied by the north channel of the St. Lawrence.

The fossils obtained from the soft, brownish marls and disintegrating shales of the point at the mouth are as follows :—

1. *Diplograptus*, sp. indt.
2. *Climacograptus*, sp.
3. *Orthograptus quadrimucronatus*, Hall.
4. *Leptobolus insignis*, Hall.
5. *Endoceras proteiforme*, Hall.
6. *Triarthrus Becki*, Green. Common.

Montmorency Falls to Cape Tourmente.

Further to the east, the Trenton is well exposed at Chateau Richer, from the beds of which much of the rock for the construction of the Lévis forts was taken, and which contains characteristic fossils. These are overlaid by the Utica, and at Ste. Anne de Beaupré the latter is followed by the greyish, sandy shales of the Hudson River or Loraine formation, the beds being similar to those seen at St. Pierre and Ste. Famille, on the north side of the Island of Orleans. At the River Ste. Anne also, at the road crossing, and in the creek three miles east of

St. Joachim, near the cheese factory, the Loraine formation is well displayed. According to the map prepared by Prof. Laflamme the Trenton occurs in limited areas directly upon the gneiss both on Ste. Anne River and on the Friponne, a small stream flowing down the mountain a short distance west of Cape Tourmente. The Utica also occurs on this stream, and a list of fossils from this spot is given in the Geology of Canada, 1863, p. 160. At Cape Tourmente itself the beds resting upon the gneiss consist of about twenty feet of conglomerate, grit and impure limestone, the former cemented by calcareous matter, just as on the Montmorenci, but yielding, in so far as searched, no fossils.

Trenton on Laurentian at Cape Tourmente.

The most important area of Cambro-Silurian and Cambrian rocks, however, is that which occurs to the west of the great anticlinal of Pre-Cambrian strata, and which extends thence to the River St. Lawrence, occupying much of the flat country lying to the south-east of that river. This area embraces a large part of what has been styled in the earlier reports of the Survey the non-metamorphic portion of the Quebec Group, which was divided into the Levis, Lauzon and Sillery formations, all of which belong to lower horizons than those which underlie much of the flat plain contiguous to the river above the village of St. Nicholas, the strata of which, with their characteristic fossils have just been described.

Sillery and Lévis formations.

Descriptions of many of these rocks have been fully given in the publications of the Survey, enumerated on pages 2–3. They present a great similarity of aspect throughout their entire extent, not only to the extremity of the Gaspé Peninsula at Cape Rosier, but even on the Island of Newfoundland, where they are well developed, and where favorable facilities are afforded, especially in the northern part of the island, for deciphering the peculiarly complicated structure of this group. They have been carefully studied there, first by Mr. Jas. Richardson in 1859-62, and subsequently by Mr. A. Murray, C.M.G., for some years director of the Geological Survey of the Island, whose map, published in 1877, contains the latest information bearing on this question as regards that locality.

Newfoundland.

With the object of rendering as clear as possible the many conflicting statements which have arisen concerning the horizon and stratigraphical relations of this peculiar group of rocks, a brief abstract of the views held from time to time by the several observers in this field is here regarded as desirable.

The earliest account of the rocks around Point Lévis and Quebec is found in a paper by Dr. J. Bigsby, read before the Geological Society of London, December, 1827. They are there described as "1st, a slaty series, composed of slates and grauwacke, occasionally passing into a brown limestone, and alternating with calcareous

Dr. T. Bigsby, 1827.

conglomerate in beds, some of which are charged with fossils; 2nd, a conchiferous brown and black limestone, sometimes based upon a calcareous conglomerate; 3rd, Gneiss." The author's chief reason for supposing the slaty series superior to the limestone is that "the latter is, in some situations, in immediate contact with the gneiss, while at others it passes into beds of the first series above mentioned, the conglomerate of which contains organic remains derived from the conchiferous limestone." The slaty series is said to "occupy the whole of the southern shore of the St. Lawrence, the Island of Orleans, and a considerable portion of the north bank of the river, including the ridge upon which Quebec is placed. In that neighborhood the mass of the deposit consists of a black and brown slaty limestone, inclined at very high angles, and alternating with semi-crystalline limestone and various conglomerates. The limestone contains several varieties of crystallized carbonate of lime, intermixed with quartz crystals and occasionally traversed by seams of bituminous matter, and near Cape Rouge and on the Plains of Abraham and Kilgraston, some of the strata consist of red and green clay slate. In the calcareous conglomerate, organic remains are mixed with fragments of clay slate, and the beds alternate with compact grey limestone and quartzose layers."

Earliest description of the rocks about Quebec.

"On the south side of the St. Lawrence, the slaty limestone of Quebec is no longer seen, but several new beds of conglomerate present themselves, one of the lowest of which contains trilobites, encrinites, corallines and other fossils, associated with vegetable impressions, probably of *fuci* and *amansiæ*."

"In the schistose beds near the mouth of the Etchemin are thin seams of coal. The horizontal conchiferous limestone is included between the slate series and the gneiss."

From the character and fossils of the limestone above described, Dr. Bigsby concluded it was the equivalent of the Carboniferous limestone of the English geologists.

Capt. Bayfield, 1843.

In a paper by Capt. Bayfield, R. N., published in the *Geological Journal*, 1845, on the transition rocks of Canada, the author states that "the Silurian limestone was traced from Lake Huron, where it contains the characteristic fossils of that formation, eastward across the Ottawa to Quebec, and was seen at various intermediate points along the north side of the valley of the St. Lawrence. The limestone at Pointe aux Trembles, six leagues above Quebec, contains, among other fossils, *Calymene Blumenbachii* and a species of *Chætetes*, which M. DeVerneuil informs me is allied to *C. petropolitana*. The limestone here dips to the south-east, conformably to the grauwacke which contains *Leptæna sericea* on the opposite side of the river. This latter

circumstance, together with the statements of an anonymous writer in the Canadian Review, that the limestone near the Falls of Montmorency declines gradually from the horizontal position till it finally dips at a high angle beneath the grauwacke on the opposite or south side of the river, and that a conglomerate, wholly composed of re-cemented fragments of limestone, containing the organic remains peculiar to Beauport, the Falls of the St. Charles and Indian Lorette, is one of the alternating members of the grauwacke or slate series, inclines us to assign to this limestone a position inferior to the grauwacke and slate, and low down among the Silurian strata. Considerable difficulty has been felt in admitting this, because the limestone has so very generally been found in nearly horizontal strata, resting immediately upon primitive rocks, in very near neighborhood to the highly inclined grauwacke and slate, but on the other hand it must be remarked that it has never, so far as we know, been found overlying the latter conformably."*

Early views of Sir W. Logan, Rep. Prog, 1843.

The first notice of these rocks on the part of the Geological Survey appears in the Report of Progress for 1843, published in 1845 by Sir William Logan, when the view was expressed that "the rocks of Point Levis came out from beneath the limestone of the St. Lawrence, and belonged to an apparently older horizon;" but in a foot note it is stated that "the bulk of evidence points to their superior position, which would make them the equivalents of the Hudson River and Loraine shale formation." In Report of Progress 1844, pp. 17-30, the characters of the several groups of rocks, which occur along the south side of the St. Lawrence, are very fully given under the head of conglomerate limestone, pillar sandstone and graptolitic shales, more particularly for that portion of the coast east of Cape Chat, and the statement is made on page 19 that there are "indications that as the south side of the St. Lawrence continues to present up to Quebec the same slightly oblique course to the run of the ridges, it is not improbable other divisions may crop out above Cape Chat which have a lower geological position than the strata in its vicinity," and on page 21, in speaking of the coaly matter which occurs in these strata and which was at that time thought by certain persons to be indicative of the presence of coal in this group, it is stated that "the rock containing it is supposed to be the equivalent of a part of the Hudson River group of the New York Geologists."

Rep. Prog, 1844.

In Report of Progress, 1847-48, p. 57, the following statement is made regarding the age of the metamorphic portion of the Eastern Townships rocks: "The facts which have been detailed in the eluci-

Rep. Prog, 1847-48.

* The slaty rocks of Quebec city, at that time supposed to be the same as those of Lévis, have recently been stated to underlie the limestone uncomformably by Mr. Jules Marcou.—A. R. C. S. See Memoirs Boston Nat. Hist. Soc., Vol. IV., 1883, plate fig. 8.

dation of the structure of the Green Mountains in their Canadian prolongation, would appear to make the plumbaginous sandstones and titaniferous red slates of the Seraphine range, in the seigniory of St. Hyacinthe, which are within a mile and a half of the Trenton limestone of that vicinity, equivalent to that of Granby; and these rocks, with their chromiferous calcareo-chloritic bands, to the dolomites and chloritic quartzose rocks of Kingsey, Shipton and Sutton; these again to the serpentine and quartz rocks of Potton, from which it would follow that the whole of the Green Mountain rocks, including those containing the auriferous quartz veins, belong to the Hudson River group, with the possible addition of the Shawangunk conglomerates." In their extension, it is stated on page 58 that "these recognized rocks of the Hudson River group have a continuous run from Lake Champlain along the south bank of the St. Lawrence to Cape Rosier."

Rep. Prog. 1849. In the Report of Progress, 1849, p. 18, a similar view is expressed under the head of Economic Materials, in connection with the reported presence of coal at Murray Bay and Bay St. Paul. The statement is there repeated that "a band of calcareous rocks of the age of the Trenton limestone of New York, which is well ascertained to be far below the Carboniferous deposits of North America, carried its outcrop in a continuous line from Grenville, on the Ottawa, to Beauport, below Quebec, on the north side of the St. Lawrence; and that another formation, contemporaneous with the Hudson River of New York, superior to the Trenton limestone, but also far beneath the same Carboniferous deposits, extended from Point Lévis to Cape Rosier." On page 32, the description of the series of rocks, which is stated to occupy the greater part of the country east of the Richelieu between the mountain belt and the St. Lawrence, may be given in condensed form as follows:—

1. Dark grey shales, interstratified with grey thin-bedded sandstones, often calcareous, and weathering yellowish-brown, and with grey, yellow weathering limestones. This series is fossiliferous, and holds shells and graptolites, and appears to be terminated by a set of bituminous shales and black limestones.

2. Grey, green and occasionally red shales with thin calcareous layers, with possibly a considerable deposit of red shale occasionally at top of the series. These shales appear occasionally to hold bands of calcareous conglomerate, cracks in which are filled with indurated bituminous matter.

3. Hard sandstones, varying in color from light grey to iron grey and sometimes slightly greenish; fine-grained and bedded, coarse-grained and massive; occasionally a conglomerate, the pebbles of which are frequently composed of Trenton limestone and contain Trenton fossils, sometimes these rocks are so calcareous as to be burnt for lime.

4. Red and green shales, which are frequently interstratified with bands of light grey fine-grained sandstone, frequently calcareous.

5. Coarse-grained green sandstone, with scales of mica and spangles of plumbago, interstratified with red and green shales. The color of the sandstone appears to be due to the presence of chlorite; but red layers as coarse as the green, and holding nearly as much chlorite, are in some parts interstratified. The beds of both colors, which are almost always massive, are in general calcareous and often present bands of coarse conglomerate, with quartz pebbles, which sometimes appear to become mingled with pebbles and even boulders of grey limestone holding fossils, probably of the Trenton formation.

These rocks, in a highly metamorphic condition, were also, at that time, stated to constitute the mountain belt, "the inferior bituminous shales becoming plumbaginous slates, the grey sandstones being probably converted into quartz rock and talcose quartz slates, and in relation to this siliceous zone, there appear to be, in the metamorphic district, two magnesian belts shewing dolomite and serpentine, the equivalents of which in the unaltered rocks require farther investigation; the red slates and green sandstones seem to become chloritic, epidotic and ferriferous slates and less schistose forms of rock, and from the geographical position of what have been called the Corneous rocks, it appears not improbable they may be referable to this part of the deposit; but a larger number of facts must be ascertained before the various divisions of the metamorphic rocks can be clearly traced to their unchanged equivalents. The whole belong to the Lower Silurian age, and they are followed by others, which are shown, by the fossils held in some parts, to be Upper Silurian."

In theReport of Progress for 1852-53, the only reference to rocks of the Quebec Group is in regard to the mass of red and green shales, with the green sandstones, which extends from Cape Rouge along the river to Point à Pizeau, the age of which was supposed to be that of the Oneida conglomerates of the New York series. These rocks, which extend back from the river in the direction of Ste. Foye, were held to overlie the calcareous conglomerates, sandstones and black shales of the city and cliffs of Quebec, or their supposed equivalents, the rocks of Point Lévis, across the river, which were again held to be above the Trenton-Utica beds of Pointe-aux-Trembles, or to be about the horizon of the Loraine shales. Rep. Prog, 1852-63.

In connection with the Paris Exhibition of 1855, a small volume, "Esquisse Géologique," relating to the Geology and Mineral wealth of Canada, was published by Logan and Hunt, in which, on page 49, it is stated that "an anticlinal axis divides the palæozoic formations of Canada into two basins. Upon the line of this axis the most recent Esquisse Géologique, 1855.

formation, except the tertiary strata, is the lower part of the Hudson River Group, known by the name of the Loraine or Richelieu shales. In the valley of the Yamaska, an outcrop of Trenton limestone marks the anticlinal which separates the two basins. Not far to the east of this limestone, a series of sedimentary rocks which constitute the upper part of the Hudson River Group, is found, resting on the Richelieu shales, but which does not exist in the western basin, from which they have probably been removed. This series is composed of massive sandstone, greyish, often calcareous, associated with grey slates, green and red, toward their upper portion, and with other black shales, bituminous and graptolitic. In some portions of this formation the sandstone becomes a conglomerate and encloses large fragments of the lower fossiliferous formations. More often, however, the sandstones pass into a bituminous limestone,.....which contains fossils. This limestone is interstratified with siliceous and bituminous dolomite, which weathers yellow and contains carbonate of iron, and the dolomite seems in places to be replaced by a ferruginous and siliceous carbonate of magnesia. These are the rocks which form the cliffs of Quebec and Point Lévis, and have a thickness of over 300 metres."

"This formation at Quebec is succeeded by red and green shales, with thin bands of calcareous matter, and intercalated towards the summit with great masses of quartzose sandstone, often calcareous, and colored by a mixture of argillaceous matter which is greenish or reddish. This series of sandstones and shales, which has a total thickness of 1000 metres, has been named by Logan, the Sillery group, and appears to be the equivalent of that which has been named by the New York geologists the Shawangunk or Oneida Conglomerate, which in Central New York lies between the Richelieu shales and the Medina sandstone."

The comparative absence of organic remains in the Sillery formation was at the time noticed, these being principally confined to what was regarded as coprolitic matter, which was also held to occur with the graptolites of the underlying shales of Point Lévis.

These rocks were stated to extend to the extremity of the Gaspé Peninsula, and to be overlaid unconformably by over 2000 feet of fossiliferous Upper Silurian sediments, which in turn were followed by the Devonian and Carboniferous formations of the Bay of Chaleurs area. The whole was supposed to form a gradually ascending series from the Trenton limestone of the vicinity of Quebec to the Carboniferous of New Brunswick.

On page 56 *Ibid*, in the chapter on the Metamorphic Rocks it is stated, "that the rocks of the mountain region have been much metamorphosed and rendered crystalline by chemical action, so that the fossils are no longer recognizable. The rocks thus metamor-

phosed belong to the Hudson River group and to the Sillery formation." And again: "The changes which these sedimentary beds have undergone are often very remarkable, some of them passing into chloritic, micaceous and talcose schists, others into felspathic, hornblendic and epidotic rocks."

Prof. James Hall, 1855.

In 1855, Prof. James Hall presented his report on the series of graptolites collected at Point Lévis in the preceding year. This was published in the Geological Survey Report, 1857, in which the various graptolites of that locality are considered as belonging to the Hudson River group.

Conclusions arrived at by Mr. E. Billings.

During the years 1856-57, extensive collections of fossils were made from the rocks at Point Lévis, as well as from what were regarded as their equivalents near Philipsburg on the lower part of Lake Champlain and about Missisquoi Bay. These comprised not only graptolites but a considerable series of trilobites and other organic remains, the systematic study of which was undertaken by Mr. E. Billings. The result of his examination showed that, while the greater portion were new species, of those that were determinable, five were known in the Chazy limestone, and twelve in the Calciferous rocks of the Ottawa Valley, while the aspect of the undetermined species indicated rather the base than the upper portion of the Lower Silurian, as had so long been supposed. The conclusion was therefore reached by Billings that these rocks belonged really to the base and not to the summit of the Champlain division, and that the Lévis rocks were really older than the Trenton limestone.

Logan's views of the structure about Quebec, 1860-61.

These conclusions were first announced by Sir W. Logan in a letter to J. Barrande, and published in *Canadian Naturalist* December 31, 1860, vol. v., p. 472, and subsequently in the *American Journal of Science*, II, vol. xxxi, March, 1861, where the opinion was expressed that "this series of rocks, to which the name 'Quebec group' was now applied for the first time, represented a great development of strata about the horizon of the Chazy and Calciferous, brought to the surface by an overturn anticlinal fold, with a crack and dislocation running along the summit, by which the Quebec group is brought to overlap the Hudson River formation."

Course of the great fault.

The fault by which this overlap is produced is said to "come to the boundary of the province, not over a couple of miles from Lake Champlain. From this it proceeds in a gently curving line to Quebec, keeping just north of the fortress. Thence it coasts the north side of the Island of Orleans, leaving a narrow margin on the island, of the Hudson River and Utica formations. From near the east end of the island it keeps under the waters of the St. Lawrence to within eighty miles of the extremity of Gaspé. Here it again leaves a strip of the Hudson River or Utica on the coast."

Supposed age of the Quebec group, 1861.

It was there further stated that "the rocks along the south side of the river are arranged in a series of parallel synclinals, with many overturn dips, separated from one another on the main anticlinal by dark grey and black shales and limestones." From the fact that these shales and limestones, formerly regarded as of Hudson River age, apparently separated the synclinals of the Quebec group rocks, it was supposed that these must be considered older, and it was suggested that "the shales and limestones which may be subordinate to the Potsdam may represent the true primordial zone of Canada." In Vermont these rocks which were there recognized as the equivalent of the magnesian portion of the Quebec group, had long been regarded by Emmons as older than the Bird's Eye formation, a point now considered to be very fairly established by the new discoveries made near Quebec.

First division of the Quebec group.

With the new fossil evidence thus obtained, the history of the Quebec Group, by which name this series of rocks has since been known, assumed at once an entirely new aspect. The five divisions of the grauwacke series, given in Report of Progress for 1849, were now divided into two portions, of which the four first were styled "the Lévis formation," while the last was called "the Sillery." The details of the former are given in Geol. of Can., 1863, p. 227-29, where it is sub-divided into seventeen parts, having a total supposed thickness of 5,025 feet, at the summit of which was placed a series of greenish sandstones and red and green shales called the Sillery, with a total thickness of about 2,000 feet.

Views of Prof. Jules Marcou, 1861.

The published correspondence between Logan, Hall and Barrande called forth a reply from Prof. Jules Marcou, in a letter addressed to Barrande, and published in Trans. Boston Nat. His. Soc., 1861, in which marked exception was taken to the new views of Logan. In this letter Prof. Marcou discusses the age of the rocks of northern Vermont and their extension into Canada about Philipsburg, regarding these as of the age of the middle portion of his Upper Taconic, and "far below the Potsdam sandstone."

As the result of his study of the rocks about Philipsburg, Marcou claimed that the limestones of that vicinity as well as those of Highgate and Swanton, in Vermont, occurred simply as lenticular masses, with a framework of slate enclosing them, and that there appeared in the series a blending of the first and second faunas of the primordial zone. This peculiarity, he considered, was an illustration of the theory of colonies, first put forth by Barrande in Bohemia, by which colonies of the second fauna were enclosed in strata which contained the first, and he proposed to call these colonies, which were confined principally to the lenticular masses, "Precursors of Creation," that is the occurrence of species or generic types which received their full development only during the following period.

The same peculiar conditions of structure were held by him to apply to the rocks of Point Lévis and vicinity; the red, brown, green and black shales, with thin beds of sandstone, being held to represent the lower part of the Upper Taconic.

Prof. Marcou's theory of "colonies."

The theory of colonies held by Marcou to apply to the Philipsburg rocks was also extended to those of Point Lévis, two zones being established in this locality, of which the primordial fossils were principally obtained from a mass of limestone found on the Harlaka road in rear of the church of St. Joseph, and styled by him the "*Redoubte*." This lenticular mass was regarded as a *lenticular primordial* of about the same age or a little younger than the lenticular primordial found in the Georgia slates of Swanton, Vt. The associated slates, limestones and magnesian conglomerates were considered to be a little higher in the series than the Georgia slates which represented the lower portion of the Upper Taconic.

His views of the structure of the Quebec and Lévis rocks

The presence of three other *lenticular primordials* in rear of Point Lévis, which occur between what is now the cemetery and the Main street, was noted, and it was claimed that these contained fossils which represented centres of creation or colonies pertaining to the second fauna, while the strata, together with the graptolitic shales and associated beds which extend to the shore of the river, were held to constitute the Point Lévis group, and to be contemporaneous with the Philipsburg group of Vermont and Missisquoi county.

The rocks of the city and citadel of Quebec, and of the plain in which Beauport, Charlesbourg and Indian Lorette are situated, consisting largely of black shales, holding, in places, large boulders of limestone, were regarded by him as the equivalents of the Swanton slates of Vermont.

The views of Logan as to the complicated and folded structure of the rocks in rear of Point Lévis were not admitted by Marcou, who held that there was "no repetition of beds in this locality, and no synclinal axes," "and that the few foldings in the cliffs near the ferry are mere accidents, confined to a distance of a few feet, and without any effect upon the whole mass of the strata." The apparent discordance in direction between the slates and the limestones, at their contact, was held to be due to the globular form of some of the lenticular masses of the limestone which were enclosed, "the slates following the direction of the globular mass instead of running in a straight line, which gives to the whole, at first view, a sort of discordance of stratification which in truth does not exist."

Billings' reply to Marcou.

This letter of Marcou's drew forth a reply from Billings which appeared in the Can. Nat. 1863, vol. viii, in which he paralleled the strata of the fossiliferous Quebec group with those of the Llandeilo of

Similar rocks in Australia and England.

England and Australia, and with the Chazy and Calciferous formations of America, and showed conclusively, from a careful examination of the large collections of fossils from various points in the group that their position was really in the lower part of the Lower Silurian, instead of the upper where they had long been placed, on the one hand, or in the Primordial, beneath the Potsdam, on the other hand, as was maintained by Mr. Marcou. This view of Billings was concurred in by the leading English and Australian geologists who had found precisely similar forms in the strata of both countries where they could be definitely located. As for the occurrence of Chazy and Calciferous forms, Billings found that none of these occur in the neighborhood of Quebec, but that, in what he regarded as the equivalents of the group in Newfoundland, in the east, and near Philipsburg in the west, a few species found in both these formations were observed in the upper and lower beds respectively. He regarded the group as a "peculiar development of strata, the upper limit of which can scarcely be newer than the Black River, while the lower horizon is probably not far from the middle of the Calciferous."

Their Lower Silurian age asserted.

Geology of Canada, 1863.

In the Geology of Canada, 1863, p. 225-97, the views regarding the structure and stratigraphical position of the several rock formations which were then known as the Quebec Group are given in great detail. Their exact horizon is not however clearly defined, since "while from their geographical position, apparently superior to the Hudson River formation, these rocks belong in reality to an older group, which is developed to a great extent in Eastern Canada, and presents somewhat different characters in the various parts of its distribution." As the rocks were still under examination, the views there expressed were liable to modification as new facts might be brought to light. The group was divided into the Lévis and Sillery formations.

Thickness and character of the Lévis division.

Of these, the Lévis, which was held to compose the bulk of the group, was supposed to have a thickness of 5025 feet, and was subdivided into seventeen parts, in ascending order from the series of green and purple calcareo-magnesian and fucoidal shales, with limestone conglomerates at the base, to the red and green shales and sandstones which were supposed to shade upward into the overlying Sillery formation, provided the series was not an inverted one, of which however there appeared to be no definite proof, unless it might be the presence of an *Obolella*, which had the aspect of a Calciferous form in some of the shales of the supposed upper portion. As regards the position of the Sillery, it was there stated that "at the summit of the Lévis is an apparently interstratified series of greenish, drab-weathering sandstones with associated shales of different colors. In their upper part, the sandstones exceed the shales, varying in character from fine to

Supposed upper position of the Sillery.

coarse, containing small pieces of black and green shales, and with quartz pebbles, generally of small size and occasionally passing into a well defined conglomerate." "The sandstones are sometimes micaceous, with small spangles of graphite. They are frequently massive, the sandy layers being separated by partings of reddish and greenish shales, and are supposed to have a total thickness of about 2000 feet."

The distribution and characters of the rocks of this group are given in the volume above cited, throughout their whole extent in Canada, from their first appearance, north of the Vermont boundary to the extremity of the Gaspé peninsula, and the supposed positions of several anticlinals, by which the structure was rendered exceedingly complicated, were defined. As in the earlier reports, the great area of crystalline schists and associated rocks of the interior or mountain portion of Eastern Quebec was regarded as the metamorphic equivalent of the fossiliferous sediments of the vicinity of the St. Lawrence; that portion which is now held to constitute the oldest member of the townships series, viz., the Sutton Mountain Range, being supposed to represent, if not the whole, a portion at least of the Sillery formation. This aspect of the question has been discussed in the Report for 1886, but more fully in earlier papers by Dr. Selywn, see p. 8. In regard to the structure of the Shick-shock Range in the eastern section, while, as in the case of Sutton Mountain, it was regarded as a synclinal, it was not held to be necessarily of Sillery age, but might represent some of the finer masses which overlie the limestone conglomerates of the Lévis.

Supposed age of the crystalline rocks of the interior.

To the south-west, the group was made to include the series of limestones and shales about Philipsburg, together with the conglomerates, composed largely of their debris, the former of which had been regarded by Marcou as Primordial, and these were supposed to represent the lowest portion of the Lévis division. They here rest upon the Potsdam formation of this locality, known in part as the red sandrock of Vermont. The structure at this point is exceedingly complicated and has been a fruitful source of controversy.

Age of the Philipsburg rocks.

To the east, in Newfoundland, the sequence appeared to be more regular, the strata being in a nearly horizontal attitude over considerable areas, and much greater facilities are, in consequence, afforded for the study of the several formations. The characters of the various beds and their relative order of sequence, as shown along the shores of Belleile Strait, are given on pp. 287-93 (Geol. of Canada, 1863) from which it appears that the Laurentian gneiss, etc., of the north side of the strait is overlaid by the Potsdam formation, representing the red sand rock of Vermont and the Beauharnois sandstone, with an aggregate

Sequence in Newfoundland.

Thickness of the several divisions in Newfoundland.

thickness of 624 feet. This is succeeded in ascending order by the Calciferous limestones, etc., with a thickness of 1570 feet, which in turn are followed by a series of rocks, the Point Rich limestones, the position of which, as compared with the beds of Quebec, appears uncertain, but which in character and position are very closely allied to the Philipsburg limestones, and which have a total thickness of 1010 feet. These are succeeded by a series of grey sandstones and shales with limestone conglomerates, which are the undoubted equivalents, both in fossils and position, of the Point Lévis rocks, as well as of some portions of those near Philipsburg, with a thickness of 1400 feet.

To these apparently succeed the greenish sandstones and associated shales which represent the Sillery in this direction, and which were presumed to constitute the upper portion of the Lévis formation. As, however, the beds near their contact are tilted at a high angle, this apparent position is not fully established, as the next rocks in the sequence are those of the metamorphic series, so that it is possible that, by an overturn, the Sillery, which in places comes against the metamorphic rocks, may be properly regarded as a lower portion of the Lévis instead of an upper. Or possibly, what may be quite as likely, two distinct series of sandstones and quartzites, presenting considerable points of resemblance, have been confounded and both placed in the Sillery formation, of which one may really represent the upper part of the Sillery proper, in accordance with the supposed apparent structure at many points, while the other may belong to the underlying formation.

The age of the group near Quebec is again stated (see p. 233, Geology of Canada, 1863) to "be about the horizon of the Chazy and Calciferous formations. The strata are brought to the surface by an overturn anticlinal fold, with a crack and great dislocation running along its summit, by which the group is made to overlap the Hudson River formation."

Quebec group divided into Lévis, Lauzon and Sillery, 1866.

Subsequently (see Report of Progress, 1866, p. 4), for convenience, the Quebec group was divided into three parts—a lower, middle and upper—known by the names Lévis, Lauzon and Sillery, the lower of which was held to contain the Philipsburg limestones, the black slates above them, and that portion of the Levis shales and magnesian conglomerates included in the numbers 1–9 of the Orleans Island section described in Geology of Canada, 1863, p. 227. This lower division was distinguished by its general black and dark color, and furnished nearly all the fossils found in the Quebec group.

Lauzon, character of rocks.

The middle or Lauzon comprised the remaining divisions of the section mentioned above (Nos. 10-17). This was held more especially to comprise rocks of red, green and purple colors, poor in fossils, only three being known at that time, two *Lingulæ* and one *Obolella*, which

occurred near its summit, and in its metamorphic condition it was characterized by the ores of the more valuable metals. Near the base a mass of greenish glauconite shales occurs locally both on the Island of Orleans and at Point Lévis, while to the westward, the rocks appeared to be more magnesian than in the vicinity of Quebec. In this direction it was held that the black shales and limestones of the Lévis series were often immediately succeeded by a thick mass of dolomite, associated with diorite, the former of which, in the more metamorphic portions, was supposed to be replaced by important masses of serpentine, with soapstone and potstone. These magnesian deposits were also supposed to occur at two horizons in the Lauzon—one at the base, the other at the summit, and both were held to be accompanied by metallic ores. Sandstones, often a hard quartzite, occur as interstratified portions of both the Lauzon and Lévis divisions, and have often a considerable thickness. Many of these, while presenting features resembling the Potsdam sandstones, are clearly interstratified portions of the so-called Lévis formation. Metalliferous zones.

The characters of the unaltered Sillery have been already given. In their altered condition these were still supposed to constitute the great bulk of the chloritic and epidotic schists and quartzites, and to pass, towards their summit, into more or less perfect gneiss. Considerable difficulty having been found in separating the magnesian bands at the summit of the Lauzon from the Sillery division, since the line of division came naturally between this band and the other rocks of the Lauzon beneath, it was regarded as most expedient to include the upper magnesian band in the base of the Sillery formation. The same view of the age of the gneisses of the Sutton Mountain section, as the altered portion of the Sillery with a synclinal structure, was expressed by Dr. Hunt. (See *Canadian Naturalist*, vol. vii, 1862.) Character of the altered Sillery.

In Pal. Fos., 1861-65, p. 69, the occurrence of *Obolella pretiosa* is mentioned in a series of olive and greenish slates at the Grand Trunk Railway bridge over the Chaudière River, as well as in similar slates at Cape Rouge. These slates are stated to be interstratified with the Sillery sandstone as an upper part of the Quebec group, but the question as to whether this is their true position was left an open one. This specimen and a species of *Lingula* were the only fossils at that time known from the Sillery formation. The new views expressed as to the age of the Quebec group, resulting from the finding of such an extensive series of fossils, evidently gave rise to much confusion relative to the interpretation of the structure of the group, a fact clearly revealed by reference to the correspondence between Barrande, Hall and Logan, already referred to, the tendency at first being apparently to put the great bulk of these rocks into the Primordial zone, owing to Pal. Fos., 1861-65. Fossiliferous slates of the Chaudiere.

the presence of so many species of Primordial aspect. This tendency was, however, to a large extent corrected by the able work of Mr. Billings and by the more careful collecting of fossils. The results of his examination of the many new species found in the Lévis rocks are stated in detail inPal. Fos., vol. i, p. 57-96, where a full discussion of the subject from the palæontological standpoint is given. The conclusion therein arrived at regarding the age of the group was "that the true place of the Lévis formation is between the Potsdam and the Trenton, and not below the Potsdam, as still maintained by some observers." At the same time he pointed out the perfect identity of the species found in the slates and limestones of Cow Head, Newfoundfoundland, where these rocks had been studied by Mr. Richardson in 1862, and later by Mr. Murray, with those found in the rocks of Point Lévis; as also the fact that the fauna from other points in the vicinity, while somewhat different, was closely related, indicating that they could be placed in the Quebec group, though not in the Lévis formation.

Conclusions of Billings as to the position of the Lévis, 1865.

Subsequently, in the consideration of the fossils from the northwest coast of Newfoundland, the parallellism between these rocks and those of Point Lévis is stated by Billings to be so close that there is no doubt the strata of the two localities belong to the same horizon. Owing to the greater horizontality of the measures, the facilities for deciphering their true structure were supposed to be much greater than at Point Lévis and the sections given in the Geology of Canada, 1863 were re-cast, and may be given in a condensed form, as follows:

Rocks of the group in Newfoundland.

	FEET.
Quartzites, limestones, dolomites and slates of Potsdam age....	2,020
Magnesian limestones, dark grey and blackish grey limestones, representing the Calciferous formation.....	1,839
Light yellowish grey, grey and whitish, magnesian limestone, bluish-grey and black bituminous limestone, representing the intermediate beds between the Calciferous and Lévis, Upper Calciferous.....	1,361
Grey calcareous sandstones and black slates, also intermediate beds.....	700
Grey and white limestone conglomerate, black shales, etc., the shales holding the graptolites of the Levis shales, the conglomerates, the trilobites and other fossils of the similar rocks of Point Lévis.....	700
According to Billings, these are the true equivalents, of the Lévis shales and conglomerates.	
Greenish sandstone and red shales, Sillery.....	2,000

In Geol. Can. 1863, p. 879, a further comparison is made between the rocks of the Quebec group as seen in Quebec and their development

in Newfoundland, from which we learn that the lower portion or Potsdam of the latter locality is, from its lithological characters and the presence of *Paradoxides*, held to be clearly the equivalent of the red sand rock of Vermont. The graptolites, simple and compound, of the upper part of the section also leave but little doubt that these strata are the equivalents of those of Point Lévis, while at the same time the presence of *Maclurea ponderosa*, a thick-shelled and peculiar gasteropod, is common to these as well as to the Stanbridge conglomerates east of Philipsburg. The limestones of div. 2 (see above) contain fossils of Calciferous age and can be assigned to the base of that formation, while those of Philipsburg would belong to its summit. This clearly establishes the fact that the Philipsburg and Stanbridge series are newer than the red rock of Vermont, a view which is not contradicted by the stratigraphy or structural arrangement in the vicinity of Philipsburg. It follows from a consideration of the facts just presented, as is pointed out by Billings, Pal. Fos. p. 65, that "the rocks of Point Lévis, viz., the Point Lévis conglomerate limestone and graptolitic shales, are at least 2000 feet above the true Calciferous formation." From the fossils alone, he says, he "should judge that the Lévis formation immediately succeeds the Calciferous, though the physical evidence seems to show that this is not the case."

Comparisons between Quebec, Newfoundland and Philipsburg.

Position of the Lévis in regard to the calciferous.

Further, if we consider the section of the rocks of Philipsburg and vicinity (pp. 844-46, Geol. of Canada, 1863) we find that the conglomerates of Division D., which are elsewhere stated (p. 852) to be the Stanbridge conglomerates, are made up of the debris of the limestones constituting the upper part of division C. of the Philipsburg series, and regarded (see above) as of the Upper Calciferous horizon. This, of necessity, would place a physical break of considerable extent between the Upper Calciferous formation and the Lévis conglomerates; and as we have seen, from the statements and comparisons just made, that the conglomerates of Lévis, Stanbridge and Cow Head, in Newfoundland, are all of the same horizon, we must infer that those of Lévis, together with the associated graptolitic shales, are superior at least to the Upper Calciferous limestone of the Philipsburg series.

Further comparisons between Lévis and Philipsburg.

In support of the views just expressed, the paper by Billings (see *Canadian Naturalist*, 1861, vol. vi, p. 310), "on some of the Rocks and Fossils occurring near Philipsburg, C.E.," may be cited. These rocks are there divided into two series, "1st, Magnesian Limestone and Underlying Slate; 2nd, Blue thin-bedded and nodular limestone. The first division which constitutes the lower beds of the series, is found along the eastern side of Missisquoi Bay, and consists of "magnesian limestone, often arenaceous" and with quartz veins, interstratified with nearly pure limestone; also limited areas and lenticular masses of hard white or

Rocks of the Philipsburg, views of Billings.

yellowish-white sandstone, intercalated with the limestone. The thickness of the series is estimated to be not much less than 400 feet. Succeeding these are the thin-bedded, dark-colored limestones of No. 2, in which have been found about forty species of fossils which show this part of the limestone series to be the equivalent of the upper part of the Calciferous sand rock. On p. 315 *ibid.* he shows that the fossils from division, No. 2 agree very closely with those from the limestone No. 2 of Lévis, and establishes by this fact that the general aspect of the whole of the fossils from the two localities is the same, while at least one-half of the species are common to both, and then states clearly that "he holds limestone No. 2 of Philipsburg to be the equivalent of limestone No. 2 of Lévis. This statement would undoubtedly hold good were the Lévis fossils obtained from the matrix of the rock. But in *Canadian Naturalist*, 1860, vol. v, p. 301-02, in enumerating the fossils from the Lévis limestone, he says: "All the specimens described in this article were found in the conglomerate limestones near Point Lévis, opposite Quebec. It is not yet decided whether the fossils occur in the boulders of the conglomerate or in the matrix."

Philipsburg conglomerates of same horizon as those of Lévis.

That these fossils are, however, in many cases at least, clearly in the pebbles as distinct from the paste of the conglomerates is evident, and it is from this apparent neglect to distinguish between the limestone proper and the limestone pebbles of the conglomerate that much of the confusion and uncertainty appears to have arisen. This is also, to some extent, doubtless due to the early statement of Sir Wm. Logan, in Can. Nat., 1860, vol. v, p. 472, that he had satisfied himself, "notwithstanding the conglomerate aspect of the bands of rock which contain our new fossils, that the fossils are of the age of the strata."

Fossils from the pebbles of the Lévis conglomerates.

It must be remembered, however, that the problem was not even then considered as conclusively solved, and subsequent researches have shewn that some at least of the fossils found at Lévis in the pebbles of the conglomerate are of the age of the Upper Calciferous limestones, from the débris of which the conglomerate are partly made up. This fact therefore must of necessity assign both the Stanbridge and the Lévis rocks to a later period.

Such, in brief, is the history of this interesting group of rocks down to the year 1868. In the meantime, Mr. A. Murray had assumed control of the Geological Survey of Newfoundland and had begun the systematic study of the rocks of the same group as developed in that colony which were first studied by Jas. Richardson in 1860-62.

In the reports of the Newfoundland Survey, 1864, pp. 49-50, Sir Wm. Logan presents in tabular form the relative position of the several members of the Quebec group as then understood, in which he places it above the Upper Calciferous and intermediate between that forma-

Geol. Sur. of Newfoundland, 1864.

tion and the Chazy. The division of the group into three parts was given, of which the Lévis was regarded as the lowest and held to comprise the limestones, and black shales of Point Lévis, Orleans Island and Philipsburg, containing graptolites, trilobites, etc., which were, for the most part, identical with the Skiddaw slates. The second or Lauzon, once a part of the preceding, but now separated from it on account of its great mineralogical importance, was distinguished as the metalliferous zone of the Lower Silurian of North America. It embraced magnesian rocks, such as dolomites, magnesites, serpentines, diorites, chloritic and steatitic beds, with micaceous and gneissic strata and rich cupriferous slates, with gold and silver, nickel and chromium. It yielded only two fossils, an *Obolella* and two *Lingulæ*, and was overlaid by 2000 feet of sandstone and conglomerate, interstratified with green and red shales, which constituted the Sillery formation, but was apparently destitute of fossils. The opinion is again expressed that over a large part of its distribution the Quebec group is crystalline and metamorphic, and the characteristic minerals are found in both the altered and unaltered portions.

Views of structure held by Sir Wm. Logan, 1864.

In Mr. Murray's Report, 1873, page 336, the opinion of Mr. Billings, 1863, as to the age of certain fossils sent from Newfoundland is quoted thus: "These rocks are the upper part of the true Calciferous, and lie next below the Lévis formation, comparing them to divisions H, I, K, L, M, of the table on p. 879, Geol. Can., 1863, while the succeeding fossiliferous limestone conglomerates, limestones and shales of the Lévis are regarded as divisions N, O and P of the same table.

Geol. Surv., Newfoundland, 1873. Structure of the Quebec group, A. Murray.

It will be seen from all the evidence adduced from so many sources that the true position of the Lévis was very conclusively established both on palæontological and stratigraphical grounds as distinctly newer than the Calciferous, and this conclusion has been sustained by the most recent examination.

In 1868, Mr. Jas. Richardson, assisted by Mr. McOuat, began anew the study of the formations along the south side of the St. Lawrence, in the area comprised between that river and the boundary of the state of Maine, and extending from the Chaudière River on the west to the Temiscouta road which crosses the country southward from River du Loup to Temiscouata Lake. The result of this work appeared in the Report of Progress for 1869, accompanied by a map, in which the various formations there found are grouped on an entirely new plan, and supposed to extend from the base of the Potsdam to the Upper Silurian, both inclusive, the former of which was now made to include much of what had hitherto been regarded as belonging to the Quebec group. This was divided into three portions, a lower, middle and upper. The results of this exploration were briefly summed up by

J. Richardson, 1868-69.

New views of structure.

Sir Wm. Logan in his introductory report for 1869. In this report, the central axis, since found to be the extension of the Sutton Mountain anticlinal, is still described as a synclinal in the Sillery, following the old view of the structure of this range, and extending along the middle of the area "with a breadth of from two to twelve miles, affected by several minor undulations, and presenting a ridge of broken country, much covered by forest and little fitted for purposes of agriculture." On the south-east side of this ridge, the Lauzon was supposed to emerge, having a breadth of one to six miles and was followed by the black shales and limestones of the Lévis formation, which in turn were overlapped to the south-east by what was regarded as the Upper Silurian area of the Eastern Townships, but which is now known and described as of Cambro-Silurian age. The structure between this central ridge and the St. Lawrence is thus described: "On the north-west side, the Sillery is followed by the Lauzon only, in circumscribed and isolated portions, without the Lévis formation; the Sillery being in contact for a great part of its distance with what is now supposed to be a lower and unconformable series of rocks. Like the rocks of the Quebec group this lower series consists of red and black shales, limestones, sandstones and conglomerates, having an arenaceous base and limestone pebbles. It was formerly classed as belonging to that group, and it is only on the evidence of its fossils that it can be placed in a lower horizon. Some of these fossils are of known primordial species, and all have, in the opinion of Mr. Billings, an undoubted primordial aspect, but the manner in which they occur does not at once produce a satisfactory conviction that they determine the age of the deposits. The fossils, with but few exceptions, are in the pebbles of the conglomerates, which though derived from the destruction of primordial rocks may not possibly lie in such now. The series seem almost to stand in place of the Lévis, but the want of conformity shewn by the contact with the Sillery, and the occurrence of a *Salterella* in an even-bedded limestone would seem to carry the preponderance of evidence the other way. Provisionally, this series will be considered primordial, and as belonging to the upper part of the Potsdam. It consists, in ascending order, of the following divisions :—

Structure south side of the St. Lawrence.

Supposed areas of Potsdam rocks.

1. Red and green shales, surmounted by even-bedded grey limestones, in which a species of *Salterella* occurs, with black phosphatic nodules.
2. Grey sandstone, with black shales interstratified with conglomerates, having a calcareo-arenaceous cement, and holding limestone pebbles, with occasional black phosphatic nodules. The limestone pebbles hold fossils of primordial type.

3. Grey, quartzose sandstones, passing into quartzite, which are often of a conglomerate character, with limestone pebbles, holding fossils like those of the previous division. The beds are occasionally interstratified with black shales.

These deposits present themselves between the Sillery ridge and the St. Lawrence, in a belt of country extending the whole distance examined, with a breadth in one part of twelve miles. In this they are arranged in two main synclinal forms with many minute undulations, and they are overlaid uncomformably by two long synclinals of the Lauzon and Sillery, one of them with a stretch of sixty miles."

The above are the latest views published by the Geological Survey as to the age and structure of the rocks of this group, prior to the report of Dr. Selwyn in Rep. Prog., 1877-78, pp. 3A-9A. It is evident that much of the confusion which has arisen as to the correct interpretation of the geological structure of south-eastern Quebec is due to the opinion expressed in the first years of its study, viz., that the rocks of the Sutton Mountain range and of its extension to the north-east were arranged in synclinal instead of anticlinal form. This error in turn doubtless arose from the confounding of several distinct formations of sandstones and quartzites in one general group, subsequently styled the Sillery, a mistake first pointed out by Dr. Selwyn in the report just alluded to. Another source of error, and possibly the most considerable, was the assumption that the metamorphic rocks of that area must of necessity be the equivalents of the unaltered sediments of the St. Lawrence region, a theory which once suggested, seems to have been unhesitatingly maintained, although for its support, unnecessary inversions of strata, and profound chemical changes were requisite. That there is no marked lithological resemblance between the schists and other crystalline rocks of the central anticlinal and the ordinary sediments of the Lévis, Lauzon and Sillery, is a fact patent to any one who has ever studied the geology of the two areas.

New views of structure by Dr. Selwyn, 1877-78.

The new views of structure regarding the rocks of the Quebec group, put forth by Dr. Selwyn in the Rep. Prog., 1877-78, may be here briefly noted, owing to the great importance of the changes there made in the stratigraphical relations of the original divisions of that group. Three distinct series were recognized in descending order, as follows:

"1. Lower Silurian, held to represent the comparatively unaltered and fossiliferous portion.

2. The Volcanic Group, probably Lower Cambrian, including the coarse, thick-bedded, felspathic, chloritic and quartzose sandstones, and siliceous shalesof various colors; differing much in character from the more shaly though often similarly colored sediments of the first division, with dioritic and serpentinous rocks, crystalline dolomites, etc.

Cambrian and probably Pre-Cambrian first recognized.

3. The Crystalline Schist Group (Huronian ?), embracing the chloritic, micaceous, siliceous and other schists, also imperfect gneisses, white and grey crystalline, micaceous dolomites, and magnesian limestones, which constitute the main anticlinal of the region, and can be traced north-east through Sutton Mountain to the rear of Point Lévis."

In addition to the pointing out of the mistake which had for so long been made in the grouping of so many widely differing horizons of sandstone and quartzite in the Sillery formation as the upper portion of the Quebec group, the opinion was expressed (page 4A) that no sufficient evidence existed of any kind for the separation of the Potsdam areas indicated in the Report 1869, although the possibility of the occurrence of rocks of that age in the great mass of the fossiliferous series was admitted. In this Report the direction of the principal fault by which the Utica beds of the north side of the Island of Orleans are brought against the Lévis shales and conglomerates, and which had hitherto been held to pass in rear of the Citadel of Quebec, was changed to pass in front of the city and to reach the north side of the St. Lawrence, about one mile north of Point à Pizeau at Wolfe's Cove. The correctness of this view has since been clearly established by the finding of fossils in the city of Quebec, not only in the Cove Fields and in front of the new Parliament Buildings, but also in the cliffs bordering Champlain street, along the side of the River St. Lawrence, all of which present forms similar to those found in the rocks along the north-west side of the Island of Orleans and indicate, doubtless, a similar horizon.

Position of the great fault changed to rear of Citadellin Quebec.

The lithological aspect of the strata at Quebec and Point Lévis also shows the probable difference in the age of the rocks on either side of the river, since, while the beds which make up the cliffs of Cape Diamond, and for some distance up the river from that point, as well as those seen in excavations along the Cape Rouge Road, in rear of Spencer Wood, present the usual aspect of the black bituminous shales, with their peculiar fauna of graptolites of Utica-Trenton types. The characteristic red and green shales which form the cliffs at Point Lévis are seen to reach the west shore of the river at the depression of Wolfe's Cove, where they rest upon the newer bituminous shales and limestones, the contact being evidently due to a profound fault by which the highly graptolitic beds and associated limestone conglomerates, seen along the line of the Intercolonial Railway, below the lower ferry, are cut off before reaching the shore above Cape Diamond. In the red beds and associated strata at Point a Pizeau, which constitute the cliff in front of the church at that place, *Obolella pretiosa* occurs, a form precisely similar to that found at the Chaudière Railway bridge, as well as at the falls below, on that stream.

Difference in character of the rock along shore above Quebec.

Fault at Wolfe's Cove.

The line of this fault to the west of the point where it reaches the shore at Wolfe's Cove is indicated by Dr. Selwyn as passing to the north of Ste. Foye and thence south-westerly to the river again, where it crosses above Cape Rouge. This point may be said to be about two miles above the Cape, whence crossing to the south side of the river the contact is seen in the cliffs, about two miles south of the mouth of the River Rouert, and not far from the church of St. Nicholas. Thence it extends south-westerly in the direction of Lake Champlain to Missisquoi Bay. Fault at Ste. Foye.

In many respects the most important paper relating to the fossils of this group is that by Prof. Lapworth, published in the Transactions of the Royal of Society Canada, for 1886. This paper embodies the results of the examination of a large suite of specimens, mostly graptolites, collected along the shores of the St. Lawrence at various points from Point Lévis to Cape Rosier by Mr. T. C. Weston, but including also a few labelled from the vicinity of Cape Rouge, collected by Mr. Billings, and certain poorly preserved specimens from Cape Breton by Mr. Fletcher. The graptolites have been arranged by Prof. Lapworth into three zones and one sub-zone as follows: Prof. Lapworth, 1886.

Zone I, Cape Rosier Zone.—Zone of *Dictyonema sociale* and *Bryograptus*.

Zone II, Ste. Anne Zone.—Zone of *Phyllograptus Anna*. Graptolites from the rocks three miles above Ste. Anne.

Zone III, Griffin Point or Marsouin River Zone.—Zone of *Cœnograptus gracillis* including

Sub-Zone III A.—Rocks of the Cove fields and St. John's Market, Quebec, and the north side of the Island of Orleans.

Of these the first is considered to represent the oldest or to be of the horizon of the Cambrian, principally from the presence of *Dictyonema sociale*, a *Clonograptus* and a *Dichograptus*, two of which are regarded as new species. This *Dictyonema* has not, in so far as is yet known, been figured from the Point Lévis beds, the most westerly point from which it is reported being Matane. Graptolitic zone I., presumably Cambrian.

Zone II is regarded by Prof. Lapworth as newer than the preceding by a well marked interval, and as much older than Zone III. None of its species are common to the other zones, so far as known, nor are they known in European equivalents of these zones. The species determined, which are principally from Ste. Anne des Monts, are all well known Point Lévis species, according to Prof. Hall, and pertain to the corresponding Arenig-Skiddaw of the English Survey. Zone II. base of Cambro-Silurian.

The third zone is also distinguished apparently by a fauna peculiarly its own, "the presence of a single one of which is sufficient to settle the age of the rocks in Great Britain, and in all likelihood in America." Zone III.

The rocks of this zone have been long regarded by the Geological Survey as belonging to the horizon of the Utica or Hudson River, and are so described in earlier reports. This view was derived from the similiarity of the contained graptolites to those found on the Hudson River, at Norman's Kill, which was first pointed out by Prof. Jas. Hall, to which position the New York geologists have always assigned the strata of that place. Prof. Lapworth holds that while there is no doubt that the fossils found in the rocks of Zone III belong to the second Ordovician or Cambro-Silurian fauna, they are newer than the graptolitic strata of Point Lévis, that is, they belong to the Trenton-Utica instead of the Calciferous-Chazy fauna on the one hand, or of the Utica-Hudson on the other.

Zone III. presumably Trenton-Utica.

The position of Zone III, the equivalent of the Norman's Kill rocks, is, according to Lapworth, about the middle of the Llandeilo formation, above the Arenig and below the Caradoc, or in Canadian geology, about midway between the base of the Point Lévis phyllo graptus beds and the summit of the Loraine or Hudson River group.

Sub-zone A.

The position of the Sub-zone A appears to be difficult to decide. Prof. Lapworth says "the specimens are all of Llandeilo-Bala age and the general facies indicates a horizon about the summit of the Cœnograptus or Marsouin beds zone." He says, "the association of forms reminds me of that of the highest Glenkiln or lowest Hartfell beds of the south of Scotland. I should imagine that they follow on at once upon the Cœnograptus beds without a break. Indeed, it is possible that *Cœnograptus* may be detected among them,* but, judging from the British phenomena, this is doubtful. It is not unlikely that these Cove-field beds mark the transition from the Marsouin beds into the lowest zone of the Black River and Trenton limestone. The presence of a form identical with or closely allied to the *G. amplexicaulis* of Hall, points in this direction."

"There is nothing in the Cove-fields or St. John's market fauna that reminds us in the slightest degree of the fauna of Point Lévis. The fossils are the fossils of the Marsouin River fauna or second Ordovician fauna, and have not a species in common with the first Ordovician fauna—the typical fauna of Point Lévis."

Prof. Lapworth summarizes the results of his investigations on the fossils from the various localities as follows:

Conclusions of Prof. Lapworth as to the horizons of the graptolites.

"1. The graptolites of the collections examined are all derived from rocks of greater antiquity than the so-called Utica and Hudson River rocks, if we regard these as typified by the fauna hitherto described from the graptolitic rocks of Lake St. John, Canada, and those of the Valley of the Mohawk, in the State of New York.

* Found by Mr. Ami in 1888 on the north-west side of the Island of Orleans.

2. There are two grand faunas represented in the collection, viz.: Two grand faunas represented.

A. The so-called Quebec fauna of the Calciferous-Chazy formations of Cape Breton, Cape Rosier, Point Lévis and Ste. Anne, which answers to the fauna of the British Upper Tremadoc and Arenig rocks and their European equivalents.

B. The Griffin Cove, Marsouin River and Norman's Kill fauna, which answers to the faunas of the middle zones of the European Ordovician or Cambro-Silurian rocks.

3. In each of these grand faunas are found two sub-faunas, those of the lower fauna being the most distinctly separable. Two sub-faunas.

A. Quebec or Calciferous-Chazy fauna:—

Sub-fauna 1. Cape Rosier, and Barasois River zone of Calciferous age. Tremadoc rocks of Great Britain, and *Ceratopyge* and *Dictyonema* beds of Norway.

Sub-fauna 2. The Ste. Anne River Zone of Point Lévis age, typical Arenig of Great Britain. *Phyllograptus* beds of Scandinavia.

B. Trentonian, Marsouin River or Norman's Kill Fauna:—

Sub-fauna 1. The Cœnograptus Zone of Griffin's Cove and the Marsouin River, answering to the Middle Llandeilo beds of Great Britain and the Glenkiln beds of Scotland, etc.

Sub-fauna 2. The Cove-fields and Island of Orleans sub-fauna. Apparently destitute of *Cœnograptus gracilis*, and answering to the highest Llandeilo or lowest Caradoc beds of England.

4. The last of these sub-faunas shews evidence of transition into the Utica-Loraine graptolitic fauna of the Mohawk Valley, New York and of Lake St. John, Canada."

Concerning the position of the upper division, formerly the Hudson River and Utica of Logan and Hall, Prof. Lapworth says:—"It appears at present that we are destitute of any clear evidence that true Utica and Hudson River strata occur anywhere along the south side of the St. Lawrence from Gaspé to Quebec, all the strata seeming to be older in point of time than the Utica proper, as typified by the rocks of the Ottawa and Lake St. John. As to the two formations of the Trenton and Utica, being mapped in New York and Western Canada essentially on lithological grounds, it is exceedingly probable that the line between them differs greatly in true geological age, when followed from Quebec to Ottawa and New York; so that in some localities, where the Trenton limestone series is poorly developed, the Utica of that locality actually descends to and includes the Norman's Kill and Marsouin Zone. But this is a fact for future investigation. The facts as they stand, relate Lapworth's conclusions as to the upper divisions formerly supposed to be Hudson River or Utica.

the Marsouin and graptolitic shales to the Trenton, rather than to the Utica slates, as at present understood."*

Quebec City rocks.

"The so-called Quebec rocks, of the town of Quebec, as typified by the fossils forwarded from the Cove fields and St. John's Market, are not of Quebec age at all. They are probably the newest rocks represented in the collection, and possibly shade upwards from the Marsouin graptolitic shales of Orleans Island and Cape Rouge.† They appear, however, to be of greater antiquity than the Utica shales of Lake St. John, answering to the basement zone of the British Bala, instead of to the middle zone, which seems to be the place of the Lake St. John shales."

General conclusions.

From a careful consideration of all the facts presented in the valuable paper of Prof. Lapworth, it is evident that in the main the Geological position of the associated rocks, as constituting a lower portion of the Cambro-Silurian system given in the preceding pages, from both the stratigraphical and palæontological evidence, is clearly maintained by the latest determination of the graptolitic fauna, with the possible exception of the lowest or *Dictyonema* zone, which from the presence of three species only is considered by Prof. Lapworth to belong to a lower formation. Of these species, two, a *Clonograptus* and a *Dichograptus*, are apparently new, and as yet undetermined, and their occurrence need not therefore be considered conclusive as determining exact zones. The presence of *Dictyonema* appears, then, to be the only reason why those portions in which this form is known to occur, otherwise intimately associated with strata holding Cambro-Silurian fossils, and which have so long been regarded as belonging to that group, should be removed from their apparently proper position in the series and placed in a different geological system; and in view of the wide range *Dictyonema* is known to possess, we may well hesitate before deciding upon such a separation, unless confirmatory stratigraphical evidence can be presented.

Distribution of the unaltered Quebec group rocks.

The rocks which have been described above, as belonging to the unaltered Quebec group, form a belt along the south side of the St. Lawrence, having a breadth of from twelve to twenty-five miles. Their characters have been given with great fulness in the reports already reviewed.

Work of the past two seasons.

During the past two seasons, but more especially in 1888, much time has been devoted to a systematic study of the several divi-

* All the stratigraphical evidence shows that the beds in question are above the Trenton limestone. They probably represent a downward development and great thickening out of the Utica proper of Lake St. John, Ottawa and New York.—A. R. C. S.

† In regard to the fossils from bituminous shales said to be from Cape Rouge, there is probably some mistake in the labelling of the specimens, the rocks of that place being the oldest of the fossiliferous Q. G. series.—R. W. E.

sions of the group and its contained fossils, more particularly in the vicinity of the St. Lawrence River, where magnificent sections are afforded along the south shore, as well as on the group of islands lying midway in the channel. Of all of these, and of the main shore, carefully paced surveys were made as far as the River Ouelle. These surveys have now been plotted to a uniform scale of twenty chains to the inch, as it was found that on any smaller scale the many complicated folds and faults which everywhere affect these rocks could not be indicated. The object of these surveys was to determine, if possible, the true relative positions of the Lévis and Sillery conglomerates, sandstones and shales, the results of which may now be given in some detail.

Coast surveys.

In the vicinity of Lévis, St. Joseph, and on the extreme south-west end of Orleans Island, the series of shales, black, green and grey, with hard, generally thin bands of yellow weathering, dolomitic limestone, and beds of greyish limestone conglomerate, usually known as the Lévis formation, is well exposed. The slates are generally easily recognized on smoothed weathered surfaces, from their usually greenish shade striped with black, and in certain portions, more particularly the black bands, they are thickly covered with impressions of graptolites and other fossils as lingulæ, discinæ, etc. These peculiar rocks, while occasionally seen at other points, have not apparently a wide distribution along the coast or adjacent country between Levis and River du Loup, at which place our examinations during the past season ended. The beds of limestone conglomerate which are associated with these are generally thin, and frequently occur as lenticular and often local masses, thinning out rapidly at either extremity. About Lévis these conglomerates occur in a series of outcrops between the river front and the road to the south-east of the forts, about one mile and a-half distant, and their distribution and synclinal arrangement have been very clearly indicated by Sir Wm. Logan in the atlas accompanying the Geology of Canada, 1863. Since that time, however, the building of the Lévis forts has disclosed outcrops, at that date concealed, some of which have been found to be richly fossiliferous, and these have thrown additional light upon the vexed question of the structure and relative position of the various beds in this area.

Rocks of Lévis and vicinity.

Limestone conglomerates.

In the section accompanying the map of the distribution of the limestone conglomerates at Lévis, just referred to, the series of anticlinals which occur on the line of section between the river and the middle fort, is indicated. Four well defined axes can be recognized in this distance, two of which at least are completely overturned. Of these the most easily recognized is that along the cliff which fronts or overhangs the road between the Victoria hotel at Point Lévis and St.

Four anticlinals at Lévis.

First anticlinal.

Joseph. On the road going up this cliff, along the stone wall, about 300 yards south of the lower ferry, the overturned arch of this fold is clearly seen near the sharp bend at the top. Above this, toward Point Lévis, the same overturned and at times crushed beds, which indicate the crest of the anticlinal, are also well exposed; these beds along the road, near the toll-gate, have yielded a considerable variety of forms, among which the following are easily recognized :—*

RHABDOPHORA.

Fossils from below Victoria Hotel, Point Lévis.

1. *Diplograptus tricornis*, Carruthers.
2. " sp.
3. " *folium*, Hisinger (as of Nicholson).
4. *Glossograptus ciliatus*, Emmons.
5. " sp. indt.
6. *Trigonograptus ensiformis*, Hall.
7. *Clonograptus rigidus ?* Hall.
8. *Climacograptus*, sp. indt.
9. " *scalaris*, Hisinger.
10. *Nemagraptus*, sp.
11. *Dichograptus ? ramulus*, Hall.

BRACHIOPODA.

12. *Orthis*, Sp. allied to *O. Hippolyte*, Billings.

A short distance below the Victoria Hotel, in the black and green shales overlying the red, were found :—

1. *Phyllograptus typus*, Hall.
2. *Dichograptus*, sp.
3. *Tetragraptus brachiatus*, Hall.
4. *Didymograptus constrictus*, Hall.
5. *Dawsonia*, sp.

From conglomerate band west of the toll gate were obtained :—

1. *Crinoidal columns.*
2. *Leptæna decipiens*, Billings.
3. *Euomphalus*, sp.

Lowest Lévis zone.

The fossils above enumerated were obtained partly from the limestone bands and partly from the black and green shales, and should properly represent the lowest portion of the Levis formation as dis-

* These fossils have been examined and determined by Mr. H. M. Ami.—R. W. E.

tinguished from the Sillery, since directly underlying them are the red and green Obolella shales which form the anticlinal near the Victoria hotel, and with which are associated the beds of Sillery sandstone. These red shales, in rear of the hotel have also yielded graptolites, but owing to the crushed nature of the beds, the former are badly preserved and much distorted, and have not yet been determined. *Obolella pretiosa* is also found here.

Rocks south-east of Point Lévis.

From the Victoria hotel, the road going up the steep hill in the rear to the south-east passes over these red and green shales, and a short distance beyond the most westerly of the three Lévis forts, the peculiar grit and sandstone known as the "Sillery sandstone" occur in several well-defined ridges extending eastward at intervals for about three miles, and separated from each other by beds of red and green and sometimes black or grey shales. The character of these sandstones has already been given, and they sometimes pass into a fine conglomerate made up for the most part of pebbles of quartz with pieces of shale. These different kinds of rock are well seen in the quarries to the south-east of Point Lévis. Tracing these outcrops of siliceous rock they are found to be, in every case observed, lenticular masses, sometimes very limited in extent, but occasionally of very considerable area, enclosed in the red shales in the same way as on the west side of the river at the Sillery quarries. It is plain, therefore, that the Sillery sandstones and associated red shales are part of the same formation. Now, if we examine the series of anticlinals which occur between the lower ferry of Lévis and the middle fort we find these red shales cropping out in nearly or quite every case where the anticlinals occur, and dividing the synclinal areas which hold the graptolitic shales and associated limestone conglomerates, thus clearly indicating the lower position of the red shale series. In order to prove conclusively the synclinal structure of the Lévis graptolitic shales, carefully located collections of fossils were made at various points, more particularly along a line of section between the Intercolonial Railway and fort No. 2, from which the following results have been derived.

Association of Sillery sandstones with red shales.

Intercolonial Railway cutting below Lévis.

A "Tetragraptus zone" is seen in a cutting on the Intercolonial Railway 1600 paces below the lower ferry or I. C. R. station. These overlie a thin band of limestone conglomerate and are in turn overlaid by a heavy band of the same, the paste of which is highly siliceous and in places almost a quartzite with scattered pebbles of limestone: a short distance further west, these shales and conglomerates are underlaid by heavy beds of hard Sillery-like sandstone and grit. The fossils in this cutting are abundant and the zone is one of the lowest in the Lévis series. Among the species collected the following have been definitely recognized:—

Fossils.

1. *Dichograptus octobrachiatus*, Hall.
2. " *Richardsoni*, "
3. *Goniograptus Thureaui ?* McCoy, or n. sp.
4. *Tetragraptus serra, Brongt.* (= *T. bryonoides*, Hall.)
5. " *quadribrachiatus*, Hall.
6. " *approximatus*, Nicholson.
7. " *fruticosus ?* Hall.
8. *Clonograptus flexilis*, Hall.
9. *Phyllograptus typus*, Hall.
10. *Lingula Irene*, Hall.

Road from Lévis to St. Joseph.

The beds of shale from which the above fossils were obtained occur on the northern side of the most westerly synclinal in the Lévis rocks. Passing southward along the line of railway about 700 yards, an offset of eighty paces to the south-east, brings one to the steep pitch and curve in the road from Lévis to St. Joseph. Here, in the cliff just to the right of the main road, looking down the river, are highly fossiliferous black and green slates which lie on the east side of the overturned synclinal basin along the centre of which the road to St. Joseph extends. The similarity of these beds to those just described will be evident from the accompanying list of forms there obtained; the zone may, for the sake of reference, be styled the " Didymograptus zone " :—

Fossils.

1. *Didymograptus bifidus*, Hall.
2. " *extensus*, Hall.
3. " *furcillatus*, Hall.
4. " *pennatulus*, Hall.
5. *Tetragraptus Bigsbyi*, Hall.
6. " *fruticosus*, Hall.
7. " *serra*, Brongt.
8. *Phyllograptus typus*, Hall.
9. *Clonograptus*, sp.
10. *Dictyonema*, n. sp. (allied to *D. delicatulum* Dn., preoccupied.)
11. *Lingula Irene*, Billings.
12. " *Quebecensis*, Billings.
13. *? Siphonotreta micula*, McCoy.

On the continuation of this cliff, one hundred and fifty yards to the west, the following were obtained :

1. *Dendrograptus*, sp.
2. *Dictyograptus*, cf. *D. Homfrayi.*
3. *Tetragraptus serra*, Brongt.
4. *Lingula*, allied to *L. Quebecensis.*

5. *Linnarssonia*, sp.
6. *Lingula*, sp.
7. *Shumardia granulosa*.

Fossils from cliff facing the foundry, Lévis.

Further west, in front of Carriere & Laine's foundry, a further collection was made as follows :

1. *Tetragraptus quadribrachiatus*, Hall.
2. " *Bigsbyi*, Hall.
3. " *serra*, Brongt. (= *T. bryonoides.*)
4. *Diplograptus dentatus*, Brongt. (= *D. pristiniformis*, Hall.)
5. *Dictyograptus*, n. sp.
6. " *irregularis ?* Hall.
7. *Dictyonema delicatulu ?* Dn. sp. (Species preoccupied 1881, Lapworth.)
8. *Nemagraptus capillaris.*
9. *Leptobolus ?* n. sp.
10. *Lingula*, n. sp.
11. *Orthis*, sp.
12. *Lingula Quebecensis*, Billings.
13. " *Irene*, Billings.
14. *Shumardia granulosa*, Billings.

Fossils from City Hall, Lévis.

Ascending the cliff near this point by a flight of steps, a band of red shales is seen near the brow of the hill. To the east, on the summit of the cliff, above the other localities, thin bands of limestone conglomerate occur and the crest of the first anticlinal passes through this point. Continuing the section towards the front street in the city of Lévis a series of greenish-grey shales, striped with black, is passed over, which extends to the city hall. Here excavations have been made in beds of shales associated with limestone conglomerate, many of which are thickly studded with graptolites , among which were determined :

1. *Didymograptus extensus*, Hall.
2. *do* *pennatulus*, Hall ? (= *D. Murchisoni*, Carr.)
3. *do* *bifidus*, Hall.
4. *Tetragraptus serra, Brongt.* (=*T. bryonoides.* Hall.)
5. *do* *Bigsbyi*, Hall.
6. *do* *fruticosus*, Hall.
7. *do* *denticulatus*, Hall.
8. *Dichograptus octobrachiatus*, Hall.
9. *do* (?) *Richardsoni*, Hall.
10. *Phyllograptus typus*, Hall.
11. *Lingula Quebecensis*, Billings.

From the pebbles of the associated limestone conglomerates were obtained Crinoidal columns, *Orthis*, sp. *Salterella*, sp. *Illœnus*, sp.

From the shales associated with the limestone conglomerates of the middle fort were obtained :—

1. *Phyllograptus typus*, Hall.
2. " *angustifolius*, Hall.

and from the associated greyish and black shales,
Lingula Quebecensis, Billings.

Positions of the several anticlinals at Lévis.

The axis of the second anticlinal in this section is in the town of Lévis about a fourth of a mile back from the edge of the cliff on the road up from above the lower ferry, the opposing dips being clearly seen and the underlying red Sillery shales showing in the streets. The axis of this should cross the road from the city hall to fort No. 2, near the Catholic church. Limestone conglomerates again occur on this road, ten chains south-east from the main back road in Lévis and rest on both sides upon the red slates; this marks presumably the crest of the third anticlinal. The fourth occurs near the corner of the road a short distance west of the fort No. 2, where hard gritty beds with red and green shales are exposed overlaid on the eastern side by the usual Lévis black and striped grey shales and limestone conglomerates in thin bands, the synclinal structure of which, and their overlying position in regard to the red slates, can be well seen in the trench along the east side of the embankment which connects the different forts. Thence to the east of fort No. 2 the limestone conglomerates and fossiliferous shales are well exposed in low ridges, the structure of this portion to the St. Henry road being doubtless an overturned synclinal, since on that road just beyond the toll gate the red shales and sandstones of the Sillery again occur.

The general dip of most of the beds in this line of section is to the south-east, and at first glance the series would appear to be a regularly ascending one. At several points, however, the overturned position of the beds is very evident and thus gives a key to what we believe to be the true structure as indicated above. That the limestone conglomerates and associated shales occur in synclinals is very clear from the section exposed in the cutting in the Intercolonial Railway at St. Joseph station where the northern end of a synclinal is cut directly across.

Lévis shales and conglomerates overlie the Sillery.

Sir Wm. Logan's section

The anticlinal structure of the greater part of this section is well shewn on the map of Lévis, published by Sir W. Logan in 1866, though the overturned synclinal in the eastern portion is not there indicated, the red shales being represented as coming in upon the Lévis conglomerates and fossiliferous shales in the upper portion of the group.

The fossils above described, while apparently not very greatly differing in their horizon, may be all regarded as pertaining to the Lévis formation, the lowest division being that found just below the Victoria hotel where the relationship to the red shales of the upper part of the Sillery is very close. On the shore below St. Joseph are several localities from which fossils were obtained, of which the lowest is very similar to that near the Victoria hotel. This is on the west side of the cove where the brook which crosses the I.C.R. at Harlaka Junction enters the St. Lawrence about one mile and a half north-east of that place. Here the graptolites occur in a band of black and green shales in places irony and interstratified with red and green shales of the upper Sillery, and contain, besides the graptolites, *Obolella pretiosa*, the same as found in the shales of Point Lévis and at Point a Pizeau. These presumably represent the lowest zone of graptolites in the Pointe Lévis section. The species determined are:— Shore below St. Joseph. Fossils.

1. *Tetragraptus serra*, Brongniart.
2. *Didymograptus extensus*, Hall.
3. *Obolella*, prob. *O. pretiosa*.
4. " sp.

On the shore, half a mile to the west, certain bands of black and greyish dolomitic shales with green and brown slates are thickly studded with graptolites, among which are:—

1. *Phyllograptus angustifolius*, Hall.
2. *Tetragraptus serra*, Brongniart.
3. " *approximatus*, Nicholson.
4. " *Bigsbyi*, Hall.
5. " *quadribrachiatus*, Hall.
6. " *Hicksi*, Lapworth.
7. *Didymograptus*, allied to *D. furcillatus*, Lapworth.

In the cutting in the snowshed on the Intercolonial Railway, half a mile west of Harlaka junction, a series of red, green, black and brown shales occur, the red portion of which is evidently of upper Sillery age, since they contain enclosed beds of Sillery sandstone a short distance to the south-west. They also hold fossils, from which a cursory examination revealed the presence of:— Snow-shed cutting west of Harlaka Junction.

1. *Lingula Quebecensis*, Billings.
2. *Phyllograptus typus*, Hall, with other forms.
3. *Tetragraptus serra*, Brongniart.

The foregoing lists of fossils from various points will give a fair idea of the fauna of the typical Lévis rocks. Other collections were made from the interstratified beds of conglomerates, but as these were in all cases from the limestone pebbles, and not from the matrix, their value in determining exact horizons from these rocks is doubtful. It may, however, be said that while several of the former, more especially of the trilobites, have a Cambrian aspect, many of the others have a distinctly Cambro-Silurian character, and in some of the pebbles, graptolites of the kind found in the lower zone from the Intercolonial Railway cutting were obtained. The forms obtained from the pebbles in the various bands of conglomerate will be enumerated in a subsequent page.

Character of the fossils from pebbles in the limestone conglomerates.

The red shales and Sillery sandstone series, which are now held to underlie the fossiliferous Lévis rocks just described, first appear at the Victoria hotel, which point may be taken as forming their most northerly limit along the south side of the St. Lawrence, in the vicinity of Lévis at least, since to the northward they are almost entirely and directly overlaid by the Lévis shales and conglomerates; but on the roads going south-east toward St. Henry, of which there are two, one straight out past fort No. 2, and the other following up the valley of the Etchemin, the Sillery rocks are well displayed. For a space of nearly four miles, ridges of sandstone and grit form prominent features in the landscape, and break the otherwise monotonous character of the flat country between Lévis and St. Henry. On the Etchemin River these areas of sandstone first commence one mile below the Intercolonial Railway bridge. To the west of Lévis the red shales form conspicuous cliffs in the direction of Hadlow, near which place the interstratified beds of sandstone come to the railway. Thence toward Chaudière junction, along the line of the Intercolonial, formerly the Grand Trunk, alternations of red, green and black shale, with areas of sandstone, occur, to within one mile and a-half of that point, or almost to the railway branch crossing to Breakey's mill. All these beds along the railway have a very regular dip to the south $< 35°$ 60°. Beyond this place the country is covered by clay to the junction, where a small cutting in black and green shales shows the presence of *Obolella*. Along the south side of the St. Lawrence the ridges of Sillery sandstone continue to the mouth of the Chaudière, having a breadth southward on that stream of one and three-fourths of a mile, or to the Grand Falls below the Grand Trunk Railway bridge. At the falls, which are over heavy beds of red and green shale, holding *Obolella pretiosa* with thick, interstratified beds of grey sandstone, the strata dip S. $< 40°$, the sandstone and grit being largely developed below this point to the mouth of the Chaudière. To the west of this river they continue along the south bank of the St. Lawrence for

Sillery sandstones and shales.

Lévis to Chaudière Junction.

Chaudière River, lower part.

about three miles, when the exposures of grit and sandstone cease, the shore above showing beds of red, green, black and grey shales. Along this part of the river the diverse dips visible show this portion of the Sillery formation to be thrown into a series of folds, equalling those which are found in the the rocks at Lévis and below that place. On the St. Lawrence section above the Chaudière, after passing the outcrops of sandstone, the red and green shale series extends to a point two miles above the wharf at St. Nicholas, where the fault from the north side of the river brings them into contact with fossiliferous strata of Hudson River age, the particulars of which have already been given. To the south of the St. Lawrence, along the line of the Grand Trunk between the Chaudière and the Becancour rivers, but few outcrops of rocks are visible. Where seen they consist of red, green and black shales, with an occasional low ridge of hard Sillery sandstone, similar to what is visible at the railway bridge on the Chaudière, and where the inter-stratified beds of black and green shale contain abundance of *Obolella pretiosa*, with *Protospongia fenestrata*, *Lingula* and two species of *Phyllograptus*. This fauna may be classed as that of the upper Sillery.

West of the Chaudière River.

Fossils from Chaudière at Railway Bridge

On the west or Quebec side of the St. Lawrence a carefully paced section was made along the shore from that city to the mouth of the Jacques Cartier River. The part more particularly referring to this group of rocks is that included between Wolfe's Cove, two miles above the city, where the fault between the rocks of the citadel and those of the Sillery formation reaches the shore, and a point one mile and three-quarters above the mouth of Cape Rouge River, where the fault between these rocks and the Hudson River formation comes to the river from the vicinity of Ste. Foye. In this section, which apparently comprises all the members of the Quebec group visible on the north side of the river, no trace of the Lévis fossiliferous shales and conglomerates is seen. The section is presumably an ascending one from the contact fault above Cape Rouge to the extremity of Point à Pizeau, though several local faults in the upper Sillery portion have complicated the structure somewhat.

Cape Rouge to Wolfe's Cove.

The lowest rocks seen in this section, according to this view, are hard quartzose sandstones, calcareous in the joints, and associated with black, grey and green shales and occasional thin bands of limestone, and holding a band of limestone conglomerate four feet thick, which is made up of small pebbles of hard grey limestoneand white quartz, in a very hard, greyish, siliceous paste, the whole differing greatly in aspect from the conglomerates of Lévis. The quartzites form a ridge or hill, over which the road up the river from Cape Rouge passes, and along which the beds are well exposed. They dip south-easterly $< 50°$-$80°$. Occasionally pebbles of greyish limestone are scattered

Characters of the rocks near Cape Rouge.

Cape Rouge village.

through the quartzite. These rocks extend along the shore toward Cape Rouge for nearly a mile, beds of green, grey and black shale predominating in their upper part, many of which are covered with fucoids, and approaching the mouth of Cape Rouge River a few beds of dark-red shale are seen. Along the road going up the steep hill above the village the black, green and grey shales are well seen in the cuttings, but, though closely examined, no graptolites or other fossils were found. Following the shore northward, these shales clearly underlie the dark-red and green shales of the headland from which this locality takes its name, and they shew, a short distance further east, interstratified beds of Sillery sandstone, in which the Sillery quarries are situated. Thence these alternations of red and green shales and sandstones extend almost to Pointe à Pizeau, the sandstones terminating about half a mile west of the road leading to the Sillery church at this

Point à Pizeau.

place. The lenticular and often local character of the sandstones already noticed is well seen in this section. From Point à Pizeau to Wolfe's Cove no sandstones show, the rocks being red, green and black shales. From these, in the cliff in front of Sillery church, *Obolella pretiosa* was obtained, the rocks being precisely like those at the Grand Trunk Railroad bridge over the Chaudière. The strata along this part of the section are thrown into several folds, and faults, generally local and probably of small extent, are visible at several points. The areas of sandstone in rear of Sillery are in no case of any great thickness, that in which the quarry is located being probably as thick as any; its surface breadth on the road to the west is 320 paces, with an estimated vertical thickness of about 250 feet, in which, however, several partings of shale occur. The contact of these red and green

Fault at Wolfe's Cove.

shales of the Sillery series with the black bituminous shales and dark-brown bituminous limestones of the citadel series is well seen fifty paces north of the forks of the road leading up the hill from the head of Wolfe's Cove, a deep gully marking its probable course, and the fault extends thence through the grounds of Spencer Wood in a direct line to the forks of the road east of Ste. Foye, whence it changes its course and passes to the north of that village, 100 yards from the main road, changing again a short distance west, and extending thence to the St. Lawrence above Cape Rouge, as already indicated. By the fault north of Ste. Foye the grey shales and sandstones of the Hudson River series are brought into contact with the red and green shales of the Sillery.

Rocks of Quebec City.

In the report of 1863 the shales, limestones and conglomerates of the Citadel and city of Quebec were supposed to belong to the upper part of the Lévis formation, and to underlie very closely the red shales of the Sillery, though their true position was even then regarded as very doubtful.

The subsequent study of these rocks by Dr. Selwyn brought some new facts to light, from which, both on stratigraphical grounds and from the evidence of fossils collected at several points in the city, it was decided that the position of these rocks was much newer and altogether above the Lévis and Sillery strata. Additional large collections of fossils from various points in the city were made during the past season by Messrs. Ami and Giroux, the result of the examination of which, and some points in regard to the structure, will be given further on. Recent collections of fossils at Quebec.

From Wolfe's Cove the red and green shales of the Sillery cross the St. Lawrence and appear on the east side at Point Lévis, where their distribution has already been given, and none of the graptolitic shales or conglomerates of the Lévis series have been recognized on the north side of the river, these being confined in this area to the town of Lévis itself, where they rest on the red and green shales, as described, whence they extend to St. Joseph and along the shore for about two miles below, as indicated by the fossils enumerated on page 58K. Thence crossing the south channel of the St. Lawrence, they constitute a limited area in the extreme south-west end of the Island of Orleans, the southern margin of which is seen to be terminated by a well-defined fault between the limestone conglomerates, with their associated fossiliferous shales, and the red and green slates, near the foot of the stairs leading up from the head of the small cove east of the hotel. On the north side of the island these Lévis rocks are terminated by the great fault which brings up the black bituminous shales and limestones, which have been formerly described as of Utica or Hudson River age, and which are the undoubted extension of the rocks of the city of Quebec. From these Lévis rocks at the end of the island the following fossils have been obtained:— Absence of true Lévis rocks on north side of St. Lawrence River. Island of Orleans south-west end.

1. *Clonograptus rigidus*, Hall.
2. *? Dichograptus octobrachiatus*, Hall.
3. *Dichograptus ? Richardsoni*, Hall.
4. *Ptilograptus plumosus*, Hall.
5. *? Tetragraptus serra*, Brongniart.
6. *Dawsonia*, sp. indt.
7. " *acuminata*, Nicholson.
8. *Acrotreta*, sp. nov.
9. (*?*) *Turrilepas*, sp., fragments, with the surface marked by concentrically arranged lines of growth.

On the south side of the ledges on which this hotel is built Mr. T. C. Weston obtained *Loganograptus*.

Leaving for the present the development of these rocks as seen along the shores of the St. Lawrence and the several islands which lie in the

channel below Quebec, we will examine the structure of the group as displayed in the sections along the Etchemin and Chaudière rivers.

Etchemin River section.

On the first of these streams the rocks of the Sillery, more particularly the sandstones and associated shales, have already been referred to as extending upward to within one mile of the railway bridge on the Intercolonial Railway. Above the last exposure of the Sillery sandstone formation the red, green and black shales extend for fifty chains, beyond which, to the bridge, grey, green and black shales, probably representing a slightly lower series, occur. The great falls of the Etchemin occur ten chains below the bridge, and the green and black shales here have yielded to Mr. Weston *Obolella pretiosa*, a form similar to that from the Sillery of Point à Pizeau. Above the bridge the green, black and grey shales extend to a small brook about two and a fourth miles below St. Henry village, the dips all along being south 20°–50°. At this brook the red and green shales again come in on the south side of the anticlinal and extend up to the village, in which space several foldings are seen, but the general character of the red, green and black shales is maintained throughout. Above St. Henry the river flows for several miles through intervales, and exposures are rare both on the stream and on the road between St. Henry and St. Anselme. Just above the village the stream makes a great bend of nearly two miles to the south-west, and then resumes its regular course. Three-fourths of a mile above the upper part of the bend, black and green and grey shales, with hard bands, occur, with a bed of limestone conglomerate, in which Mr. Weston, in 1877, obtained from the pebbles:

Fossils from between St. Henry and St. Anselme.

1. *Leptæna sericea*, Sowerby.
2. *Orthis platys*, Billings.
3. *Camerella varians*, Billings.

The associated shales form a peculiar band, which is repeated three times on this river in the next three miles, the intervening space being occupied by red and green shales of the Sillery formation. From the black shales near a grist mill close by the upper exposure, which is a half-mile above the great gorge of the upper fall, the following graptolitic forms were obtained:—

1. *Dicranograptus*. cf. *D. clingani*, Carr.
2. *Climacograptus bicornis?* Hall.
3. *Diplograptus cf. D. mucronatus*, Hall.
4. " sp. indt.; Polypary with closely arranged thecæ,
5. *Dicellograptus sextans*, Hall.
6. " *Moffatensis*, Carruthers, var. *divaricatus*, Hall.
7. " sp. indt.; same form as found in similar rocks from Crane Island.

At this point sharp faultings are seen on both sides of the exposure of black shales, and thence upward the stream shows a succession of red and green shales for several miles above St. Anselme. Toward Ste. Claire beds of grey, green and black shales occur, with bands of hard quartzite of considerable extent, which latter will be described later. Faults.

The occurrence of these black fossiliferous strata on this river is peculiar. At no other point south of the St. Lawrence have they been observed, but on the north side of Crane Island, about one mile above the church, and again on the south side, one mile east of the wharf, precisely similar shales are found containing similar forms. From the north side of the island a small collection yielded : Similar rocks and fossils on Crane Island.

1. *Dicranograptus cf. D. Nicholsoni*, Hopkinson.
2. *Dicellograptus sextans*, Hall.
3. *Dicellograptus Moffatensis*, Carruthers, var. *divaricatus*, Hall.
4. *Dicellograptus*, sp. indt.

A peculiar feature accompanying these black shales is the presence of heavy beds of blackish, very hard, cherty shale, precisely similar to that seen at Griffin Cove, Gagnon's beach and the Marsouin. The presence of *D. sextans* at all these places shows the horizon of the Etchemin shales to be not far removed from the rocks of the localities mentioned, and their position at this place is doubtless that of a repeated synclinal upon the red and green Sillery shales, complicated somewhat by faulting. Cherty beds.

From the red and green shales underlying the black shales just described, Mr. Weston, in 1877, collected *Obolella pretiosa*, fragments of a *Tetragraptus* allied to *T. Headi*, Hall, and the funicle of a *Clonograptus* allied to *C. rigidus* or *C. flexilis*.

The sections on the Chaudière River above the Grand Trunk Railway bridge present, for the most part, rocks of the upper Sillery horizon. Near St. Lambert green sandstones, interstratified with the usual red and green shales, occur, in which Mr. Weston has found an *Obolella* like the form at the bridge below. Above St. Lambert black and green shales, like those on the upper part of the Island of Orleans, near Patrick's Hole, contain graptolites, with fragments of *Obolella* or *Lingula*. Between this and St. Bernard beds of limestone conglomerate, with green and black shales, the pebbles of which contain fragments of Orthis-like shells and Crinoid stems, are found, the associated shales containing *Phyllograptus Anna* and *P. angustifolius*. These indicate a probable synclinal of Lévis rocks at this place, while the underlying Sillery formation is affected by a series of foldings such as are seen to the east on the Etchemin. Sillery shales and fossils. Chaudière River section.

The relative positions of the Sillery and Lévis are well observed in the sections between Lyster and Somerset, on the west, and the Craig road, which passes through Leeds. On the line of the Grand Trunk, between Lyster and Stanfold, the red and green shales and hard sandstones of the Sillery are well exposed at intervals. To the westward of Lyster they show down the Becancour River to the fault, between this formation and the Hudson River rocks, about ten miles from the mouth of the stream. Along the railway these rocks form the western side of a synclinal basin, the eastern edge of which appears at Inverness and St. Sophie. On the road east of Lyster to Ste. Agathe the characteristic red and green-striped shales are seen at intervals to the road leading north between ranges xii and xiii Nelson. Blocks of trap are scattered along this road, outcrops of which occur in places on range xi. The dip of these red slates is south-easterly. One mile south of Ste. Agathe Corner ledges of bluish-grey dolomitic slates and limestone conglomerates dip S. 10° E. $<$ 50°, the pebbles containing traces of fossils, which, however, were not determined, but the rocks look like those of Lévis, and these undoubtedly overlie the red slates of the Sillery. On the road leading south-east from Ste. Agathe to the Craig road these bluish-grey slates, which strongly resemble those of Brompton Falls, below Sherbrooke (see Report 1886), extend for quite three miles, in which probably several low undulations occur, to a well-defined synclinal, the dips being E. and N. 60° W. These slates are like those associated with the limestones of the Arthabaska area, and a short distance east of the synclinal they rest upon limestone conglomerates and grits, with hard bluish-grey slates like those near Ste. Agathe. Further to the north-east these rocks extend towards St. Patrick, and reach the road to Ste. Marie about four miles north-east of St. Sylvester. In some of their undulations these doubtless connect with the fossiliferous strata and limestone conglomerates of St. Bernard, already described. In the vicinity of St. Patrick they rest to the east upon the red and green slates and sandstones of the Sillery.

Lyster and Stanfold.

Ste. Agathe.

St. Sylvester.

St. Patrick.

In St. David a mixture of limestone conglomerates and dolomitic shales of various colors, red, green, grey, etc., occurs, in which very diversified dips are seen, indicating abrupt folds or faults. These probably indicate the synclinal at this place, and they also rest upon the red slates of the Sillery to the west. On the road from Leeds village to Inverness the eastern limit of the synclinal is bounded by red and green Sillery shales and hard sandstones, one mile and a-half east of Glenloyd Mill, where these rocks dip W. $<$ 30°. In the fields a short distance west of this, ledges of limestone conglomerates, presumably the extension of those seen on the road from Ste. Agathe to Craig road, occur. At the mills on the River Becancour the rocks are greyish and

St. David.

Leeds to Inverness.

bluish-grey-striped massive slates, like those of the Brompton Falls on the St. Francis River, which thence extend south-westerly to Inverness Corner, where beds of limestone conglomerate also occur, with a north-west dip, and resting on hard green and black slates, which are now regarded as constituting a portion of the Cambrian system, the red and green shales being apparently overlapped by the black slates and conglomerate series. Glenloyd mill.

In the vicinity of Somerset, and between that place and Ste. Sophie, a tract of tolerably flat country extends, with a breadth of several miles. In this area beds of the graphitic limestone and black shales occur, similar to those described as occupying the basins of Arthabaska and Danville. These can be traced to the north-east in rear of Ste. Julie, but there they apparently terminate. They overlie a series of blackish-grey slates, which are like those described as occurring in the Wotton area of the last report, and which in turn rest upon the red shales and sandstones along the east side of the Grand Trunk Railway east of Stanfold. Somerset and Ste. Sophie.

To the east of Somerset, in the direction of Ste. Sophie, these dark limestones rest upon a series of highly altered schists and schistose quartziferous shales, which constitute a high ridge extending towards St. Norbert, and thence form the high belt of hills toward Halifax. In this direction also the red slate series is wanting, and the limestones are in apparent contact with what we have called the Pre-Cambrian series.

From the evidence obtained from so many widely scattered localities, the position of the red slates and sandstones of the Sillery beneath the fossiliferous beds of the Lévis, both upon the mainland and on the upper end of the Island of Orleans, can be assumed with considerable certainty, both on stratigraphical and on palæontological grounds, for, while numerous faults are found, some of which are of great extent, and great overturning of the strata, the overlying position of the Lévis is so often seen in places where their relative positions can scarcely be reversed, that the conclusions above stated are, it is believed, no longer a matter of doubt. Lower position of the Sillery.

Before we take up the consideration of the south side of the St. Lawrence below Quebec and the several islands in the channel, a brief statement of the stratigraphy as now held may be given for the better comprehension of the structure of the St. Lawrence section. Ascending sequence of strata of the fossiliferous Quebec group from Cape Rouge northward.

Beginning, then, with what we regard as the lowest members of the group, viz., the beds near the central fault above Cape Rouge, we have in ascending order:

1. Black, green and grey shales, with hard and heavy bands of greyish, sometimes yellowish-white quartzose sandstone, which are thickest

in the lower portion, and with occasional thin bands of limestone conglomerate, the pebbles being generally small and the paste highly quartzose. The quartzites have occasional scattered pebbles of greyish limestone.

Lower Sillery

2. Greenish, greyish and blackish, with occasionally dark-reddish or purplish-tinted shales, with bands of hard greyish sandstone, generally fine-grained, and in thickness from one inch to a foot, the massive quartzites being absent and many of the greenish layers being covered with fucoidal markings, well seen on the shore above Cape Rouge and in the cutting along the road above that village.

3. Bright-red shales, often with thin greenish or greyish bands, which in places are calcareous. The rocks on a smoothed surface, have a striped red and green aspect; in the upper part occasional beds of a foot or more of hard green-grey sandstone occur.

4. Red, greenish-grey and black shales, with interstratified masses, often lenticular, of greenish and greyish Sillery sandstone, ranging in thickness from two feet upward, in which the Sillery quarries are located. This is the typical Sillery sandstone, which ranges from a fine-grained homogeneous rock to a fine quartz conglomerate, much of the rock being characterized by the presence of small flaky pieces of shale and scattered small pebbles or large grains of clear quartz, the bands of sandstone being separated by partings of various colored shale. The local and lenticular character of the sandstone is well seen in the Sillery section, some of the heaviest beds inland thinning out before reaching the shore in either direction. In the upper part, at Sillery church, *Obolella pretiosa* occurs, from which point an anticlinal crosses the river to Point Lévis, and appears in the cliffs at the Victoria Hotel, where the same *Obolella* is found.

Upper Sillery.

5. The Lévis shales and conglomerates of Lévis city and the shore and cliff below South Quebec and St. Joseph and the west end of Orleans Island, the synclinal disposition of which has already been described.

Lévis.

6. The black and greyish-striped or banded shales, overlaid or associated with the black and graphitic shales and limestones of the Arthabaska and Somerset synclinal, which latter do not appear in the Point Lévis and Quebec sections.

Upper Chazy or Lower Trenton.

7. The black or brownish bituminous shales and limestones of the city of Quebec and north-west side of the Island of Orleans of Trenton-Utica age.

Trenton-Utica.

The south shore of the St. Lawrence below Lévis displays, for several miles, strata abounding at certain points with graptolites, the principal forms of which have already been enumerated. Thirty chains below the lowest fossil locality, or three miles below the ferry

wharf at St. Joseph, a well-defined fault is seen, the strata in the intermediate space being thrown into several sharp folds. This fault brings up a series of limestone conglomerates and shales, which in aspect resemble the rocks of divisions 1 and 2 of the Cape Rouge section. The conglomerates here occur in thin bands, of which the first has a thickness of fifteen feet in the cliff, thinning into three feet on the beach. Band 2, separated from this by thirty-three feet of greenish and greyish shale, is eleven feet thick, and is made up of large and small pebbles of siliceous dolomite and grey limestone, in a hard siliceous paste. Band 3 has nearly all its pebbles of dark-grey limestone, with calcite and thin pieces of shale, with a thickness of ten feet, and is flanked on the south-east side by grey sandy and quartzose flags and green-grey shales. The series dips S. 65° E. $<$ 55°. The pebbles of the conglomerate yielded fragments of trilobites, which have been examined by Mr. Ami and found to be portions of *Olenellus Thompsoni* with *Olenoides* or *Microdiscus*. The hard quartzose sandstone on the east flank contains also scattered pebbles of greyish limestone.

Shore above Beaumont.

Fossils.

The fault at this place apparently marks the eastern limit of the fossiliferous or graptolitic shales of the Lévis formation, and no beds of Lévis aspect appear east of this point, as far as our observations extended during the past season. Between this and Beaumont green and grey slates, with thin, hard bands of quartzite, and occasionally thin, grey limestones and fine limestone conglomerates occur, which represent the rocks of division 2. From certain hard, sandy beds, one mile east of the conglomerates, numerous graptolitic forms were obtained, most of which were, however, fragmentary and difficult to determine. They are, however, similar to others found near St. Michel with *Obolella pretiosa*, and may, therefore, be assigned generally to the fauna of the Sillery.

Eastern limit of the Lévis on the shore.

In this space the strata are most intricately folded; the green hard slates and sandstones constituting the lower part and showing at times in the anticlinals, while in the synclinals the red and green striped shales come in. A mile and a-half west of Beaumont Brook, ten anticlinals can be seen in the space of fifteen chains, the rock being the hard greenish-grey shales and hard quartzite beds of division 2. The apparent plasticity of the rocks at the time of their folding is here remarkably displayed, since the beds curve in sharp bends without the smallest indication of crushing or cracking, the hard sandstones apparently being precisely the same on the concave side of the arches as in the convex. Many of the green shales associated with the red along this part of the coast are thickly marked with beautiful impressions of fucoids. The beds of the Sillery sandstone do not appear, though heavy beds of hard grey quartzite show at intervals,

Beaumont.

but these are apparently the equivalents of the lower part of division 1 of the Cape Rouge section. Frequent faults occur, and below Beaumont Brook these are repeated every few chains, their position being in many cases marked by a jog in the coast line, which follows the line of the fault, and a similar series of green, grey and red shales is repeated several times.

Beaumont to St. Michel.

But little variety occurs in the character of the rocks between Beaumont and St. Michel de Bellechasse. Repetitions of green, grey and black shales, with hard quartzites and occasional thin bands of limestone conglomerate form the anticlinals, and red and green shales with thin hard bands of calcareous sandstone, and reddish limestone, at times dolomitic, shew in the upper part. These rocks strike from north to north-east across the south channel of the St. Lawrence, and reach the south side of the Island of Orleans, between St. Laurent and its east end, called Traverse Point, the strata of that section being identical with those of the shore just described. One mile east of the wharf at St. Michel, green, grey and black shales and thin hard sandstones, overlaid by reddish shales, contain fossils, among which were recognized:

Fossils from St. Michel.

1. ? *Dichograptus ramulus*, Hall.
2. *Dendrograptus*, sp.
3. *Dawsonia*, sp.
4. *Obolella desiderata?* Billings, or a closely allied species.
5. *Obolella pretiosa*, Billings.
6. *Acrotreta*, sp.

Half a mile further east, in a band of black shale, *Dictyonema, cf., D. delicatulum*, Dn. (preoccupied), and a species of *Bryograptus*, are found.

St. Michel to Vallier Point.

From this to the extremity of the point, two miles below the wharf at St. Michel, the usual series of black, green and red shales occupy the shore. At the point a well defined anticlinal brings up the black, green and grey shales of division 2. These extend across the strike to the mouth of the Boyer River, near which another crushed anticlinal in similar rocks is seen. Thence to Vallier Point, which is the west extremity of Bellechasse Bay, the rocks of division 2 are continuously exposed, being overlaid to the south along the road, beyond St. Vallier Church, by the red shales and sandstones of the Sillery. Twenty chains south of Vallier Point these older rocks are overlaid by the red shales on the shore of the west side of the Bay, whence they extend to Berthier Village. East of Berthier to St. Thomas the shore is entirely occupied by the red and green shales, and grey or occasionally brown sandstones of the true Sillery of division 4. They strike along the shore, which keeps nearly along the crest of an anticlinal for

Berthier to St. Thomas.

several miles. In the Village of St. Thomas these shales have yielded *Obolella pretiosa* and sponge spicules. Thence to L'Islet the same rocks are continuously exposed, the headland of Cape St. Ignace being composed of the Sillery grits. Near L'Islet, in the green shales associated with the red, *Obolella pretiosa* and an allied form probably *O. desiderata*, were found at several points, the rocks in the intermediate space being thrown into a series of anticlinals with south or north dips at angles of 60° to 85°. St. Thomas to L'Islet.

East of L'Islet the red and green shales present heavy ledges which form prominent ridges along the shore for some distance, and extend to the Trois Saumons River. At the L'Islet wharf the associated sandstones contain an interstratified bed of fine limestone conglomerate four to ten feet thick, with small pebbles of limestone and quartz, which shades off into grit. Along this part of the coast the strike follows the shore line, the dip being S. 30° E. $<$ 60°–80°. Between Trois Saumons and the brook one mile to the east, the green and black shales with thin hard bands occupy the shore, an anticlinal occurring midway, and thence east to near the wharf at St. Jean Port Joli the ordinary red and green shales of division 3 are seen. Slightly lower beds occur at the wharf at St. Jean, with thin beds of hard grey limestone; but 150 paces east red and green shales again come in and extend to within five miles of the church of St. Roch des Aulnets. At this place a series of anticlinals show on the several points bringing up the lower beds of division 2, with bands of greyish limestone holding remains of small trilobites, among which an *Agnostus* was recognized. These are associated with black and green shales, and they are repeated at intervals for one mile and a-half along the shore, when a fault and sharp anticlinal again bring into view the red and green shales which extend thence to St. Roch. L'Islet to St. Roch. Fossils.

In these red and green shales *Obolella pretiosa* also occurs, and near St. Roch the beds of hard Sillery sandstones have associated beds of limestone conglomerate, which now begin to constitute an important feature in the Sillery rocks of this area. In no part of the shore have we found any rocks which, from their lithological character or their contained fossils, should be assigned to a lower horizon than the lower Sillery. From this to River du Loup the shore presents the same general aspect, except that the quartzites which have a considerable development to the south of St. Michel and St. Thomas come to the shore above St. Roch, owing to a sudden change in the strike northward towards the St. Lawrence at this place. This northward change of strike extends from a point four miles west of St. Roch to the St. Roch Post Office and Brook, which is two miles east of the church. Beyond this the strike rapidly assumes a more St. Roch to River du Loup

easterly direction, which continues along the shore. By this deflection the heavy beds of quartzite, with the associated red and green shales which form the prominent ridges to the south from St. Gervais to L'Islet are brought to the coast, and thence extend to and beyond River du Loup. In all this stretch of coast from St. Michel to River du Loup no fossils other than *Obolella* and sponge spicules have been found, with the exception of a small collection of bivalve shells and fragments of trilobites near Notre Dame du Portage, and some indistinct graptolites associated with *Obolella*, at the crossing of the Ruisseau de L'Eglise, on the Intercolonial, and three miles east of St. Paschal station, among which were *Climacograptus*, sp., *Diplograptus*, sp., *Nemagraptus*, sp. indt., *Didymograptus*, (*?*) sp.

Notre Dame du Portage.

Fossils.

In the collection from Notre Dame du Portage the following genera were recognized:—

1. Obscure graptolite, with a long stipe.
2. *Lingula*, sp. nov. (?), (a small narrow shell, with brown test and lamellar lines of growth.)
3. *Obolella*, like a young specimen of *O. pretiosa*.
4. *Orthis*, sp.
5. Strophomenoid shell.
6. Fragments of a pteropod-like organism.
7. *Beyrichia*, sp. (With prominent crescentic sulcus and eccentric lobe.)

The relations of the areas of quartzose sandstones, and red and green shales of this interior belt to the typical Sillery of the coast section, may now be considered; and this is an important point, since in the Report, 1869, as already pointed out, these rocks were in part regarded as of Potsdam age, on the evidence of *Salterella* in the pebbles of the associated conglomerates and supposed markings of *Scolithus*. South of Lévis, the ridges of Sillery sandstones, which are often of considerable extent, occur as lenticular areas, and extend on the St. Henry road for about three miles. To the south of this, along the Etchemin, the sandstones do not apppear till we reach the vicinity of Ste. Claire; the intervening space being occupied by the series of red, green and black shales, already described. Eastward to St. Charles junction, the rocks described on the coast section about Beaumont, shales of various colors are found, but a couple of miles east of St. Charles, ridges of the Sillery sandstone rise from the flat country to the south of the railway. Between St. Charles and St. Gervais red shales occur, which, along the course of the Boyer River, extend to St. Henry. A low ridge of the Sillery is seen near the road to St. Gervais, about two miles

St. Charles to St. Gervais.

south of St. Charles. At St. Gervais a very considerable development of this highly quartzose sandstone begins, the composition of which, except for its rather more siliceous aspect, is precisely like the rock of the Sillery quarries, small pebbles and grains of quartz, and pieces of greyish or black shales, often of considerable size, being found. As with the typical Sillery of the shore, the hard quartzites are interstratified with red, green and black shales. South of St. Gervais, towards St. Anselme, these rocks terminate about three-eighths of a mile from the corner, beyond which the red and green shales continue to St. Anselme. About one mile north of the road between St. Anselme and St. Henry, and a short distance west of St. Anselme, a heavy boss of trap cuts through the shales, with which are associated at this place beds of sandstone and grit of Sillery aspect. Along the road leading south-west from St. Gervais, Mr. Weston obtained the usual Sillery fossil, *Obolella pretiosa*, from the green and red shales. Between St. Gervais and St. Raphael, the quartzite forms conspicuous white weathering ridges, their interstratification with the red, black and green shales being well seen at the brook and mill, one mile and a half north-east of the former place. Here, Mr. Weston also obtained *Obolella pretiosa*, a Linguloid shell, crinoidal fragments and a *Buthotrephis*. The same *Obolella* was obtained from interstratified shales in quartzite at River du Sud, beyond St. Raphael, also near St. Francois church, at St. Thomas and at Berthier, the specimens being in all cases precisely similar to those found at the railway bridge on the Chaudière.

St. Gervais to St. Anselme.

St. Gervais to St. Raphael.

Between St. Thomas and L'Islet the ridges of quartzite and shales form a range of hills, just to the south of the back concession road, about two miles and a-half from the Intercolonial railway. About St. Aubert these quartzose rocks vary much in character, at times being hard and siliceous, at others resembling the typical Sillery rock. Considerable areas of limestone conglomerate are associated with them near this point, as well as in the ridges three miles south of St. Thomas. They first show along the shore road in conspicuous beds on the road between St. Jean Port Joli and St. Roch, about three miles below the former place, where they are clearly an interstratified portion of the red and green shale and sandstone series of the Sillery formation. The conglomerates are composed of pebbles of quartz, greyish limestone and sandstone, cemented by a gritty and highly quartzose or sandy paste. On the Elgin road, which goes south about four miles below St. Jean, hard quartzose sandstone, with limestone conglomerate and red and green shales, occur at intervals to the railway. South of this, exposures of sandstones are also seen, but at the corner of the back road leading across to St. Aubert, great ledges and ridges of this quartzose sandstone come in. This rock, while weathering white, is, on fresh

St. Aubert.

Elgin Road.

fracture, a brownish grey, in which respect it resembles the bands of Sillery sandstone on the Island of Orleans, below St. Jean. The associated conglomerates are made up of large and small pebbles of greyish and sometimes brownish sandy limestone, sandstone and quartz and the mass of the sandstone contains bits of shale and pebbles of quartz, like the typical rock of Sillery; the associated black and green shales west of St. Aubert contain *Obolella pretiosa* also.

Change in strike.

Near St. Aubert these rocks change their strike and run towards, the coast, reaching it above St. Rochs, as already described. Further east a repetition of these show in similar conspicuous ridges and rounded hills, which rise abruptly from the flat plain along the line of the Intercolonial between St. Roch and Ste. Anne de la Pocatière. In many places the ridges of quartzose sandstone west of and in the vicinity of Ste. Anne have interstratified beds of limestone conglomerate, like that near St. Aubert. These ridges of conglomerate and quartzite west of Ste. Anne have an anticlinal structure, the opposing dips to the north and south being well seen on the road half a mile west of the church. The anticlinal in the underlying red and green Sillery shales is also seen just on the rise of the hill south of the church, and again one mile east of the village. That these beds of shale, quartzite and conglomerate are of the horizon of the Sillery further west is seen in the presence of *O. pretiosa*, as well as in the general character of the strata. In the conglomerates, many of the pebbles are derived from some lower band of limestone conglomerate. The same peculiarity was observed in the rocks of the Brandy Pots, lying in the St. Lawrence off River du Loup, where precisely similar beds occur as at Ste. Anne. The same character of sediments occupy the country about Kamouraska and the back country, showing along the several roads running southward towards the boundary. These have already been described fully in the report of Mr. Richardson, 1869. On the road from River du Loup to Lake Temiscouata they occupy the section between the St. Lawrence and nearly to the crest of the ridge at St. Honoré, midway to the lake, alternations of red, green and black shales, with great areas of whitish weathering quartzose sandstone, being visible at intervals; but at St. Honoré, the underlying black, wrinkled slates of the Cambrian anticlinal come into view, and extend southward to the vicinity of St. Louis de Ha Ha. This country has been worked out by Messrs. Bailey and McInnes.

Ste. Anne de la Pocatière.

River du Loup to Lake Temiscouata.

Orleans Island to Crane Island

The islands which lie in the channel of the river below Quebec form a chain nearly forty miles in length, extending from Orleans Island to the Isle of Cranes, which is opposite to St. Thomas and L'Islet. Of these Orleans Island is the largest, having a length of twenty miles from the South-West Point to Point Traverse, and a breadth in its widest

part of about five miles. Along its shores, three rock formations are recognized, viz., that on the north side, hitherto regarded as of Utica or Hudson River age; that on the south-west end, known as the Lévis; and that of the south, and, in fact, comprising nearly the whole of the island, which we regard as the Sillery, and probably, in great part, its lower portion. The rocks of the Levis formation of the south-west end, with their contained fossils, have already been described on p. 59 K The rocks of the south shore to Traverse Point are identical in character with those of the shore from above Beaumont to St. Michel, being, in fact, the extension of those across the river channel to the island. Like those of the mainland, they also contain *Obolella pretiosa*, with fragments of graptolites, at several points, but no traces of the Lévis rocks proper are seen below the fault which cuts off this formation east of the Island Hotel. The Sillery sandstones are but slightly developed. On the line of section between St. Jean and St. Famille, and at the eastern half of the island, the general structure is seen to be that of a double anticlinal, affected by various minor folds, along which, at two points, hard Sillery sandstones come to view. On the north-east end of the island, heavy beds of coarse, green, sandy shales, passing at times into a shaly sandstone, occur along the road between St. Famille and St. François. These are associated with red and green shales along the shore, in which respect they are like the Sillery, and at the east end of the island include a band of limestone conglomerate twenty feet thick, which in aspect is like that described from St. Aubert and St. Anne de la Pocatière. It is probable, therefore, that the great bulk of the sediments on this island is the true equivalent of the Sillery formation. The rocks of the north side which are separated from those just described by a well-defined fault of considerable extent, are divisible into two portions. Of these the lower series, stratigraphically, is the black bituminous shale and brown limestone of the extreme north-west end, called False or West Point. The rocks extend along the road towards St. Pierre for seventy chains, where their contact with the green and grey shales of the Lévis formation takes place. At a small brook about half a mile further east, the limit of the black bituminous shales is seen, a fault separating them from the grey and green-grey shales. Below this point, greyish and greenish shales and sandstones of Hudson River age occupy the shore, and show along the road down the north side of the island for several miles above Ste. Famille. They are also seen on the road traversing the island to St. Jean for nearly three-fourths of a mile south of Ste. Famille Corner, the exposures not being continuous, but below Ste. Famille they are readily seen for one mile and three-fourths to the sharp bend in the road

Orleans Island, three formations.

North side of Island.

Hudson River rocks.

to the southward and a small brook, where they are brought into contact with the red and green shales of the Sillery by a fault. This fault is well seen on the shore two miles east of Ste. Famille, the rocks of Hudson River age being greyish sandstones and shales, with beds of greyish limestone, which are much crushed along the line of contact. Graptolites of Hudson River type occur in the shales at this place.

Concerning the age of the greyish beds of this section there can be but little doubt. They are identical in character with those from the opposite or north side of the St. Lawrence, as well as those of Ste. Croix, above Quebec, which contain typical Hudson River forms. But the Utica age of the blackish shales and limestones is still somewhat uncertain. Large collections of fossils were made from these strata during the past season, which show them to be of the same horizon as the rocks of the Citadel Hill, Quebec, as well as those of the north side of the Gaspé Peninsula, of the Marsouin River, Griffin Cove, and Gagnon's Beach.

Probable age of the black shales and bituminous limestones of the north side.

The black shales and limestones below the village of St. Pierre, which should underlie the Hudson River strata, are not visible along the north side of the Island, owing probably to the great stretch of mud flats in this direction; but they should occupy a portion of the North Channel, and be brought into place by a fold or anticlinal in this direction, which repeats the Hudson River beds of the north side.

From the conclusions of Prof. Lapworth it seems probable that the horizon of the black shales is that of the upper part of the Trenton or transition to the lower Utica, but closer study of the fossils from Quebec will be necessary to definitely determine their exact position.

Rocks of the south side.

Between the fault which cuts off the Lévis on the south side, east of the Hotel, and the village of St. Laurent, five miles and a half distant, sixteen well defined anticlinals are recognized in the rocks along the shore. These consist for the most part of red, green, grey and black shales, with hard bands of grey sandstone which are sometimes of considerable thickness, like the strata of Point à Pizeau and Sillery. In some of the anticlinals, the hard grey quartzose sandstone and green shales of the lower part of the Cape Rouge section are brought to view, and occasional beds of hard siliceous limestone conglomerate, like that above Beaumont, come to the shore in beautiful folds, overlaid in the synclinals by the red and green shales of the upper Sillery series.

St. Laurent to St. Jean.

Below St. Laurent, toward St. Jean, the shore for some miles is occupied by the red shales. Midway, black and green shales hold *Obolella* and imperfect graptolites, the rock resembling that of the Chaudière Bridge. Below St. Jean, the red and green rocks continue to the mouth of the Delphine River, beyond which the series of green,

black and grey shales and quartzose sandstone, which constitute divisions 1 and 2 of the Cape Rouge section, come in and extend in a series of folds to the eastern extremity of the island, around which they are well exposed to the cove at the north-east end.

St. Jean to Ste. Famille.

A section on the road between St. Jean and Ste. Famille passes over two well defined ridges separated nearly midway by a flat half a mile in width, through which a brook flows eastward. The southern portion of each ridge is composed of red and green striped shales, underlaid by green-grey shales and hard sandy beds, indicating the two anticlinals noted above.

Madame sland

Madame Island and Isle Reaux lie to the south-east of the east end of Orleans Island, and distant from it one and a half to two miles. The former, or more westerly, has a length of 130 chains and a maximum breadth of thirty chains. The latter has a length of 225 chains and a breadth of about twenty-five chains. At low tide, extensive reefs of shale and sandstone extend in all directions, and nearly connect the two islands. They are both generally flat, but each has a low ridge extending along the centre of the island. Madame Island is composed entirely of grey, green and black shales, probably of division 1, with several prominent reefs of hard quartzose sandstone off the east end, similar to those found at Traverse Point on the east end of Orleans Island. These reefs curve across the flats at the east end, and then bend sharply to the eastward, where they skirt the flats to the southward of Reaux Island, being visible at low tide.

Reaux Island.

The rocks of Reaux Island are slightly higher in the series, being black, green, grey and red shales, like those near St. Michel on the main land, and contain *Obolella pretiosa*, as at that place. In neither of these Islands do beds of limestone conglomerate appear. Grosse Isle, which is the seat of the Quarantine Station, lies one mile and a-half south-east of the east end of Reaux Island. This island, with Patience, the Brothers, Barrier, Two Head, Canoe, Mill, Race, Margaret and Cliff islands, forms a chain lying about the centre of the River, and showing rocks of general similarity. On all of these islands, some of which are of small size, the strata are greatly folded. In the Report of 1866–69, the most of these rocks were assigned to the Lauzon division of the Quebec group. The rocks of Grosse Isle may be described as fairly representing the rest of the group.

Grosse Ile.

Along the north side and forming the greater part of a ridge which traverses the central and western half of the island, grey and greenish sandy shales, holding scattered pebbles of limestone, occur in places forming a tolerably coarse sandy grit, like that in the north-east end of Orleans Island. This, probably, represents the lowest part of the series, succeeding which, on either side, are beds of greenish-grey sandy shales.

holding many pebbles of limestone and passing gradually into a true shaly limestone conglomerate. These directly underlie the limestone conglomerates proper, which occur in beds from two to ten feet thick, associated with red, green and black shales, hard sandstones and dolomitic limestone. The general aspect of these rocks is similar to the conglomerates of Beaumont and the east end of Orleans rather than to those of Lévis. While several foldings occur, the general structure of the island is that of a double anticinal, the synclinal extending through the centre, and being occupied by the red and green shales of the upper Sillery, without the beds of sandstone. These red strata occupy most of the south side of the island, more particularly east of the Quarantine wharf; the extreme west point, which is a small island at high tide, being composed of green grits like the rock of the northern ridge. The limestone conglomerates are especially developed on the north-east shore, where they extend west for fifty chains from the eastern extremity. From the pebbles, small fragments of trilobites were obtained, but no fossils preserved sufficiently for determination.

Patience Island

Patience Island lies to the north of Grosse Isle, five-eighths of a mile distant. It consists of a central ridge of the same green sandy shales and grit, flanked on either side by the slaty conglomerate, with heavy beds of limestone conglomerate on its eastern end, where the rocks are thrown into a series of sharp folds, the synclinals being occupied by red and green shales. The same rocks are seen in each of the Two Brothers, which lie midway between the eastern ends of Patience Island and Grosse Isle. On Barrier Island, sixty chains north-east of the latter, only the green sandy shales remain, in which, however, the anticlinal structure is visible.

Two Head Island.

On Two Head Island, which presents to the west a bold, almost impassable cliff of the hard, green, shaly sandstone, these rocks are flanked on the south side by the pebbly shales, but on the north by a very complicated set of limestone conglomerates, and red and green shales. The arched structure of the conglomerates is beautifully seen at several points, and especially in a small detached islet off the east end, where the rocks have been cut squarely off, and present a very fine section, showing the green gritty shales at the base, the pebbly green slates and red beds above, and the limestone conglomerates at the crest of the anticlinal.

Crow and Heron islands.

There are two small islets, Crow and Heron, to the north-east of Two Head; the most westerly of these, Heron, shows a synclinal at the western end, from which the limestone conglomerates have been swept away, the green, sandy shales remaining. On Crow Island the north side is occupied by the usual green, sandy beds, while the south shows red and green shales of Sillery aspect. The structure of this islet is

also a synclinal. Further east, Canoe Island lies to the north of Crane Island, and has a length of 125 chains and a maximum breadth of twenty chains. The rocks present a very complicated series of foldings, but are very uniform in character with those just described. Limestone conglomerates are found in small patches at various points all round the island, resting upon the green, sandy shales, and pebbly conglomerates, as on Grosse Isle. From the pebbles of the conglomerates at the east end fragments of *Olenellus Thompsoni* were obtained, in which respect they resemble the beds above Beaumont and at the east end of Orleans Island. Canoe Island.

To the south-east of Grosse Isle are Cliff and Margaret islands, the former being a prolongation of the latter, but separated by a narrow channel. Cliff Island is composed almost entirely of the green, sandy shales, which form a bold, rugged cliff along the north side, and in which an anticlinal structure is apparent running through the centre. On the south side these are flanked for a short distance by the pebbly shales. The underlying green shales extend across to Margaret Island, and form a ridge at the north-west end for three-fourths of a mile, underlaid on the beach to the north by a series of black, green and grey shales of division 2 of the Cape Rouge section. The south-east side of the island is flanked by the red, green and grey shales of the Sillery. The foldings of the east end of the island are very complex, the succession as seen in the other islands being repeated in cross-section four times in twenty chains. No fossils were obtained by us from these rocks, though Mr. Richardson reports finding *Phyllograptus angustifolius* and other species in the rocks of the south side. These must have come from some bands on the flats below high water mark, which overlie the red and green shales as at Lévis. The extreme length of Margaret and Cliff Islands is two miles and three-fourths, with a breadth in the widest part of twenty-five chains. To the south-east of the east end of Margaret Island, and between this point and Crane Island, lie four small islands. Of these the first is ten chains from the shore, and has a length of about eight chains. It consists of green shales, flanked by red, and forms the southern side of a synclinal between this and Margaret Island. The next in order is Middle Island, about the same size, also consisting of green, sandy and red shales. Race Island has an anticlinal structure, the lowest rocks being the green, sandy shales, already described, flanked by the pebbly shales, the red beds being absent. Mill Island, a short distance east of the last, is the same, but has a patch of the red shales and limestone conglomerates on each side, flanking the anticlinal; while Haystack Island, separated by a narrow channel from Mill Island, shows also an anticlinal structure in the green shales. Cliff and Margaret Islands. Islands between Margaret and Crane Islands.

The last remaining island of the group, viz., Crane Island, which is connected by a considerable stretch of marsh with Goose Island to the east, differs somewhat from those just described, and which, from their similarity, evidently represent the crests of a series of anticlinals in the lower Sillery rocks. The rocks of Crane Island were regarded by Mr. Richardson as belonging to the Lévis and Lauzon divisions, with a band of Potsdam at the western extremity. They may be briefly described as follows. Along the south shore from the western end to a point three-fourths of a mile east of the wharf, are green, grey and black shales, with thin, hard, sandy bands, like those of division 2 of Cape Rouge, which apparently form an anticlinal extending through the centre of the island, and flanked by the red and green shales of division 3 or lower Sillery. At the extreme western end heavy beds of hard, grey quartzite appear, which resemble the hard bands of division 1. These are flanked along the north side by red, green and grey shales, like those of St. Michel, of which they are without doubt the equivalents. These rocks overlie the green and black shales, the latter occupying the flats and the cliff, the former extending along the course of the island inland, and crossing to the north shore forty chains west of the church, or about one mile and three-fourths from the west end. Sixty-five chains west of the church at this point, where the road comes down to the beach, a band of black shales, with hard, cherty beds, precisely similar to those described on the Etchemin, occur. Evidences of faults between these and the red and green shales are plain, and in character these black beds represent those of the Marsouin. They are fossiliferous, containing graptolites of the following species:

Crane Island.

Fossiliferous black cherty shales.

1. *Dicranograptus*, cf. *D. Nicholsoni*, Hopkinson.
2. *Dicellograptus sextans*, Hall.
3. " *Moffatensis*, Carruthers.
4. " var. *divaricatus*, Hall.
5. " sp. indt.

These are distinct in character from the other rocks of this section from loose pieces of which *Obolella* were obtained. On the south side of the island, sixty chains east of the wharf, a similiar band is seen, but this appears to be intermediate between the green, black and grey shales of the lower series and the red and green shales of the Sillery formation, due probably to a fault. Crossing the island from near the church, red and green shales are exposed for about ten chains, then black, green and grey shales of the anticlinal to the south side of the island, upon which the red and green shales are again seen along the shore. Should these black graptolitic shales be the equivalents of the

Utica-Trenton, their positions must be due to a sharp fold or fault between Canoe and Crane Islands, precisely similar to the infolded bands of like character seen on the Gaspé shore below Tartigo River.

There yet remains to be considered the peculiar group of rocks of the City of Quebec, concerning the horizon of which considerable difference of opinion has arisen within the last half-dozen years. In order to find, if possible, some definite clue to their true age, Messrs. Giroux and Ami were instructed to make a carefully located collection of fossils from various points, and from their observations the following conclusions are derived. Quebec City rocks.

The country along the lower part of the St. Charles River, to the north of the great escarpment, is occupied, in part at least, by true Hudson River sediments. These are seen near the foot of the escarpment in contact with black bituminous shales, limestones and calcareous conglomerates, at a point between Côte de la Negresse and Côte Sauvageau, fifty paces west of Tower No. 4, and a little east of a small gully and brook. The fault between the two sets of rock is well marked by a change in the character of the sediments and by a clearly defined difference in strike of the two series. This point marks the most easterly observed contact of the Hudson or Loraine shales proper, with the rocks previously indicated; but to the west this is seen on the slope of the hill, near Ste. Foye, as already noted, where, however, the contact is with the red and green shales of the Sillery formation. On the line of section between Côte d'Abraham and Champlain street, near and a little west of the city wall, large collections of fossils were made at Côte d'Abraham, the rear of St. John Market, in St. Patrick street, and at the Drill Shed, just beyond the Grande Allée, where the following species were obtained, and have been examined by Mr. Ami. Fault north of the city. Fossil localities.

Between the Grande Allée and the Drill Shed.

In black, carbonaceous, flaggy strata, alternating with films of carbonaceous shales, the beds inclined at an angle of 50° south, rock, iron-stained. Drill shed.

1. *Diplograptus foliaceus ?* Murchison.
2. " *angustifolius ?* Hall.
3. " sp. indt.
4. *Climacograptus, cf. C. confertus,* Lapworth. About fifty thecæ in the space of one inch, polypary parallel-sided, and with numerous crowded serratures. Rather common.

5. *Climacograptus perexcavatus*, Lapworth.
6. " *bicornis*, Hall, var.
7. *Dicellograptus ?* sp. indt.
8. *Dawsonia campanulata*, Nicholson.

From between St. John Market and St. Patrick street.

1. *Diplograptus foliaceus*, Murchison.
2. " sp., cf. *D. rugosus*, Emmons.
3. " sp., cf. *D. confertus*, Nicholson.
4. " sp. resembling *D. mucronatus*, Hall, but with longer slender spines, which extend outward at an angle of 50° to the axis of the polypary from the angle of aperture of the thecæ.

St. John Market.

5. *Climacograptus bicornis*, Hall.
6. " " var. *caudatus*, Lapworth.
7. " *perexcavatus*, Lapworth.
8. " *scalaris*, Hisinger. var. *normalis*, Lapworth.
9. *Dicellograptus sextans*, Hall.
10. *Corynoides calycularis* ? Nicholson.
11, 12, 13. *Lingula*, 3 sp. All apparently undescribed, and characteristic of these rocks.
14. *Obolella* sp. A small and nearly circular species of this genus appears to be represented.
15. *Acrothele ?* sp. A shell resembling a closely related but smaller species from the Beccaguimic River, N. B.
16. *Orthis*. Fragments of one or more species of this genus occur in the limestone conglomerate band near the St. John Market.
17. *Leptæna*,, n. sp. A diminutive species closely resembling that found in the black limestones of the Beccaguimic River, N.B.
18. *Leptæna sericea ?* Sowerby. A large form similar to that which occurs in the Utica and Hudson River formations of Ontario, the Island of Montreal and vicinity. This *Leptæna* occurs in the limestone conglomerate bands, which are interstratified or dovetailed in the black bituminous graptolitic shales, and the association of species at this place is totally different from that met with in the localities above mentioned.
19. A small brachiopod with broad hinge line, semicircular outline, elevated beak, flattened anterior margin, and sides with thread-like radiating striæ, and still finer, crowded concentric lines.

20. *Illænus*, sp. A nearly entire cephalic shield of a species of this genus, which appears to be undescribed, occurs in the pebbles of the limestone conglomerate. The glabella is nearly square in general outline, rather abruptly rounded anteriorly and apparently broadly rounded in front, rather gently convex, bearing a small tubercle a little in advance of the neck furrow. The species bears a considerable resemblance to Barrande's *Illænus Bouchardi*, but may be distinct from it and from other species recorded from Canada.

21. Pleura of a trilobite of doubtful generic reference, perhaps related to the genus *Illænus*.

22. *Hydrocephalus ?* or perhaps a new genus. This collection contains a mould or impression of a diminutive trilobite, one-eighth of an inch in length, whose head and the remainder of the body are sub-equal. Cephalon rather strongly convex, semi-elliptical in outline, length and breadth sub-equal. Pygidium very small, semi-circular; body made up of five thoracic segments, which are apparently destitute of spines and tubercles, and decreases in size from the head to the pygidium. It was first referred to *Æglina*, but subsequent investigation led to its separation from that genus. It is here provisionally referred to the genus *Hydrocephalus*, but a better suite of specimens would no doubt reveal its true generic affinities.

23. *Cyphaspis?* or *Holometopus?* A very imperfect specimen. It occurs in a four-inch band of linguliferous limestone and is probably an undescribed species.

24, 25. Two species of entomostraca occur, associated with No. 23. One a large and rather conical form, probably a *Primitia*, and a smaller one, most likely a *Beyrichia*, with a deep sulcus posteriorly,

A subsequent collection from the same locality contain the following species:—

1. *Diplograptus Whitfieldi*, Hall.
2. *Crinoidal fragments.*
3. *Lingula*, sp. nov.
4. *Acrothele* (*?*), large form, n.sp.
5. " small do.
6. *Orthis*, sp. indt.
7. *Stricklandinia*, sp.

8. *Ampyx*, sp. (pygidium of).
9. *Trinucleus*, sp. (portion of ornamented border).
10. *Cheirurus* (?), sp. (portion of glabella).
11. *Asaphus*, sp. (pleuræ of large species).
12. *Bathyurus* (?), sp. (pygidium).
13. *Cyrtolites*, or allied genus of discoid gasteropod.

Cote d'Abraham.

The collection of fossils from Côte d'Abraham, in which are several monticuliporids, has also been examined by Mr. Ami. In it he also recognized :

1. *Orthis*, sp., cf. young specimen of *O. testudinaria*, Dalman.
2. *Leptæna sericea*, Sowerby.
3. *Asaphus*, sp., portions of pleura of a species of this genus.

Mr. Ami has also made a preliminary study of sections of a number of the monticuliporids.

Stratigraphical positions of the several conglomerates.

With reference to the fossils from the bands of limestone conglomerate, of which a very complete list has already been published in the Geology of Canada, 1863, it may be said that during the past two seasons good collections were made, not only from the beds about Lévis, but from several of the islands, from the Beaumont shore and as far down as Ste. Anne de la Pocatière, where the conglomerates are associated with the Sillery sandstones. From the lithological and fossiliferous character of the associated strata, it would appear that bands of conglomerate of several different horizons occur. Thus the beds of Lévis are intimately associated with the highly graptolitic shales of the Lévis formation, which we have found to constitute the upper part of the Quebec group, and overlie the red shales and sandstones of the Sillery. At Ste. Anne the conglomerates are associated with the Sillery sandstones as an integral part of the red shale series, and presumably belong to a lower horizon, as is also the case with the bands on Canoe Island and Grosse Isle, together with the other islands of the group. On the Beaumont shore, as at the contact above Cape Rouge, the beds of conglomerate are in the green and black shales, which contain thin, hard quartzose bands, the stratigraphical position of which is below the Sillery red shales, while in the city of Quebec the conglomerates are distinct from all these, and have a newer aspect, more properly belonging to the Trenton-Utica period, as proved by the character of the associated fossiliferous shales. While some of the fossils obtained from the limestone conglomerates, both of Lévis and other places along the shore to the east, have an undoubted Cambrian aspect, it may be

said here that, in so far at least as the collections made during the past season are concerned, all these Cambrian forms come from the pebbles and not from the paste. Thus at Fort No. 1, in rear of Lévis, pebbles of two pounds weight contained *Salterella*, but other pebbles from the same mass showed large Orthoceratites, with a diameter of two to three inches, while other pebbles again were well rounded pieces of an older limestone conglomerate. Limestone conglomerates.

In pebbles taken out of the conglomerates of the east end of Canoe Island the following species were found : Canoe Island.

Salterella pulchella, Billings.
Olenellus Thompsoni, Hall.
Microdiscus, sp.

The association of the conglomerates here is with red and green shales and hard sandstone of Sillery aspect.

From the conglomerates on the shore, midway between Beaumont and St. Joseph the pebbles yielded *Olenellus Thompsoni*, Hall, and *Olenoides* or *Microdiscus*, the associated rocks being green and black shales and hard quartzose sandstone. Beaumont shore.

From the pebbles in the conglomerates of Fort No. 3, in rear of St. Joseph de Lévis, were obtained:— Fort No. 3, Lévis.

1. *Salterella rugosa*, Billings.
2. *Orthoceras*, sp. like *Xerxes*, Billings.
3. *Cyrtoceras Syphax*, Billings.
4. " *Metellus*, Billings.

From the low ridge west of the high ridges which bound the Catholic Cemetery on the west, in rear of St. Joseph, were obtained : Lévis, near cemetery.

1. *Orthis Mycale*, Billings.
2. " *electra?* Billings.
3. *Camerella calcifera*, Billings, Lévis form.
4. " *polita*, Billings.
5. *Holopea*, sp. indt.
6. *Cyrtoceras Alethes*, Billings.
7. " ? sp. nov., (annulated).
8. *Bathyurus quadratus*, Billings ; portion of head and body.
9. " *Saffordi*, Billings ; several pygidia.
10. " *bituberculatus*, Billings : several heads.
11. " *Timon*, Billings ; pygidium.
12. ? *Conocephalites Zenkeri*. Billings.

West end of Orleans Island.

From the west end of the Island of Orleans:

1. *Orthis apicalis*, Billings.
2. *Orthis*, sp. indt.
3. *Camerella polita*, Billings.
4. *Cyrtoceras*, sp. indt.
5. *? Asaphus canalis*, Conrad; a nearly entire pygidium of a trilobite probably identical with this species.

Conclusions.

From a consideration of the many facts presented in the preceding pages in regard to the structure of the Lévis and Sillery divisions of the "Quebec group," a comparison can now readily be made with the rocks seen along the south side of the St. Lawrence to Cape Rosier, the description of which, east of Métis, was given in the Geological Survey Report of 1881-82. For although at that time it was strongly suspected that the true position of the Sillery formation was beneath the Lévis, it was held that, in view of the opinion which had prevailed for so many years to the contrary, it would not be wise to make such a change without the most convincing proof. This change in stratigraphy we now consider to be so thoroughly established, that but little, if any, doubt can exist on the subject; and upon this interpretation of the structure much of the difficulty which arose as to the correct understanding of the points stated in Prof. Lapworth's paper on the graptolites now disappears. From Métis to Cape Rosier the great bulk of the rocks, with the exception of the portion between Marsouin and a point about three miles below Griffin Cove, together with certain other limited areas clearly marked by characteristic fossils of an upper series, belongs to the Sillery formation, and much of it to the lower portion of that division, and entirely below what we regard as the fossiliferous or graptolitic Lévis formation of the city of Lévis and the south-west end of the Island of Orleans; and at only one point, viz., three miles above Ste. Anne des Monts, do we find what may be regarded as probably a Lévis zone. The rocks of Cape Rosier, in which the *Dictyonema sociale*, *Clonograptus*, etc., were found, as well as those two miles below Great Matane River, where similar forms occur, represent divisions 2 and 3 of the Cap Rouge section and the Beaumont shore, as well as of the the strata on the south side of the Island of Orleans, consisting of black, green and grey shales, with some red beds, together with the grey limestones and hard, greyish quartzites, while the associated limestone conglomerates are like those seen at Beaumont and at the east end of the Island of Orleans. This character is maintained with great uniformity for the entire distance west of Marsouin, though at certain points the Sillery sandstones and red and green shales representing division 4 are more highly developed

Sillery underlies the Lévis formation.

Rocks of the south side of he St. Lawrence to Cape Rozier.

than at others. The rocks of this section would, therefore, both on the evidence of Prof. Lapworth from the fossils, and from the comparison with the stratigraphical sequence of the Cape Rouge rocks, belong to a portion of the Cambrian system, probably representing the upper and middle divisions of that system, while the overlying Lévis graptolitic shales and limestone conglomerates would represent the lower portion of the Ordovician or Cambro-Silurian system. The lowest Cambrian would, therefore, come into its natural place upon the flanks of the pre-Cambrian ridges, which constitute the high lands of the interior anticlinal axis described in the preceding report and in subsequent pages of the present one. Cambrian age of the Sillery.

Three zones of conglomerate limestones can also be clearly defined, viz.: 1st, that associated with the green, black, grey and reddish or purple shales, in which the pebbles are very varied as regards size and character including sandstone, quartz and limestone trap; 2nd, that of Lévis proper, already well described; and, 3rd, that of the city of Quebec, which differs in character from each of the other two. In the pebbles of the first, *Olenellus Thompsoni* is found at various localities, and it is probable that the pebbles of conglomerate found in the conglomerates of the Lévis series are derived from these beds. Three zones of limestone conglomerate. Cambrian zone

From the conglomerates of zone 2, that of Lévis and the west end of the Island of Orleans, a much greater variety of fossils is obtained, including species which belong to a higher or later horizon, while their association with the Lévis graptolitic shales sufficiently indicates their stratigraphical position. In the same way, the interstratified position of the conglomerates of the Citadel hill, in Quebec, or zone 3, with the highly fossiliferous strata found at different places in the city, which present a distinctly newer aspect than the Lévis, fixes relatively the position of this zone. Lévis zone. Trenton-Utica zone.

The relations, or rather the exact horizon, of these Citadel rocks is still to some extent doubtful. Large collections of fossils were made during the past year, which show the presence of a fauna distinct in character and species from that found in the true Loraine or Utica formations, on the one hand, and from the Trenton or Chazy, on the other. The stratigraphical position of these beds does not afford much assistance in working out the problem, since while it may be safely asserted that they are closely related to the rocks which occur along the north side of the Gaspé peninsula, below the Marsouin, and on the north-west side of the Island of Orleans, which have long been regarded as of Utica or Hudson River age prior to the paper by Prof. Lapworth on this subject, there appears to be no palæontological evidence by which they could be definitely assigned to either of these Quebec city rocks.

Their stratigraphical relations.

horizons. They are brought by the great St. Lawrence and Champlain fault directly against the red, green and black shales of the Sillery formation, wherever seen on the Gaspé shore, as well as at Wolfe's Cove, below Sillery church, while on the Island of Orleans this fault brings them against the fossiliferous rocks of the lower part of the Lévis formation. In character of sediments also the rocks of the city of Quebec differ from those of the Utica in the fact that the former have a large development of bituminous limestone, while the latter in the vicinity are mostly brown, black and occasionally greyish shales, with only occasional bands of hard dolomitic limestone. They are equally different from much of the limestone of the Trenton as seen at Beauport, Lorette, etc. While the fossils are of species distinct from those of the formations just named, several of them, according to Prof. Lapworth, would seem to indicate the lower portion of the Trenton formation by their affinities, and some of the Monticuliporids collected during the past season have the aspect of the lower Trenton rather than of the Utica. It would, therefore, appear that these rocks are a peculiar development above the Lévis, and about the age of the Trenton formation, but the exact horizon of which, from the fossils yet obtained, is exceedingly difficult to determine.

Probable horizon indicated by their fossils.

In the list of fossils enumerated by Prof. Lapworth in his paper on the Graptolites, Trans. R. S. C., Sec. iv., 1886, a mistake has evidently been made in the labelling of some specimens which are said to be from a point half a mile above Cape Rouge. These fossils indicate beds of the Trenton-Utica or Marsouin zone, but no such strata are anywhere to be found in the vicinity of Cape Rouge, since from that village to the contact fault, nearly two miles above, the shore is occupied by the lower rocks of the Sillery or Cape Rouge Section, while above this for several miles the brownish-grey shales and greyish sandy beds of the Hudson River formation occur, similar to those seen on the south side of the river, about two miles south of St. Nicholas. This correction is deemed necessary in view of future explorations for fossils in this direction.

C. Cambrian.

Character,

The characters of the rocks which have for several years been regarded as constituting the Cambrian system of eastern Quebec are given with considerable detail in Rep. of Progress. 1877, Dr. Selwyn, pp. 5 A and 6 A, as well as in Annual Report, 1886, Part J, and the areas now under discussion are but extensions to the north-east of those there described. They consist for the most part of hard quartzites, often bluish-grey in color, veined in all directions with quartz, and

frequently containing an abundance of clear blebs of glassy quartz; they do not present the pebbly character so often seen in the beds of the Sillery formation, and they have occasionally a purplish shade and are interstratified with purple, greenish and black slates. A considerable area of green, sometimes schistose quartz-veined slate also occurs at several localities near the base of the series. At times the black slates, associated with the white or gray quartzite is finely micaceous, yet differing in character from the mica schists of the underlying system. These are well seen on the roads leading from the Craig Road to the several stations on the Quebec Central Railway. Limited outcrops of greyish sub-crystalline limestones are found occasionally in the first and second concessions north of Beauce Junction and in the township of Mailloux along the road leading north-east from the village of Buckland, and also near West Broughton. In all these places they are associated with the black slates and quartzites and have been burned for lime for local purposes.

Black slates and limestones.

The volcanic portion of the Cambrian, is also well developed in this direction, but is confined, for the most part, to the eastern side of the anticlinal. It is marked by the presence of frequent outcrops of trappean rocks, often concretionary in character and of greyish or reddish-brown colours. These rise into several lofty peaks, among the most conspicuous of which may be mentioned Broughton Mountain, on lot 25-26, range X and XI, of Broughton and Moose Mountain in the north-west part of the township of Cranbourne, to the north of the great bend of the River Etchemin, whence the volcanic rocks extend for some miles in a series of lofty ridges and hills to the north-east and south-west, though in the former direction, owing to the wilderness character of the country it was found impossible to outline this part of the series definitely. Serpentines also occur in connection with these rocks both massive and as agglomerates, though to a very limited extent as compared with their great development to the south-west. The large areas of serpentine rocks apparently extend northward no further than the township of Thetford. Small outcrops only occur on the Bras and Des Plantes branches of the Chaudière in Vaudreuil in connection with diorites which, in the form of dykes and bosses, form areas of considerable extent in this vicinity.

Volcanic portion.

North of the Chaudière the Cambrian rocks are divided, for some distance, into two portions by the ridge of Pre-Cambrian schists which marks the prolongation northward of the Sutton Mountain anticlinal, and which crosses the Chaudière in the vicinity of Beauce Junction. South of the river in St. Elzear and St. Frederic, these rocks, at times, apparently conceal the older schists nearly to the vicinity of St.

Chaudière and vicinity.

Severin, while further south, areas of Cambrian rocks form overlapping patches or closely infolded basins in the Pre-Cambrian. In Tring and Vaudreuil the Cambrian is concealed over a considerable area by the Cambro-Silurian rocks which extend north-east from Lake St. Francis while further to the east it is overlapped by the rocks of the eastern Cambro-Silurian area which continues thence to the boundary of Maine.

North of the Chaudière the western boundary of the lower Cambrian is somewhat difficult to trace, but it apparently follows a somewhat irregular line to the Etchemin being unconformably overlapped by the Sillery red slates, conglomerates and sandstones, the contact of the two series being near the village of Ste. Claire. Thence the line extends towards St. Lazare, crossing the road to Buckland near the Abenaquis River, beyond which the lower Cambrian quartzites and shales form the high ridge between St. Damiens and Buckland. Further to the north-east, the road leading from Armagh to Mailloux crosses the strike of these formations. Good sections of the Sillery sandstones and red and green shales are seen on this road for several miles southeast of Armagh Corner, being well exposed at the crossing of the Rivière du Sud, one mile and a half distant, where their folded structure is beautifully displayed. South of this stream the red and green shales are seen for two miles further, beyond which the Mailloux green and black altered slates of the Cambrian are found, though exposures are very rare, to the corner of the Taché road near Mailloux church. Further to the north-east, on the road south from St. Thomas, the northern limit of these rocks is seen about one mile north of the Taché road. Further east on this road, the line between these and the upper Sillery rocks crosses about three miles east of the village of St. Marcelle.

St. Lazare to Buckland.

Road south of St. Thomas.

Taché Road.

The Taché road extends north-easterly through the townships of Mailloux, Montmagny, Patton, Arago, Garneau, etc. South of this road the only settlements are St. Magloire in Roux, and St. Pamphile on the Elgin road, near the boundary of Maine.

The Cambrian rocks apparently conceal from view the schists of the underlying anticlinal, or lap completely round the northern extremity of the Pre-Cambrian ridge, which gradually declines in elevation in this direction, about the middle of range I, township of Rolette, a few miles south east of St. Paul de Buton, since no rocks of the older series are seen on the track which extends south-east past Lac au Crapaud, Cambrian and Cambro-Silurian sediments only being visible in this direction.

Rolette.

Throughout the entire area of these lower Cambrian rocks no fossils have yet been found by anyone.

No fossils yet found.

In lithological characters, part of these resemble, in many respects, those of the coast series of Nova Scotia, while in part they resemble

the lower portion of the Cambrian of New Brunswick. The most that can be said of them stratigraphically is that they are intermediate between the chloritic and micaceous schists of the central anticlinal and the overlying rocks of the Sillery, from which they differ considerably in character. Resemblance to the Cambrian of New Brunswick.

Much of the strata just described, north of the Chaudière, were considered by Richardson in 1869 to be in part of Sillery age, and in part to belong to the Potsdam formation. While there is presumably a considerable interval separating the two horizons, as at that time understood, there are certain beds in both formations which possess many points of resemblance to each other. This question has, however, been pretty fully discussed in previous pages, and no further remarks are here necessary. It may, however, be added, that much of the confusion which has prevailed in regard to the true position of these rocks has been due to the apparent similarity and consequent grouping into one formation of all these sandstones and associated shales. On the old view as to the composition of the Sillery formation, it was quite correct to say that much of what was then so called was older than the Lévis, though it did not follow that all of what then was called Sillery should be placed in the same horizon. Views of Richardson, 1869.

Considerable difficulty has been experienced in fixing the position of certain black slates which are closely associated with the chloritic and micaceous schists of the central anticlinal. While in places somewhat micaceous, they differ in character very considerably from the rocks which we have called Pre-Cambrian, and at certain points a manifest unconformity between the two series is evident. This is well seen on the road from Broughton station on the Quebec Central Railway to Harvey Hill, the regular strike of the underlying chloritic rocks being nearly east and west, where the overlying black slates, with which are associated beds of greyish limestone, at times strike nearly north and south. On this account, and because of the much greater metamorphism of the lower series, an attempt to separate them has been made; and while, in the absence of fossils which might be conclusive, no other evidence than that presented can now be adduced, this separation will serve to distinguish the crystalline schists which are often richly metalliferous, from the slaty series, which has as yet proved comparatively poor in this respect, if we except the quartz veins which may be, and presumably in many cases are, auriferous or carry argentiferous galena. Black slates of the central area.

Concerning the Cambrian age of the serpentine belt, several of the remarks just made will also apply. The serpentines are apparently associated with two different groups of rocks; thus, certain areas are associated with great masses of concretionary as well as massive diorites, Volcanic portion of the Cambrian.

in which the latter largely predominate, as in the Moose Mountain and Etchemin districts. The associated rocks here are green, black and red slates with hard quartzites, which at first glance resemble some portions of the Sillery formation. Somewhat similar red slates also show near the Colway, on the Chaudière, where also diorite and serpentine in small outcrops are seen; near these, also, a small boss of granite occurs in the black shales.

Serpentines, diorites, etc.

Further south are the great serpentine areas of Thetford and Coleraine. The country rock is mostly a black or greenish slate with hard schistose quartzite, though at Coleraine station beds of dark red slates with conglomerates similar to those which flank the Stoke Mountain range, and which are described in the Report for 1886, occur, but which differ greatly in character from the crystalline schists of the central axis; while in connection with the chloritic and micaceous schists other areas of serpentine are found, generally of limited extent and frequently associated with talcose minerals, soapstone being often present. These are well seen in the Leeds district, north of Kinnears' mills where the rocks in which the serpentines occur are distinct in character from those seen in the productive asbestus district, as also from those in the township of Broughton. The manifest difference in the character of the strata, together with the fact of the occurrence of a great line of fault between the crystalline schists of the Sutton Mountain anticlinal, and the slates and serpentines to the east, are the chief reasons for the separation of these two series into Pre-Cambrian and Cambrian.

Economic importance of the Cambrian rocks.

The importance of these areas of Cambrian rocks, from an economic standpoint, has already been alluded to in the last Report, 1886, in connection with the gold and asbestus deposits of Eastern Quebec. The remarks then made have been fully sustained by the work of the past season, and it seems to be clearly established that the greater part at least of the gold, is derived from the quartz veins in this series of rocks. That these veins, which occur in great numbers in the slates and quartzites, are not uniformly auriferous, is no more than should reasonably be inferred, since the same feature is common to all gold regions; but it is probable that the greater richness of certain areas is due to the same principle that appears to be established now for the Nova Scotia auriferous leads, viz.: that the most productive veins occur along the axes of the anticlinals. This principle should apply both to the Chaudière and to the Ditton areas, since in the latter the most of the gold yet found is certainly derived from veins which are near the centre of the anticlinal axis in that locality.

It is possible, also, in the Chaudière district, that the frequent outcrops of diorite seen about St. Francis, and for a few miles in either direction, may have had some favourable influence in determining the auriferous characterof this section.

A. B. PRE-CAMBRIAN.

Formerly regarded as Lauzon and Sillery.

Underlying the series just described are the rocks of the central anticlinal referred to this period, and already alluded to in former reports as constituting the oldest rocks of the Townships. In the report for 1869 by Mr. Richardson, they were described as belonging in part to the Sillery and in part to the Lauzon division of the Quebec group. The view was at that time held that these rocks were the extension of those seen in the Sutton Mountain range, while the structure was supposed to be the same, viz., an overturned synclinal.

Eastward extension of the crystalline schists.

The axis of the Sutton anticlinal has been traced carefully during the past season and found to extend with great regularity north-east from the townships of Wolfestown and Halifax, through Leeds to the Chaudière River, where it is seen in the cuttings of the railway along the south slope of the river valley, about one mile south of Beauce junction. Northward it is observed in the brook which crosses the road in rear of that place between the concessions of St. Joseph and L'Assomption, though the older rocks are concealed for several miles on either side of the river by the overlapping slates and quartzites of the Cambrian system just described. The ridges of chloritic schists again rise into prominence a short distance further to the north-east in the concession of St. Adolphe and extend thence in an unbroken line for nearly thirty-five miles, forming the high range of hills seen in Frampton, the eastern part of Buckland and the adjoining townships of Standon, Mailloux and Roux, beyond which the prominent elevations gradually sink and the older rocks disappear about midway in the western portion of the township of Rolette. The widest part of this area is in Standon where it has a breadth, north of the Etchemin, of nearly five miles. On the west side it is overlapped by the black, wrinkled slates and quartzites of the Cambrian, which are seen in places to rest upon the older schists in a nearly horizontal attitude, and on the east it is likewise overlapped by the volcanic portion of the same system.

Their occurrence in Gaspé.

Further to the north-east, in Patton, Talon, etc., though the anticlinal structure is maintained, none of the rocks of the crystalline schist series have been recognized, as far at least as the Temiscouata road. Between this point and Matapedia Lake the belt of country constituting the height of land, has not yet been fully examined, though prominent ridges occur; but east of that lake the old rocks come into view again and constitute the Shickshock range. This has been shewn on the map of the Gaspé Peninsula. See Geol. Surv. Rep. 1880-81-82.

Development south of the Chaudière.

To the south west of the Chaudière the Pre-Cambrian rocks are well seen in continuation of those already described as occurring in Chester and Wolfestown. Within the last few years several new roads have been made which connect the old Craig road with the stations of Black Lake, Thetford and Robinson, on the Quebec Central Railway, and these have afforded good facilities for determining the limit of the schists in this direction. It is probable that several folds occur in the older rocks of this section, some of which include limited areas of the overlying Cambrian, which, under the aspect of purple, black and green slates and quartzites, are seen to lie nearly flat upon the upturned edges of the schists at several points on the Thetford and Broughton roads, the difference in the direction of the strike and dip of the two series being at times well marked.

The area of the older chloritic and micaceous rocks which varies considerably in the townships of Halifax, Ireland, Inverness and Leeds, rapidly diminishes towards the Chaudière by the overlap of the Cambrian strata till it has a breadth of not more than one mile at the southern boundary of the township of Ste. Marie, beyond which point these older rocks are apparently entirely concealed. Areas of chloritic and talcose schists also occur in a ridge extending through the township of Thetford.

Among other lines of traverse crossing the crystalline rocks of this system three may be described as illustrating the anticlinal structure of the area south of the Chaudière. Of these the most southerly is on

Lines of section Ste. Sophie to Halifax.

the road from Ste. Sophie, east of Somerset, to Halifax. On this road, after crossing the flat occupied by the graphitic black shales and limestones, the first rocks seen are green slates, sometimes dark colored and highly schistose, with a great quantity of quartz in irregular veins. They are much twisted, but have generally a high dip to the south-west. In many respects they resemble the Pre-Cambrian rocks of New Brunswick, and represent probably either a portion of that system or the lowest members of the Cambrian series. Thence for two miles the road rises rapidly over greenish schistose slates with an occasional purple-tinged band to near the top of the ridge where green chloritic and micaceous schists come in, the dip of the series for this portion being N.W. Thence alternations of chloritic and micaceous schists are seen along the crest of the ridge and down the eastern slope to the crossing of the brook, nearly two miles west of Halifax Corner, where a band of black mica slates, similar to the rocks in the vicinity of Wolfestown, crosses the road. Green micaceous schists, however, again come in and extend to the road from Halifax to Wolfestown, east of which, towards Black Lake, alternations of green schist and black wrinkled and sometimes micaceous

slates, which may represent infolded areas of Cambrian sediments, occur. A series of synclinals is seen in the area east of Halifax, but the structure of the main ridge, east of Ste. Sophie, is undoubtedly an anticlinal one.

The second line of section between Inverness Corners and the Thetford mines crosses the Craig road near Bullet Brook.

Inverness to Thetford Mines.

The beds of green and black striped shales, with limestone conglomerates, seen to the west of Inverness are directly underlaid by green and grey slates, which are cut by quartz veins near Inverness Corner; while two miles east of that place, at the jog in the road near Irving, the black, wrinkled, irony slates appear. None of these slates have the distinctly schistose character of the Pre-Cambrian, but about half a mile further on, where a road runs south to Bullet Brook, green chloritic and micaceous schists come in and form the entire ridge between this point and Craig road, a distance of two miles and a fourth. On the second part of this section, that east of the Craig road, the first rocks near Bullet Brook are twisted green, grey and black slates, containing quartz-veins, which have been opened at this place for copper. Crossing the brook on the road to Thetford, the road ascends rapidly over mica-schists, silvery-grey, green and chloritic. These occupy the entire extent of the ridge nearly to the beginning of the descent to Thetford, a distance of four miles, having a general dip of N. 15°–50° W. < 15°–30°. The axis of the anticlinal is well seen near the eastern summit of the ridge, about four miles and a-half west of the Quebec Central Railway at Thetford station. Near the summit a belt of black, wrinkled and slightly schistose slates crosses the road, with a breadth of nearly two miles, being succeeded by green chloritic and micaceous schists, which thence extend down the road leading to Thetford brook as far as the crossing on the line between lots 23 and 24, three-fourths of a mile west of the Thetford River. Thence the black and grey slates and hard quartzites which accompany the serpentines extend to that stream. In this section also the structure of the second ridge is a true anticlinal one, all the sediments lying to the east of the summit, dipping apparently to the south or south-east, while those to the west dip in the opposite direction. The position of the black, somewhat schistose slates, which are occasionally micaceous, is the same as further to the south about Wolfestown, where we have considered them as infolded areas in the older schists.

St. Sylvester to Broughton.

The third section, between St. Sylvester and Broughton, exhibits a similar succession of rocks. Here the breadth of the crystalline schists is very much reduced. They are first met with at the foot of the steep hill on the road leading from Harvey Hill through the ranges of Handkerchief and St. Frederic, where the ridge of crystalline schists is

the most prominent feature in the country, and has a direct breadth of one mile and a-half. Between this hill and the brook east of St. Sylvester Corner, purple, black and green slates, with hard quartzites, are the principal rocks, and these rest directly upon the schistose series, the dip of both being north-west. The rocks which border the crystalline schists on the east are similar in character to those on the west, and are distinct in character from those of the main ridge.

Areas north of the Chaudière.

North of the Chaudière the section across the central ridge is from the usual series of black, green, grey, and occasionally purple slates, with hard quartz-veined quartzites on either side, across a central area of chloritic and micaceous schists, having a breadth of nearly four miles east of West Frampton, with a distinctly defined anticlinal structure near the summit of the ridge. To the south-west of this ridge, in the vicinity of Les Saintes Anges, the rocks seen on the several roads are micaceous black and grey slates and quartzites, with bands of dark-grey crystalline limestone. Similar rocks are seen in the cuttings on the Quebec Central Railway along the hill south of the Chaudière, and they have been regarded by us as representing possibly the lower portion of the Cambrian, though they may be a portion of the older series. The green chloritic schists appear in a small outcrop at a brook crossing the back-road about one mile north of Beauce junction.

Black and grey slates of Standon.

It will be seen from the several sections here presented that the succession of the strata is tolerably uniform and that the central anticlinal axis in the schists is constant. The distribution to the north-east and the termination of the schists have already been described. There is, however, an apparently overlapping basin of slates of Cambrian aspect, which crosses the Etchemin River in the vicinity of Standon, and can be traced for some four or five miles to the south-west and north-east of that point. It has in no place a greater breadth than one mile, and generally is much narrower, the rocks comprising it being distinct in character from the crystalline series.

From a careful consideration of all the facts presented above, it appears conclusive that, not only on lithological grounds but stratigraphically, the divisions of the Eastern Townships rocks, as now given, can be clearly maintained, many sections having been studied and the relations of the several groups being the same throughout.

The apparent absence of fossils from the beds which are now considered Lower Cambrian is not to be taken as conclusive of their non-existence at some point, since as in the case of the Lower Cambrian of New Brunswick, where diligent search has been prosecuted for more than twenty years and immense collections of primordial fossils made, it is only very lately that organic remains have been detected

in the lowest beds. The metamorphic condition also of a great portion of the strata in the Townships might preclude the discovery of traces of organisms, and even as regards the fossiliferous portion of the Quebec group it is found that the fossils are confined to very limited areas, and that great thicknesses of strata are apparently entirely devoid of any sign of organic life.

CRYSTALLINE AND IGNEOUS ROCKS.

Granites.—The areas of granite found in the limits of the north-east quarter sheet are, so far as now known, confined to two localities, the great masses which form such conspicuous features in the south-eastern portion of the province, not extending so far northward. Of these granites a very limited outcrop is seen about half a mile south of the Chaudière River and about one mile east of the Bras du Sud-Ouest in Beauce. The other is found in connection with large masses of white granulitic rock which form an important feature in the serpentine areas of Coleraine, and Thetford, where the rock, which consists generally of felspar and quartz, at times contains mica. Between Black Lake station and Thetford mines on the Q C. Railway, these white masses are very conspicuous, forming hills from half a mile to two miles east of the railway. In some of the asbestus workings, dykes of this rock, from a few inches to several feet in thickness, are seen to cut the serpentine and, at times, appear to have shattered the rock in contact, thus leading to the belief that the granulite is a newer rock than the serpentine.

Outcrop near the Chaudière

Outcrops in Coleraine and Thetford.

Diorites are somewhat largely developed in this section as well as in that to the south-west. The continuation of the peculiar chain of peaks which extends from the Vermont boundary south of Owl's Head through Orford and Ham mountains into Adstock, is seen in the Broughton Mountain, and again on the north side of the Chaudière in the great mass of the Moose Mountain range and in several peaks to the north-east of it, not designated by special names. These rocks, as stated in Part J, Annual Report, 1886, are closely associated with the serpentine, of portions of which the latter may be and probably is an alteration, and in the serpentine areas of Thetford and Coleraine great masses of diorite rock both massive and concretionary are found. On the Chaudière also, between the Colway and the Gilbert, considerable outcrops of dioritic rocks occur, generally of greenish or greyish shades but, at times, as on the Colway of brownish color. The most extensive of all these is the mass in Cranbourne, known as Moose Mountain, which has been outlined over an area ten miles in length and two miles and a-half in breadth but its northern boundary has not been reached, owing to the densely

Chain of diorite hills.

Outcrops on the Chaudière.

Moose Mountains.

wooded character of the country in this direction, but it probably extends for several miles further. The areas on the Chaudière are generally of small extent, and often occur in connection with hard quartzose sandstone and black slates which are cut by quartz veins. At times these diorites are highly serpentinous, and form a serpentino-dioritic agglomerate. All these rocks belong to what is now regarded as a portion of the Cambrian system.

Diabase associated with the Sillery rocks.

Other masses of trap rock, mostly diabases, are found associated with the Sillery formation. These are greenish and brownish, and are, at times, amygdaloidal While they are quite numerous, probably the largest and most important are, 1st, near St. Apollinaire, five miles east of St. Antoine de Tilly, and not far from the line of fault between the Sillery and the Hudson River formations; 2nd, an area of considerable size whose southern limit is seen on the road from St. Gervais to St. Lazare, whence it extends to the north in a series of outcrops some of which are of large extent, for four miles to the vicinity of and beyond St. Nerée, and 3rd, a prominent hill on the road leading from the St. Henry and Anselme road to St. Gervais. These traps have exercised an apparent metamorphic action on the slates with which they are in contact, and in all the three localities, bands of slate and sandstone are intimately mixed with the trappean rocks. Small areas of similar rocks also occur with the black graphitic limestones and slates near Somerset and Ste. Julie.

Their principal development.

Serpentines.—The areas of these rocks are often of considerable size and great economic value. The largest extends from the road leading from Coleraine to Wolfestown, through Coleraine into Thetford, and is the continuation of the belt described in Part J, Annual Report, 1886, as occurring in Ham and Wolfestown. The largest development is in the northern part of Coleraine about Black Lake and in the portion of Ireland adjoining, and it is in its northern prolongation into Thetford, where it forms a belt east of the Thetford River, that the valuable deposits of asbestus occur which are known as the Thetford mines. The economic importance of this belt was discussed in the last Report, but during the past two years a great amount of exploratory work has been done by various parties to determine the existence of workable veins of asbestus, and many new outcrops have been found, which may be briefly mentioned.

Economic importance.

Observations by Mr. Obalski.

The main ridge which extends north-east from Coleraine forms a very prominent mass along the west side of the Q. C. Railway as far as Black Lake where the most northern peak, known as Silver Mountain, rises on the south-west side of that sheet of water to a height by aneroid of about 500 feet above its surface. The belt has a breadth of two miles and a-half with its western limit in lot 24, ranges I to IV Ire-

land. The elevations of this ridge were not taken by us, but on a plan by Mr. Obalski, mining engineer for the province of Quebec, several prominent peaks are noted as rising from 600 to 650 feet above the lake. In this great mass of serpentine but two deposits of asbestus of sufficient importance to warrant mining, are yet known, viz., that owned by Fenwick and Sclater of Montreal, which is on the extreme south-east corner of the mass at a distance by road of one mile and a-half from Coleraine station, and the other, owned by King Bros., of Quebec, on lots 24 and 25, range III, Ireland. On Silver mountain, however, a number of small veins of asbestus have been observed, but no attempt has yet been made to develop them. Coleraine and Ireland.

Black Lake.

This area of serpentine is bounded on the east by a ridge of diorite which extends to the small lake above Black Lake, opposite which the serpentine of the main mass crosses the stream flowing into that lake and shews in small cuttings on the railway as far as Black Lake station. The country along the Q. C. Railway for several miles north of Coleraine station is thickly strewed with serpentine boulders, but ledges rarely appear.

Black Lake to Thetford Mines

The main mass of serpentine is cut off at the shore of Black Lake, but re-appears on the north side and between the lake and the railway. West of the Thetford River it has not been seen except at one point on the road a short distance beyond that stream, where a mass of the rock occurs, but has the appearance rather of a large boulder than of a ledge. The northern line of the main belt crosses the railway a short distance north of Black Lake station and continues north-eastward with some breaks, showing diorite and granulite to the Poudrier road, which is now, for the most part of its length, merely a track largely overgrown. This road is nearly midway between Black Lake and Thetford stations. In the area lying between the railway and the Thetford River, towards the Thetford mines, diorites are occasionally seen, and several cuttings are made in the serpentine along the line of the track in this direction, but the great mass of asbestus bearing rocks keeps to the south-east of the railway towards Caribou Lake.

Thetford Mines

Near the boundary of the township of Thetford, serpentine comes in again to the west of the railway, and some rich ground is seen between it and the river, and passing into Thetford, it occupies the entire space between the river and the mines for a distance of half a mile or more, much of the surface being covered with drift so that the character of the underlying rock can only be determined by excavation.

Thetford and Black Lake road.

A waggon road has lately been made between Black Lake and Thetford, and thence alongside the railway to Robertson station. Between the two former places it rises steeply over serpentine for a mile to near the foot of a lofty ridge, on which Reid's, now Wertheim's,

Old Poudrier road.

mine is situated, whence it keeps more northerly and crosses the old Poudrier road, about one mile south-east of the railway. On this latter track the serpentine shews for several miles, the lots having been taken up by different parties as far back as lot 17, range A and B, two miles from the crossing of the Thetford road, beyond which the country is said to be swampy, and rock exposures rare. In this direction the

Granulite.

masses of white granulite form very conspicuous features and occupy a very considerable area. At Thetford the largest of these is seen near the road leading from the Thetford mines to Ireland; west of the Thetford River no traces of serpentine were observed; slates and hard sandstones being the principal rocks till the schists of the mountain ridge are reached.

Area of serpentine noted by Mr. Obalski.

The principal area of serpentine extends north-eastward from Thetford station on the east side of the railway for about one mile, beyond which it disappears; but from the notes which Mr. Obalski has kindly furnished us of his exploration, it comes in again farther to the east. Mr. Obalski says:—"In Thetford township I found serpentine on lots 10, 11, range VII; lots 14, 15, 16, range VIII; 14, 15, range IX; 5, 7, 9, 10, range X; as also in Adstock on the Coldstream River, at the end of the Poudrier road."

Little Lake St. Francis.

Mr. Obalski also spent some days exploring the country in the vicinity of Little Lake St. Francis. He says:—"On the north-east side of this lake I noticed a belt of serpentine, three-fourths of a mile wide, running north-easterly; as also near a lake without a name, near the Poudrier road. Much of this resembles the Wolfestown serpentine, but other portions were light-colored and siliceous."

Thetford to Broughton.

On the north side of the railway, in the township of Thetford, serpentine occurs in lots 16, 17, 18, range IV, containing chromic iron; and small mounds of the rock occur also on lot 13, range V; and in range XI, Broughton, along the south side of the road from Broughton station to Harvey Hill, frequent outcrops of serpentine and soapstone are seen. These were mapped some years ago by Mr. H. Y. L. Brown, but no asbestus of economic importance has yet been reported from these latter areas. Further to the north-east, serpentine and soapstone occur on

Broughton.

lot 14, range VII, on which the Broughton mine is situated. This is the most easterly outcrop of the belt known on the north side of the railway.

Chaudière district.

In the Chaudière district, serpentine occurs in three bands, separated by hard quartzites and black and grey slates on lot 13, range I, Tring, in which several small veins of asbestus were seen. Also on the Bras du Sud-Ouest, at the falls, three miles from the mouth, and in small knolls on the hill side east of that stream, and half a mile south of the Chaudière. On the Des Plantes it is seen in a hill and in the stream,

with slates and sandstones, just above the road across the mouth of the river, and further up at the Falls from one to two miles above. The outcrops at both these places are not large, but small veins of asbestus were observed. Small openings have been made to test them, although not much work has yet been done.

Beyond this, to the north-east, a small outcrop of serpentine is found in the east flank of Moose Mountain, on lot 23, range V, Cranbourne, on the west bank of the Etchemin, owned by Mr. Mangan. Here veins of asbestus up to five-eighths of an inch were seen. No serpentine was observed by us to the north of this point, but Mr. McOuat reports three small outcrops of serpentine rock on the old track, now entirely grown up, leading past Lac au Crapaud; one in range IV, Rolette, the others on range VI, Talon. The country in this direction is a densely wooded wilderness. Cranbourne.

Among other localities observed by us may be mentioned an outcrop on the concession of Ste. Catherine, near the road, four miles east of St. Sylvester Corner, owned by Mr. Fahey, of that place, near the contact of schists and crystalline dolomites, with black and grey slates. This, in so far as we could see, contained but slight traces of asbestus. To the south-west in the township of Leeds, on the road north from Kinnear's Mills, and on lots 1, 2 and 3, range X, several small areas occur; but from none of these has workable asbestus been reported, though good chromic iron was found there, and several beds of very rich magnetic iron ore occur in the vicinity. Also on range XV, of Leeds, about two miles south-west of Harvey Hill, Mr. Richardson reports several small areas of serpentine and soapstone. These, also, have not yet produced asbestus in workable quantity. Ste. Catherine. Fahey's mine. Leeds.

The character of the serpentine in these small detached areas outside of the main mass of Thetford and Coleraine is generally uniform, but differs somewhat from that in the mining districts. It is often softer and has a peculiar talcose shade and unctuous aspect, and is frequently associated with soapstone, a mixture not found at any of the quarries now worked, with the exception of the mine at East Broughton, where the workable asbestus, in so far as yet known, is confined to a single vein at the contact of the slates and quartzite with the serpentine, and which has now been worked to a depth of over 60 feet. In the lower portion of this working, soapstone of fine quality was met with, which in places forms the hanging wall of the main vein of asbestus. Difference in character of the serpentine.

Surface Geology.

The features of the surface geology to which attention was specially directed during the past two years had reference to the course of the ice-flow and the distribution of boulders and other drift. The great valley of the St. Lawrence, which in pre-glacial times must have extended from twenty-five to forty miles east of its present channel, is clearly defined by the prominent ridge of Cambrian and Pre-Cambrian rocks, and must have been of considerable antiquity. The same was probably true of many of the side streams, such as the Etchemin, the Chaudière, etc., whose pre-glacial character is clearly proved by the finding of old channels flowing into the main river, which have been filled with gravel and sand prior to the deposition of the boulder-clay.

Pre-glacial valley of the St. Lawrence.

Throughout the entire area great deposits of clay and sand are found. These are especially noted in the broad, flat country lying to the east of the St. Lawrence, over which the line of the Grand Trunk Railway passes, and where large areas of peat bogs occur. In some of the river sections thick deposits of clay are found, which have a depth of many feet, but most of these are devoid, in so far as could be seen, of marine shells, which were observed at but very few points, though this area must have been submerged for several hundred feet.

Character of surface.

Throughout this great area exposures of rock are comparatively few. Occasionally a low ridge of hard sandstone and slate appears above the surface. The river channels sometimes show fair rock sections, as on the Becancour and elsewhere, but the smaller streams do not appear to have cut through the drift in many places to the underlying rock. The surface of the country rises very gradually, after reaching the crest of the cliffs which overlook the St. Lawrence, the elevation of Fort No. 2, in rear of Lévis, being, by aneroid, 350 feet above the river, while at Beauce Junction the elevation is only about 100 feet higher. The Pre-Cambrian ridges rise abruptly, and at Harvey Hill have elevations of 1400 to 1600 feet, while the ranges of the Buckland hills have probably not far from the same height. On the east side of these ridges the country slopes gradually to the great basin of the St. John River waters, which is near the eastern limit of the province, and which, when seen from the highlands to the west, looks like a great flat or slightly undulating and thickly wooded plain, analogous to the St. Lawrence basin.

Surface elevation.

The theory proposed several years ago of local glaciers, instead of a great ice-cap, seems to be sustained by the observations of the past two years in the country lying to the south of the St. Lawrence. Striæ are not numerous, but where seen have a generally westerly course on

the west side of the main ridge, trending on the low lands towards a south-westerly or north-easterly direction along the valley of the St. Lawrence, while on the east side of the ridge the course of the striæ indicates a motion to the north-east into the upper branches of the St. John River. As a general rule, the markings, where river-valleys exist, follow the course of these. The following list from places pretty wide apart may be given :—

Striæ.

S. 55° W. on second Con. road, between St. Gervais and St. Raphael midway.
N. 80° W. on second Con. road, one mile east of St. Raphael.
N. 85° W. on fourth Con. road, near St. Nerée Church.
N. 85° W. on road to Armagh, 2½ m. N.-E. of St. Lazare.
N. 75° W. on road ¾ mile south of Armagh Church.
N. 50° W. on road 2½ m. S.-E. of Ste. Agathe.
N. 40° W. on same road, one mile west of Craig Road.
N. 35° W. cor. of road, five miles west of Tring.
S., on east side of West Frampton Ridge, also on top of ridge.
N. 60° W. on road from Frampton to Ste. Henedine.
S. 35° E. on ridge S.-E. of Frampton.
N. 60° W. near Ste. Sylvester.
S., at cor. of road near Lake Etchemin.
N. 65° E. St. Justin Church.
N. 20° E. crossing of Becancour River, one mile east of Campbell's corner, Inverness.
S. 55° W. road St. Anselme to St. Gervais.
S. 35° W. road from St. Gervais to Ste. Claire, R. VIII, Martinière.

Kames.

In many of these cases the connection between the course of the striæ and the old river valley is very plain. Though areas of sand, gravel, and clay are numerous, well defined kames are rare, the most conspicuous seen by us being on the road from Leeds village to Kinnear's mills, about a fourth of a mile north of the Osgoode River; the direction of this kame is generally parallel to the course of the stream or N. 5° E. It has a length well defined of over half a mile, with an elevation of thirty feet.

Drift Laurentian boulders inland.

Among the most interesting surface features in this section is the presence of scattered boulders of Laurentian rocks, gneiss, labradorite, limestones, etc. These in the valley and along the hill-sides of the Chaudière are so abundant that they have been used for building the church at St. Joseph, and the great variety of Laurentian rocks in this structure is an interesting geological study in itself. The elevation of the locality from which these boulders were obtained is from 450 to 600 feet above the St. Lawrence. But further inland similar boulders occur, not only in the approximately level country of the Cambrian to the east of the central axis along the line of the Quebec Central Railway, but even on the most elevated ground, as at

Harvey Hill, which is calculated, by barometer, to have an elevation of about 1,500 feet. Along the slopes of the hills in this vicinity scattered pieces, both large and small, of well rounded true Laurentian gneiss occur, the source of which could have been no other than the rocks along the north side of the St. Lawrence. It is difficult to conceive, either on the theory of local glaciers or on that of a great ice sheet, how these scattered boulders could have been deposited on the high lands of the interior, since on the former hypothesis the local glacier could have had no connection with the source of the boulders and on the latter the ice markings indicate that the course of the glacier could not have carried boulders from the hills along the north side of the St. Lawrence, across the great valley of that river, to the crest of the opposite ridges 1,500 feet or more above sea level.

Theory of their distribution.

The alternative theory to account for their present position must be one of submergence and floating ice, just as we see at the present day, the transportaion of loose stones going on from the north to the south side of the St. Lawrence by the agency of great ice-pans, which, freezing along the shore and around the beach stones, are borne away by the tide and subsequently stranded often at distances far remote. A beautiful illustration of this is seen along the shore between Cape Rouge and Point au Platon. Along this portion of the river, more particularly on the north side, but also on the south side above St. Croix, there is a series of shallow bays with great flats, bare at low tide and extending out for nearly a mile from the shore. These flats are thickly strewn with boulders of Laurentian rock, while the points which divide the bays are in nearly every case entirely composed of boulders. These have been undoubtedly left in their present position by the action of floating ice carried along by tide and wind, and stranded in these coves precisely in the same way as timber rafts, when descending the river, if they meet a strong north-east wind below Point au Platon, are driven on shore and frequently broken up. It is, therefore, quite conceivable on the supposition of a submergence sufficient to nearly cover the hill ranges of the interior, that the scattered boulders there observed were deposited by the same agency.

The distribution of the gold in the drift, for the country south of the Chaudière, was given in last report. In connection with the question of submergence the observations of Mr. A. Webster may be noted. He says "the drift appears to come from the north-east, and is found overlying a bluish-grey boulder clay, in which no gold has been observed. The gold drift contains fragments of local rocks and foreign boulders of Laurentian and newer formations;" and again, "The altitude of the gold-bearing drift appears nowhere to exceed 2,000 feet above the sea. Below this height colors of gold may be said to occur anywhere to the

Remarks of Mr. A. Webster

south-east of the great Quebec anticlinal and most abundantly on the upper waters of the Chaudière and St. Francis rivers. It has also been found on the Maine water-shed." Mr. Webster also remarks that "On the St. John and Daaquam rivers, to the north east, no gold was found, though carefully looked for. This may be owing to the swampy nature of the country and the few exposures of bed rock."*

It is, however, probable that the gold-bearing rocks of the southern area are concealed in this direction by the overlap of the Cambro-Silurian sediments already described. From the remarks in Geol. Can., 1863, p. 929, as to the phenomena observed about Lake Memphremagog and on the sides of the mountains in northern Vermont and New Hampshire, the theory of a submergence of this portion of Quebec to a very considerable depth is clearly stated. The occurrence of clay terraces at the upper end of that lake, 778 feet above sea level, with successive terraces of sand and gravel, to a further height of 579 feet, is noted, while it is further stated, *op. cit.*, "similar stratified deposits form a regular terrace-like beach in Ripton on the Green Mountains at a height of 2,196 feet. Ancient beaches are described by Dr. Hitchcock as existing in the White Mountains at elevations of 2,449 and 2,665 feet above the sea." Evidences of submergence, Geol. Can. 1863.

Economic Minerals.

Gold.—The history of the gold industry in the Chaudière district was given in the last report, and but little further can be said on the subject. During the last two years work has been carried on by four companies, with, so far as could be learned, satisfactory results. Part of this work was largely of an exploratory character. Of these companies, the works of McArthur, Copal & Co. operating near the village of St. Francis, Beauce, arethe most extensive. They are situated at Meul Brook, a branch of Mill Creek, about half a-mile from the mouth and to the south of the village. Prospecting for an old river-channel has been going on at this place for several years, but two years ago the ancient bed of the Meul stream was struck, and had been tunnelled by the end of 1888 to a distance of over 600 feet, openings being made for ventilation and the easier working of the mine. At the time of my visit, in September of that year, the end of the tunnel at 400 feet, was thirty feet lower than the present bed of the stream, which was about sixty yards to the east. Great difficulty was encountered in sinking, owing to the quantity of quicksand encountered. The bottom of the old channel contained a good deposit of well-rounded, worn gravel, cemented with sand and clay, from which nuggets of gold from $10 to $153 in

Gold mining on the Chaudière River.

St. Francis. McArthur, Copal & Co.

* Rep. Prog., 1880-81-82, p. 4 A.

value had been reported. Difficulty in washing the gravel in order to save the fine gold was experienced, the system of sluicing not being properly arranged as regards fall and other appliances necessary for obtaining the best results. The returns of the quantity of gold produced from this mine are unfortunately not to hand for publication.

Des Plantes River. H. Sewell.

At the Des Plantes, Mr. Horace Sewell, in connection with Montreal parties, has been engaged during the last two years in locating the old river-channel of that stream. During the last year a shaft was sunk on the east side of the river, about half a-mile above the road and a short distance below the old workings of Mr. Mackenzie. The bed rock was reached at a depth of thirty feet, and consisted of sandstones, slates and diorites, overlaid by about four feet of well-worn river gravel, cemented with clay and sand. This is now being followed, and coarse gold in paying quantity is reported. The Des Plantes, in the earlier days of gold mining in this section, produced a large amount of coarse gold.

Cumberland stream, Capt. Richards.

On the Cumberland stream Capt. Richards has continued his exploratory work, but when the last returns were received at the close of the season, had not apparently succeeded in striking the old channel in that quarter. No returns of output are available, but, in so far as could be learned, very little coarse gold was obtained.

The fourth company was working on the east bank of the Famine River, about one mile above the bridge across the mouth of the stream. The former workings of the St. Onge Company having proved unprofitable from several causes, a drift was started in the bank of the Famine by two of the St. Onge brothers, which has penetrated what the miners regarded as another channel in gravel carrying gold, the richness of which has not yet been learned. No attempt has yet been made to work the quartz reefs of the Chaudière district. An analysis of a piece of quartz from lot 12, range I, north-east St. Francis, was made last year by Mr. Hoffmann, who obtained .117 of an ounce to the ton of 2000 lbs., showing the auriferous character of the vein. It is doubtful if the Cambrian gold-bearing rocks appear very far to the north-east beyond Cranbourne, being probably concealed by the over-lapping Cambro-Silurian; but quartz-veins, which look well and which, from analyses made by assayers at various places in the United States, have shown a good amount of gold, occur near the road leading from St. Francis village to Cranbourne, about four miles from the former place.

Famine River. St. Onge Bros.

Harvey Hill Mines.

Copper.—The indications of copper are quite numerous in the section south of the Chaudière, but north of that stream are very slight. The most important of these, from a historic and commercial standpoint, are the celebrated mines of Harvey Hill, which were worked very

extensively some twenty years ago, but have been idle during the last ten or twelve years. Lately, however, the property has changed hands, and a company has been organized, which has begun a thorough exploration of the mines, old levels are being extended and new ones driven. A considerable quantity of good ore, much of which is of high grade, has been shipped during the last three months, but no facts which have not already been mentioned in the reports of the Geological Survey have come to light. As much attention has of late been directed to the occurrence of copper in this portion of the townships, the following list of localities, published by Mr. Richardson in the Report for 1866, but which is not generally available, may be reproduced here :—

List of copper localities—Halifax.

Halifax.

Range.	*Lot.*	
1	10	Green carbonate in dolomite and yellow sulphuret; in white quartz in chloritic slate in another place on the list.
3	10	Yellow, variegated and vitreous sulphurets, with green carbonate and black and red oxyds in a gangue of quartz calcspar and brown spar of from eight inches to three feet, running with the stratification in chloritic slate, which holds specular and titaniferous iron ore. This is the *Halifax Mine* (Geology of Canada, 1863, p. 724), in which considerable work has been done by adits and shafts. In a quartz-vein cut by an adit a small quantity of gold was obtained. Land belongs to *Celeste Dubois.*
3	16	Yellow and variegated sulphurets in nacreous slates.
3	18	Green carbonate in black slate.
5	6	Green carbonate in white quartz, with calcspar in nacreous slate.
6	6	Green carbonate in chloritic and nacreous slate.
7	5	Yellow and variegated sulphurets in white quartz, with chloritic in chloritic slate. *Théophile Girouard.*
7	6	Yellow sulphuret in a quartz-vein in dolomitic limestone. *Megantic Mining Company.*
7	9	Green carbonate in white quartz in chloritic and epidotic slate, with granular magnetite.
8	9	Yellow and variegated sulphurets in dolomite. *Black Lake Mine.* (See range 9, lot 9.)
10	5	Yellow, variegated and vitreous sulphurets.
10	10	Yellow, variegated and vitreous sulphuret.
10	11	Yellow, variegated and vitreous sulphuret.
11	5	Yellow sulphuret.
11	6	Yellow sulphuret.
11	11	Yellow, variegated and vitreous sulphuret.
11	12	Yellow, variegated and vitreous sulphuret.
11	12	Variegated sulphuret in a two-foot vein of quartz.
11	13	Yellow, variegated and vitreous sulphuret.

11	20	Yellow, variegated and vitreous sulphuret. *Canada Mining Co.*
12	10	Yellow, variegated and vitreous sulphuret.
12	11	Yellow, variegated and vitreous sulphuret.
12	13	Yellow, variegated and vitreous sulphuret.
12	18	Vitreous and variegated sulphuret and green carbonate in quartz courses in nacreous slates. — *Ryan.*
13	16	Yellow, variegated and vitreous sulphuret in nacreous slates. *English and Canadian Mining Company.*
13	17	Yellow, variegated and vitreous sulphuret in nacreous slates. *English and Canadian Mining Company.*
14	13	Yellow, variegated and vitreous sulphuret.
14	14	Yellow, variegated and vitreous sulphuret.
14	15	Yellow, variegated and vitreous sulphuret.
	16	Yellow, variegated and vitreous sulphuret and green carbonates, in a vein with quartz, bitter spar, chlorite, steatite, specular iron, and a little native gold. (Geology of Canada, p. 730.) *English and Canadian Mining Company;* land to — *Nutbrown.*
15	16	Yellow, variegated and vitreous sulphuret in nacreous slates. *English and Canadian Mining Company.*
	17	Yellow, variegated and vitreous sulphuret in nine quartz courses and three beds of nacreous slates. *Harvey Hill Mine. English and Canadian Mining Company.* (Geology of Canada, 1863, pp. 724-729.)
	18	Yellow, variegated and vitreous sulphurets. *English and Canadian Mining Company.*
20	19	Yellow, variegated and vitreous sulphurets. *Canada Mining Company.*
9	4	Variegated sulphurets.
	6	Variegated sulphurets.
	9	Yellow and variegated sulphurets in dolomite and slate. On this and on the same numbered lot in range 8 is situated the *Black Lake Mine*, in which considerable exploratory work has been done. *Dr. James Reid and others.*
11	6	Variegated and vitreous sulphurets in nacreous slate. *W. W. Stuart.*
	7	Variegated sulphuret in dolomitic limestone. *A. G. Woodward.*
	12	Green carbonate in white quartz in chloritic slate.

Ireland.

Ireland.

1	3	Green carbonate in white quartz in chloritic slate, associated with dolomite.
9	9	Green sulphuret in dolomitic limestone.
11	4	Variegated sulphuret. — *Bailey.*

Inverness.

Inverness.

1	7	Variegated and vitreous sulphuret in nacreous slate. *W. W. Stewart.*
2	4	Variegated sulphuret in a two-foot vein of quartz in nacreous slate. *Megantic Mining Company.*

	19	Green carbonate in flakes in strings of quartz cutting micaceo-chloritic slate.
3	22	Green carbonate in flakes in strings of quartz cutting chloritic slate.
4	2	Yellow sulphuret in dolomitic limestone.
	4	Variegated and vitreous sulphurets in nacreous slate. *Angus McKillop.*
6	9	Variegated and vitreous sulphurets in nacreous slate. *Jas. Steele.*
	14.	Yellow and variegated sulphuret disseminated in three quartz-veins of from one to two feet thick, running with the stratification in nacreous slate.
11	23	Green carbonates in dioritic slates on the River Becancour.

Leeds. Leeds.

2	6	Variegated sulphuret. — *Harris.*
4	4	Yellow sulphuret in dolomitic limestone. — *Ewart.*
9	8	Green carbonate in flakes in green chloritic sandstone.
10	8	Yellow, variegated and vitreous sulphurets.

Copper is also reported by Dr. Reid as occurring in Leeds, range 15, lot 14; also on lot 5, range 5, and lot 4, range 9. These localities have not yet been examined by us, as the report came to hand after our return from field work.

Thetford. Thetford.

Range.	*Lot.*	
1	6	Green carbonate in green slate, resting on black slates, with cubes of iron pyrites.

Nelson. Nelson.

11	8	Yellow and variegated sulphurets and green carbonate disseminated in diorite to a breadth of thirteen feet.

Broughton. Broughton.

5	10	Variegated and vitreous sulphurets.
	12	Variegated and vitreous sulphurets.
4	13	Variegated and vitreous sulphurets.

Frampton. Frampton.

2	14	Green carbonate in grey limestone.

St. Giles Seigniory. St. Giles.

Ste. Marguerite, 1, 2, 3. Variegated and vitreous sulphurets and green carbonates in quartz courses in nacreous slates. — *Cromwell.*

Several other localities exist in the seigniories of St. Mary, Gaspé, Lauzon and Sillery, where indications of copper are found, sometimes in diorite, at others in limestone, sandstone, etc., which are described in the report of Mr. Richardson, quoted above. None of these appear, however, to be of any economic value, and the same may be said of most of those noted in the preceding list. The above are all the localities at present known to us where copper ore has been observed within the limits of the north-east quarter-sheet of the Quebec map.

Titanic ore of Colway River.

Iron Ore.—The beds of iron ore which occur in Leeds, near Kinnear's mills, have already been described in the previous report. In a former report a bed of titanic iron ore is described by Dr. Hunt as occurring on the Colway, with a breadth of between forty and fifty feet, but of late years no attention seems to have been paid to it, presumably on account of the high percentage of titanic acid.

Chromic iron.—Local deposits of this mineral occur in connection with the serpentines at several points. From the area in Leeds, near Kinnear's mills, about fifty tons were removed two years ago by Dr. Reed and found a ready sale at a fair price. Another deposit in Thetford, range IV, lots 16, 17, seems to have a considerable extent, but is probably of too low a grade to be suitable for the foreign market, though no analysis of it has yet been made.

Thetford.

Asbestus.—The Asbestus industry continues to be one of the most important in the province, and as the work of the last two years has, to a certain extent, embraced the leading areas where mining has been prosecuted, a brief *resumé* of its progress and development has been deemed advisable as a supplement to that which appeared in the last report.

First reference to asbestus.

Prior to 1862 the presence of asbestus was known in connection with the serpentines of the Eastern Townships, since at the London International Exhibition of that year a specimen of a vein from the Seigniory of St. Joseph was placed in the collections forwarded by the Geological Survey. (See Cat. 1862). Reference to its occurrence with chromic iron in various parts of the Eastern Townships and Gaspé is found in the Can. Nat. 1862, vol. vii. It was not, however, for some years, or till 1878, that its importance, from an economic standpoint, was discovered. Since then the growth of the industry has been very rapid. Within the last two years attempts have been made to unite under one management the mines of Thetford and Black Lake, but this scheme has been only partially successful. During the past year a company was organized in London by Mr. John Bell, which now owns the Thetford property, formerly known as the Boston Asbestus Company; the Bellmina area, worked for several years by Mr. Grey for Mr. John Bell, and the Hayden lot in north half of lots

27 and 28, Range B, Coleraine, now under the management of Mr. Carter, while Mr. Thos. Sheridan remains in charge of the Thetford area, and it is but fair to say that much of the success which has attended the operations of this company is due to the economy and skill with which he has developed the property at that place. In addition to the other mines operated at Thetford in 1886 or the date of the last report on this subject, viz.: King Bros., Johnston, Irving & Co., and Ross, Ward & Co., several new openings have been commenced. The Ward Bros. have located a new quarry to the west of the Quebec Central Railway, which has struck rich ground. Mr. A. H. Murphy, in lot 28, range V., uncovered a considerable space and disclosed some fine veins, while further west, or towards the river, King Bros. and Johnston have started several prospecting pits, in all of which the asbestus is visible, and the surface indications are very satisfactory. These several trials have proved very fairly the value of the serpentines lying between the railway and the river, and shew that the productive ground of Thetford is not confined to the mound in which the mines were all at first located. On the adjoining property of Lucke & Mitchell, lot 32, range C, Coleraine, although the excavations made several years ago disclosed good workable veins, nothing further has been done to develop it. It may be said that the operations of all the companies engaged at Thetford during the past two years have been eminently satisfactory, and although the bad weather of last season interfered to some extent with the output, yet the amount of asbestus mined was greater than in any previous year. An attempt was made at the Boston Company's mine by Mr. Sheridan to prove the rock at a lower depth, which was completely successful, and veins of beautiful silky mineral, up to three inches in length, were obtained from a further depth of thirty feet, the expenses of the shaft being much more than repaid by the quantity of asbestus removed. This trial shaft is satisfactory inasmuch as it probably proves the productiveness at deeper levels of all the adjacent mines. At King Bros.' mine, which had encountered a mass of comparatively poor rock, necessitating expensive cutting, the trouble has been overcome and very rich ground again found. The returns from the Johnston mine are not yet in, but it is known that work has also been satisfactory. At the Ward mine much delay arose towards the close of last season from the quantity of water in the quarry, due to springs and wet weather, which necessitated the placing of a pump, an expense from which the other mines are as yet apparently free; but though this latter mine is situated at a lower level than the others, the size and quality of the veins is in no way inferior. The output for the Bell Company's mine at Thetford for the past season to the 21st December

Thetford Mines

Output at Bell's Mine, Thetford.

was 1,350 tons, of which there were: Firsts, 930 tons; seconds, 105 tons; while the balance was thirds, or what is there called waste, in addition to a considerable quantity in stock and undressed. This mine has, during the past year, been fitted with air compressor and drills, while hoisting engines will probably be added during the coming season.

King Bros.' mine.

From King Bros.' mine the output for the season of 1888 was 580 tons as follows: Firsts, 170 tons; seconds, 165 tons; thirds, 245 tons. In the township of Coleraine several new mines have been started, among which may be mentioned that of the Bell Company on north half lots 27-28, range B (formerly Hayden); lot 32, range B by Capt. Williams; and on the Quebec Central Railway, about one mile south of Black Lake station, by Loomis & Johnstone. From the first of these no returns are to hand, the work having been started late in the season, but an examination of the locality shewed a great number of small veins on the surface at several points, while in the cut near the foot of one of the mounds fibre of fine quality in lengths from one and a half to two inches was disclosed. Several large masses of white granulite occur in this vicinity.

Black Lake mines.

From Capt. Williams' mine, lot 32, range B, the output to 1st of October was twenty-nine tons, of which four and a half were classed as *firsts*, and the rest about equally divided between *seconds* and *thirds*. Good veins were also seen on the surface on this property.

Reed's mines now Wertheims

The south half of lots 27-28, formerly belonging to Dr. Reed, but lately sold to the Wertheims, of Frankfort, Germany, is now being opened up, it being the intention of the new company to put in improved machinery with a view to economy of production. This property is the most elevated in the district, being not far from 600 feet above Black Lake station, and the surface indications are very favorable, veins up to two inches and a half being found in a series of cuttings along the crest of the hill. The fibre of much of the veins is soft and silky, shewing that the greater elevation of the area is not the cause of the stiffness or harshness seen at some localities. Dr. Reed states that prior to the sale about twelve tons were taken from this place, of which two tons were *firsts* four *seconds* and six *thirds*. This mine is now being worked by contract at $25 per ton, made ready for the market. On the north side of the Poudrier road in lots 27, 28, 29, Range A, Coleraine, several openings have been made in which good indications were found, veins up to one inch and a half, with many small ones being observed. Also on lot 26 an opening well up on the hill shewed small veins of asbestus, and on Lot 23 the surface indications are very fair, though but little has been done in any of these lots to determine their real value.

Further to the east, about Little Lake St. Francis, though small veins occur, those seen, if fair samples, were of poor quality; the fibre being short and harsh. The present comparative inaccessibility of these more remote localities will seriously affect their value. In the southern part of Coleraine and in the south-east corner of the great ridge of serpentine which extends from Wolfestown road to Black Lake, work was begun or rather resumed by the Megantic Mining Co. Mining in this locality was started in 1886, and was noted in previous report as having disclosed a large vein of asbestus with fibre of four inches in length. This vein was not apparently persistent to any depth, the rock being greatly shattered near the surface and for some fifteen feet down, and though quite a number of veins, some of which, in the more solid rock, shewed fibre of one inch and a-half in length, much of the asbestus is greatly discolored, owing to the broken character of the rock. A peculiar feature not noticed in any other place in this district is the presence of irregular veins of mica, in scales of half an inch or more in diameter, in a paste of decomposed serpentine or soapstone. It is probable that after passing the shattered ground good mineral will be found. The output for the four months of last season to Oct. with an average of twelve men was thirty-nine tons, of which one-third would rank as *second* and two-thirds as *third* quality. On the same ridge, but on the extreme west limit, on lots 24 and 25, range III, Ireland, King Bros. have started two openings. The elevation of these by aneroid above the surface of Black Lake is 500 feet or about 300 to 350 feet above the mines at Thetford. The two knolls in which the asbestus is found at this place are about one-fourth of a mile apart, and the fibre occurs in a series of thin veins from one-eighth of an inch to over an inch in size in places, as many as twenty being found in the space of six inches. Many of these veins shew a selvage of whitish weathering serpentine on either side, separated by a thin vein of asbestus from one-fourth to three-fourths of an inch thick. Other veins of good size, ranging in thickness to one inch and three-fourths, are numerous, the general aspect of the serpentine and contained veins being much like that of the great ridge in Wolfestown. The surface indications are excellent, but the property has not been sufficiently developed to form an estimate of its production, only two months work of a few men having been spent upon it.

Little Lake St. Francis.

Megantic Mining Co., Coleraine.

King Bros., Ireland.

In the Black Lake district proper the three established mines, viz., the Scottish-Canadian, the Anglo-Canadian and the D'Auville, have all been steadily at work. Mr. Penhale, the Manager of the Scottish-Canadian, states that in the eight months ending 10th Nov., 400 tons were shipped from that mine, of which 40 tons were *firsts*, 110 tons *seconds*, and 250 tons *thirds*, but operations were hindered by scarcity

Scottish Canadian mine.

Black Lake.

of men and bad weather so that the projected new workings could not be carried on. This mine is equipped with improved machinery, air compresser, rock drills, hoisting engines, and dumping skips, and has a new set of appliances for crushing the rock, and separating the asbestus, more particularly in regard to the lower grades, to avoid the great expense of cobbing by hand. Although this machine was in operation but a short time, it is claimed by the manager to be a great success. Should this be the case and the asbestus of short fibre be easily separated, the profits of the industry will be largely increased; since many of the dumps, most of which now cover very valuable ground, can be profitably worked over, and the refuse disposed of for ballasting or other purposes while under the present system of hand cobbing, the shorter veins do not warrant the expense necessary for their separation. In this connection it may be remarked that the question of dumps is beginning to assume a somewhat serious aspect which will be aggravated as the production of the mines increases; since many of them will ultimately have to be removed, as the necessity for extending the present workings will require the space now covered up.

Anglo-Canadian mine.

Of the three Black Lake mines, the output from the Anglo-Canadian for the six months ending Nov. 15th, was, according to Mr. Hopper, about 210 tons, the average number of hands employed being 30 to 35. The principal pit at this mine has now been sunk to a considerable depth, and Mr. Hopper reports veins of asbestus from the lowest branch of very superior quality ranging from three to seven inches in length. These veins have been uncovered since my visit. The percentage of *firsts* has, according to the manager, increased from 10 to nearly 20 per cent. Openings in the face of the knoll of serpentine to the west of the principal pit are now being worked, and the indications here are very good.

Frechette or D'Auville mine

The output of the Frechette or D'Auville mine which lies contiguous to the Scottish Canadian, in the face of the hill, is given by Mr. Hopper for the season ending Dec. 1st, as about 300 tons.

The Anglo-Canadian mine has also a good outfit of improved machinery, air compressor, drills and hoisting gear, the latter being a necessity owing to the present depth of the quarry. The necessity of some machine which will clear the fibre or separate it from the rock cheaply is one which will doubtless be remedied very shortly. Large masses of granulite also occur near or to the south of these openings. In view of the considerable expense of proving areas where the surface veins are numerous but small, it has seemed to me that a few good test holes with a diamond drill would be advisable. The holes could be quickly and easily sunk, and if veins of asbestus were encountered, the core or borings would shew the character of the fibre and to a certain extent the size of the veins.

The elevation of the Anglo-Canadian mine was, by aneroid, found to be 200 feet above Black Lake station which, in turn, was about 100 feet below Thetford mines station. The workings of these mines would therefore be about on the same level as those of Thetford east of the railway. The D'Auville and Scottish-Canadian mines have an elevation of 350 feet above the station, or 150 feet above the Anglo-Canadian, while the upper works of the latter on the face of the ridge are thirty feet lower. Elevations of Black Lake mines.

In Thetford, in the areas north of the Quebec Central Railway, are several outcrops of serpentine. These have only lately been examined for asbestus. Among them may be mentioned lots 16, 17 and 18, range IV, from which veins of good size are reported by Dr. Reid, since my visit. In this belt chromic iron also occurs. Mounds of serpentine are also seen in lot 13, range V, and in range XI, Broughton, from some of which asbestus has been reported, but not in quantity sufficient as yet to be of economic value. These areas might easily be tested with the diamond drill. Serpentine areas of Thetford.

The Broughton Mine, on lot 14, range VII, Broughton, has been worked to some extent during the past two years. I visited it in September 1887, and found it to be somewhat different from the other areas at Thetford and Coleraine. The vein is at the contact of the serpentine, with blackish slates, which in places have a greyish or purple shade, and contain bands of hard bluish-grey quartzite of the Cambrian series thickly veined with quartz. The vein is overlaid in places with soapstone of good quality, from ten to fourteen inches thick, with which the asbestus seems to be intimately associated. The asbestus, of which only one vein could be detected, was eight to ten inches thick in places near the surface, but decreases at the bottom of the workings, which are some 62 feet down, to two or three inches, and becomes irregular, at times splitting into many fine strings disseminated through the serpentine, at others presenting a continuous fibre. Three shafts had been sunk to a depth of 61, 62 and 75 feet, which followed generally the slope of the bed or vein at an angle of about 75°, the rock dipping to S. 40° E. to true meridian; soapstone forms the hanging wall of the vein. The mass of the serpentine which lies to the west was carefully examined at several points, but only in one place, about 150 feet in rear of the openings, were small strings of asbestus of one-fourth to a half an inch seen. Much of the fibre in the north slope appeared to be stiff and harsh and not of good quality, while other portions were beautifully silky. The serpentine of this place resembles in character that near St. Sylvester and along the Chaudière. Broughton mine.

Probable cause of difference in quality of fibre.

The cause of the great difference in quality of the fibre from different points, more especially comparing Black Lake with Thetford, has long been a source of enquiry among the mine owners and managers. By some it is supposed to be due to the level of the different workings, the works of the Scottish-Canadian Company at Black Lake being about 250 feet above those at Thetford, yet this can scarcely be taken as conclusive, since at the Reid mine, now Wertheim's, 300 feet or so higher, much excellent fibre is found; as also in the works of the Scottish-Canadian Company itself, and the D'Auville mine adjoining, where very fine silky fibre is seen. The fibre at the surface, especially where fire has passed, is always harsher than that from lower depths, owing to the loss of a certain percentage of the contained water; and it has been suggested that a more likely reason for the difference in quality may be the dehydration of the asbestus by the action of the intruded diorite or granulite, which at certain points in the Black Lake district occupy a considerable area. If the soft, silky fibre be placed on the fire, it speedily changes its character and becomes harsh and brittle. The serpentine, near the contact with the granite veins or masses, is often very considerably shattered, as though the presence of the granite had exercised a marked influence.

At Thetford the granitic rock in the mines is limited to small and thin dyke-like veins, which have not produced any deleterious effect upon the asbestus. It must, however, be said that the stiff fibred mineral is not in all cases confined to the vicinity of the visible granites, and other causes may in such cases have produced a similar effect.

Map of asbestus areas.

The map of the asbestus region, accompanying this Report, has been compiled principally from our own surveys, using the line of the Quebec Central Railway, which has been kindly furnished us by the Department of Public Works, Quebec, for a base line. All the mines at present in operation in the districts of Thetford, Coleraine and Wolfestown are indicated on it; but in the attempt to place the lines from the Crown Land plans, so many discrepancies were found in the several surveys available, that the designation of these on a plan certified by the office was found impracticable. A thorough re-survey of these areas is of the greatest importance, since lands which now have a comparatively small value may in a very short time be valued at very large sums. In regard to the areas of Belmina, Wolfestown and Danville no late returns are to hand. At Belmina nothing has been done during the past year, the force there employed being transferred under Mr. Carter to the new Bell Company's property, near Black Lake. Exploratory work has been going on during the past year along the great ridge north of Breeches Lake, but

nothing definite as to results has been received, although such information has been promised. The Danville mine has been working with a reduced force, though at last advices from the Manager the output was increasing and the prospects more favourable. During the past season 207 tons were taken out. Danville mine.

Soapstone.—Many deposits of this mineral occur in Broughton, but the quality is in most cases not sufficiently fine to satisfy the market, the shade being dark and the rock too opaque. Considerable quantities have been shipped from the Broughton Mine, where from the lower asbestus workings a very good quality of the soapstone is obtained The quarry at Belmina, formerly Carter's, now Fenwick and Slater's has also been shipping to various points.

Mineral Paints.—The only locality in this section at which mineral paint was observed is that described in the Catalogue of Economic Minerals, Colonial and Indian Exhibition, London, 1886, at Ste. Anne de Montmorenci, where deposits of brownish and brownish-black iron-ochre of considerable extent occur.

Limestones are found at several points, but are not now burned to any extent, and the facility with which the Dudswell lime can be distributed has caused the abandonment of some kilns. Among other places in Broughton where the rock occurs and has been burnt, may be mentioned, top of hill half a mile east of West Broughton church, near the road. Limestone also occurs on lots 3 and 4, range IV, Thetford, on land occupied by Joseph Ouellette, who has burned it. Near St. Victor de Tring, on the road to St. Francis, a bed of limestone conglomerate has also been used for burning lime. Outcrops of grey limestone are also found along the back roads in rear and to the north-east of Beauce Junction, where several kilns have been burned. The rock is a hard, greyish, sub-crystalline limestone, and occurs with hard quartzites and black slates. Further to the north in Mailloux, lots 30-32, range N.W., along the road, there are several exposures of limestone similar to the last, and with the same association of black slates and quartzites. Localities of limestone.

The deposit on the Chaudière, between the Famine River and the village of St. George, has already been referred to under the head of Devonian. These limestones have been burned for many years for local consumption, and were at one time the chief source of supply for the upper Chaudière district. St. George.

Marble.—A considerable outcrop of deep red marble, veined with white calcite, occurs a short distance east of the Colway (formerly Guillaume) River, associated with red slates and sandstones, which resemble the Sillery of Quebec in lithological character, and may represent an overlying area of these rocks in a synclinal basin such as Colway River.

occurs further east beyond St. Francis village. The bed is from ten to forty feet thick, and is exposed at intervals for half a mile on the strike. The rock takes a good polish, and has a handsome appearance. It is not far from the dioritic rocks which show in the bed of the Colway, and which may have been the cause of the alteration.

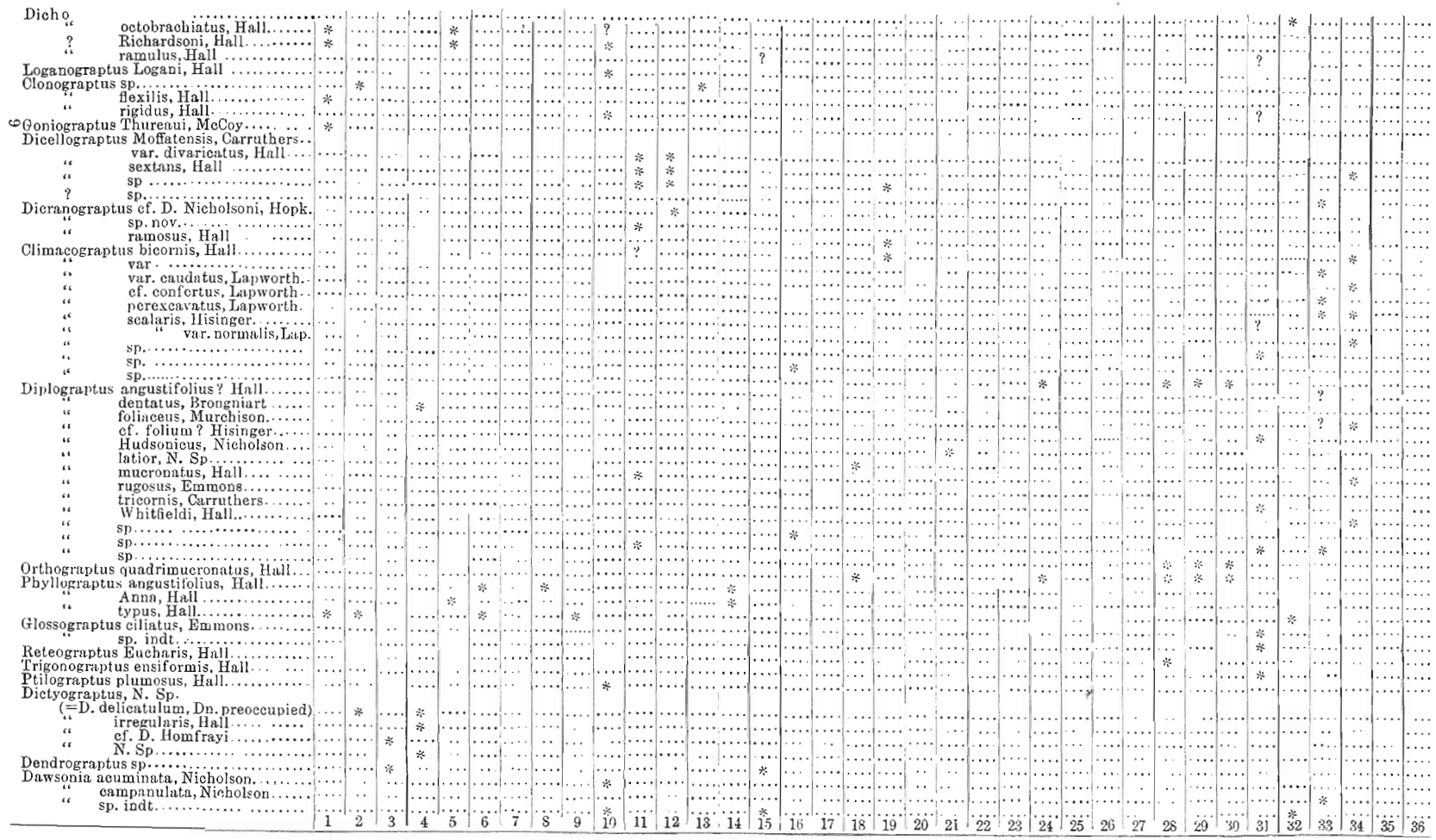
Building Stones.—The greenish, grey sandstones of the Sillery formation, both above Quebec and at Point Lévis, produce a very durable stone which has been extensively used both in Quebec and Lévis. The rock splits readily, and blocks of almost any required size can be obtained. Hard and more quartzose beds of the same formation occur at various points, and have already been described. The white granulite rock of Black Lake and Thetford should yield a very handsome and durable stone, but no attempt has yet been made to quarry it.

APPENDIX.

SYSTEMATIC LIST OF FOSSILS, WITH LOCALITIES AS REFERRED TO IN THIS REPORT, EXCLUSIVE OF THOSE SPECIES OBTAINED IN THE LIMESTONE CONGLOMERATE BANDS.†

By Henry M. Ami, M.A., F.G.S., Assistant Palæontologist.

GENERA AND SPECIES.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	I. C. R. outlier. 1,000 paces below the lower Levis Ferry, Lauzon, Que., p. 52K.	Road from Levis to St. Joseph, Que., Diluvium on the Zone, p. 52K.	150 yards West of last locality, Delisle Zone, pp. 52K and 53K.	Cliff facing the Koundry, Levis, p. 53K.	Outcrop at City Hall, Levis, Que., p. 53K.	Shales associated with conglomerates near City Hall, Levis, Que., p. 54K.	Mouth of Beech 1½ miles N.N.E. of Mare-bata Junction, I. C. R., p. 56K.	One half mile West of last locality, p. 56K.	Stone-yard, cutting West of Marbaker Junction, p. 56K.	Island of Orleans, South-West End, p. 59 K.	Dickenson River, Que., 2½m. below St. Anselme, p. 60K.	Crane Island, St. Lawrence R., Que., p. 61K.	St. Anselme, Que., Weston, 1877, p. 61K.	St. Bernard, Que., Chaudière R., p. 61K.	St. Michel de Bellechasse, Que., p. 66K.	St. Paschal, Rivière du Vaisseau de l'Eglise, I. C. R. crossing, p. 68K.	Notre Dame du Portage, Que., p. 68K.	Two miles above St. Nicholas, Que., pp. 15K and 16K.	River and a half miles above St. Nicholas, Que., p. 16K.	Ste. Croix, Que., N. of wharf, p. 17K.	Beauceour River, Que., p. 17K.	Pointe-aux-Trembles, Que., p. 18K.	Loretto, Que., pp. 19K and 20K.	Charlesbourg, Que., Hay yards N. of Ch., p. 20K, and 1 mile West of Village.	Charlesb'g, Que., Templeman's Quarry, p. 21K.	Beauport, Que., Parent's Quarries, Mr. St. Cyr, 1888, pp. 21K and 22K.	Montmorency River, above the bridge, left bank, pp. 22K and 23K.	Montmorency R., Que., Ravine below the Falls, p. 23K.	Montmorency R., Que., mouth of river. Lower point, p. 24K.	Montmorency R., Que., between steps & lower point. East side of gorge.	Below Victoria Hotel, Point Levis, Que., near Toll-gate, p. 30K.	Below Victoria Hotel, South Que., Que., in black and green shales, p. 31K.	Quebec (City, between Grande Allée and New Drill Shed, p. 74K.	Quebec (City, between St. John Market and St. Patrick St., pp. 78, 79, and 80K.	Côte d'Abraham, Quebec City, p. 80K.	Chaudière R. R. R. Bridge, Que., p. 87K.
Protospongia fenestrata, Salter																																				
Hyalostylus sp.																																				
Salpingoeca compacta, Billings																																				
" var. minuta, Ami																																				
? (Glyphoglæa ?) sp.																																				
Leptophragma magotias, Hall																																				
Nematophytus capillaris, Dawson																																				
? sp.																																				
Dictyospongia bilobata, Hall																																				
" confluens, Hall																																				
" extensa, Hall																																				
" foraminifera, Lapworth																																				
" pennatuloides, Hall																																				
" sp.																																				
Tetragraptus approximatus, Nicholson																																				
" bigsbyi, Hall																																				
" decipiens, Hall																																				
" fruticosus, Hall																																				
Logania, Hall																																				
Urceus, Lapworth																																				
quadrigeminus, Hall																																				
sp.																																				
Graptograpsus, Broegniart																																				


Dicho
" octobrachiatus, Hall
? Richardsoni, Hall
" ramulus, Hall
Loganograptus Logani, Hall
Clonograptus sp.
" flexilis, Hall
" rigidus, Hall
Goniograptus Thureaui, McCoy
Dicellograptus Moffatensis, Carruthers
var. divaricatus, Hall
" sextans, Hall
" sp
? sp.
Dicranograptus cf. D. Nicholsoni, Hopk.
" sp. nov.
" ramosus, Hall
Climacograptus bicornis, Hall
" var
" var. caudatus, Lapworth
" cf. confertus, Lapworth
" perexcavatus, Lapworth
" scalaris, Hisinger
" " var. normalis, Lap.
" sp.
" sp.
" sp.
Diplograptus angustifolius? Hall
" dentatus, Brongniart
" foliaceus, Murchison
" cf. folium? Hisinger
" Hudsonicus, Nicholson
" latior, N. Sp.
" mucronatus, Hall
" rugosus, Emmons
" tricornis, Carruthers
" Whitfieldi, Hall
" sp
" sp
" sp
Orthograptus quadrimucronatus, Hall
Phyllograptus angustifolius, Hall
" Anna, Hall
" typus, Hall
Glossograptus ciliatus, Emmons
" sp. indt.
Reteograptus Eucharis, Hall
Trigonograptus ensiformis, Hall
Ptilograptus plumosus, Hall
Dictyograptus, N. Sp.
(=D. delicatulum, Dn. preoccupied)
" irregularis, Hall
" cf. D. Homfrayi
" N. Sp.
Dendrograptus sp.
Dawsonia acuminata, Nicholson
" campanulata, Nicholson
" sp. indt.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

GENERA AND SPECIES.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	I.C.R. cutting, 1600 paces below the Lower Levis ferry, Levis, Que., p. 62k.	Road from Levis to St. Joseph, Que.	Didymograptus Zone, p. 52k.	150 yards West of last locality, Didym. Zone, pp. 52k and 52k.	Cliff facing the foundry, Levis, p. 53k.	Outcrop at City Hall, Levis, Que., 53k.	Shales associated with conglomerates near City Hall, Levis, Que., p. 54k.	Mouth of brook 1¼ miles N.E. of Harlaka Junction, I.C.R., p. 55k.	One half mile West of last locality, p. 53k.	Snow-shed, cutting West of Harlaka Junction, p. 55k.	Island of Orleans, South-West End, p. 59k.	Etchemin River, Que., 2½ m. below St. Anselme, p. 60k.	Crane Island, St. Lawrence R., Que., p. 61k.	St. Anselme, Que., Weston, 1877, p. 61k.	St. Bernard, Que., Chaudière R., p. 61k.	St. Michel de Bellechasse, Que., p. 66k.	St. Paschal, Buissean de l'Eglise, I.C.R. crossing, p. 68k.	Notre Dame du portage, Que., p. 68k.	Two miles above St. Nicholas, Que., pp. 15k and 16k.	Five and a half miles above St. Nicholas, Que., p. 16k.	Ste. Croix, Que., N. of wharf, p. 17k.	Bécancour River, Que., p. 17k.	Pointe-aux-Trembles, Que., p. 18k.	Loretto, Que., pp. 19k and 20k.	Charlesbourg, Que., fifty yards N. of Ch., p. 20k, and 1 mile West of village.	Char esbourg, Q., Templeman's Quarry, p. 21k.	Beauport, Que., Parent's Quarries, Mr. St. Cyr, 1888, p. 21k and 22k.	Montmorency River, above the bridge, left bank, pp. 22k and 23k.	Montmorency R., Que., Ravine below the falls, p. 23k.	Montmorency R., Que., mouth of river, Lower point, p. 24k.	Montmorency R., Que., between steps & Lower point, Eastside of gorge.	Below Victoria Hotel, Point Levis, Que., near Toll-gate, p. 50k.	Below Victoria Hotel, South Que., Que., in black and green shales, p. 50k.	Quebec City, between Grande Allée and New Drill Shed, p. 77k.	Quebec City, between St. John Market and St. Patrick St., pp. 78, 79, and 80k.	Côte d'Abraham, Quebec City, p. 80k.	Chaudière R. R. R. Bridge, Que., p. 57 k.
Corynoides calycularis, Nicholson																																				
Glyptocystites or Glyptocrinus																																				
Glyptocrinus decadactylus, Hall																																				
Heterocrinus sp. var. Canadensis, Billings																																				
Serpulites dissolutus, Billings																																				
Ptilodictya falciformis, Nicholson																																				
Pachydictya acuta, Hall																																				
Prasopora lycoperdon, Vanuxem																																				
" var. Selwyni, N. Var.																																				
Diplotrypa Quebecensis, N. Sp.																																				
Batostoma Ottawaense, Ford																																				
Monotrypa incerta, N. Sp.																																				
Amplexopora discoides, James																																				
Lingula curta, Hall																																				
" Irene, Billings	*	*		*																																
" obtusa, Hall																																				
" Philomela, Billings						*																														
" Quebecensis, Billings		*	?	*	*				*																											
" riciniformis, Hall																																				
" sp																																				
" N. Sp. ?																																				
" N. Sp																																				
" N. Sp				*									*																							
Obolella pretiosa, Billings							?	*									?																			
" sp															*																					
" sp																																				
Elkania desiderata, Billings																																				
Linnarssonia sp			*																																	
Leptobolus insignis, Hall																													*							
" (?) sp				*															*																	
" N. Sp. (?)																																				
Acrothele sp																																				
" N. Sp																																				
Schizocrania filosa, Hall																																				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Schizocrania or Discina, sp.																									*											
? Siphonotreta micula, McCoy		*																																		
Acrotreta sp.										*					*																					
Discina Pelopea, Billings																							*													
" sp.																				*																
Paterula Sp. Nov.																																		*		
Crania sp.																					*				*											
Orthis emacerata, Hall																				*																
" pectinella, Conrad																											?									
" testudinaria, Dalman																		*		*		*	*		*		*	*							?	
" sp. nov. (?)																							*													
" sp.																															*					
" sp.				*																																
" sp.																	*																			
" sp.																																		*		
Skenidium ? sp.																							*													
Strophomena alternata, Conrad																				*		*	*		*		*									
" deltoidea, Conrad																						*				*										
" sp.																	*																			
Leptæna sericea, Sowerby																		*		*		*			*	*	*	*						?	?	
" N. Sp.																																		*		
Zygospira Headi, Billings																		*		*	*															
" modesta, Say																											?									
" or N. G.																							*	*	*		?	*								
Anazyga recurvirostra, Hall																				*							*									
Stricklandinia ? sp.																																		*		
Camerella hemiplicata, Hall																							*			*										
" n. sp. (?)																							*													
Pterinea Trentonensis, Hall																							*													
Ambonychia radiata, Hall																		*		*	*															
Modiolopsis sp.																							*													
" sp.																		*																		
Vanuxemia sp.																											*									
Ctenodonta dubia, Billings																							*													
Lyrodesma pulchellum, Emmons																										*										
" sp.																				*																
Orthodesma parallelum, Hall																		*		*																
Murchisonia gracilis, Hall																				*							*									
" perangulata, Hall																											*									
Bellerophon bilobatus, Sowerby																				*			*	*			*									
Bucania punctifrons, Emmons																							*				*									
Cyrtolites sp.																																		*		
Conularia Trentonensis, Hall																							*			*	*									
Theca N. Sp.																							*													
Lituites undatus, Emmons																							*													
Endoceras proteiforme, Hall																							*		*	*			*							
Orthoceras anellum, H. or N. Sp.																										*	?									
Turrilepas sp.										*																										
Leperditia cylindrica, Hall																								*												
Primitia Canadensis, J. var. nana, Jones																							*													
" N. Sp.																												*						*		
Beyrichia N. Sp.																							*													
" sp.																	*																			
Shumardia granulosa, Billings			*	*																																
Trinucleus concentricus, Eaton																							*				*									
" N. Sp. (large form)																		*		*																
" sp.																																		*		
Ampyx sp.																																		*		

GENERA AND SPECIES.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	I.C.R. cutting, 15 paces below the Lower Levis ferry, Levis, Que., p. 52K.	Road from Levis to St. Joseph, Que., Didymograptus Zone, p. 52K.	150 yards West of last locality, Didym. Zone, pp. 52K and 58K.	Cliff facing the foundry, Levis, p. 53K.	Outcrop at City Hall, Levis, Que., p. 53K.	Shales associated with conglomerates near City Hall, Levis, Que., p. 54K.	Mouth of brook 1¼ miles N. E. of Harlaka Junction, I.C.R., p. 55K.	One half mile West of last locality, p. 53K.	Snow-shed cutting West of Harlaka Junction, p. 55K.	Island of Orleans, South-West End, p. 59K.	Richelieu River, Que. 2½ m. below St. Anselme, p. 60K.	Crane Island, St. Lawrence R., Que., p. 61K.	St. Anselme, Que., Weston, 1877, p. 61K.	St. Bernard, Que., Chaudière R., p. 66K.	St. Michel de Bellechasse, Que., p. 66R.	St. Pascal, Kamouraska, Que., p. 68K. crossing, p. 68K.	Notre Dame du Portage, Que., p. 68K.	Two miles above St. Nicholas, Que., pp. 15K and 16K.	Five and a half miles above St. Nicholas, Que., p. 16K.	Ste. Croix, Que., N. of wharf, p. 17K.	Bécancour River, Que., p. 17K.	Point-aux-Trembles, Que., p. 17K.	Lorette, Que., pp. 19K and 20K.	Charlesbourg, Que., fifty yards N. of Ch., p. 20K, and 1 mile West of village	Charlesb'g, Que., Templeman's Quarry, p. 21K.	Beauport, Que., Parent's Quarries, Mr. St. Cyr, 1888, p. 21K and 22K.	Montmorency River, above the bridge, left bank, pp. 22K and 23K.	Montmorency R., Que., Ravine below the Falls, p. 23K.	Montmorency R., Que., mouth of river, Lower point, p. 24K.	Montmorency R., Que., between steps & Lower point, East side of gorge, p.	Below Victoria Hotel, Point Levis, Que., near Toll-gate, p. 50K.	Below Victoria Hotel, Point Levis, Que., in black and green shales, p. 50K.	Quebec City, between Grande Allée and New Drill Shed, p. 77K.	Quebec City, between St. John Market and St. Patrick St., pp. 78, 79, and 80K.	Côte d'Abraham, Quebec City, p. 80K.	Chaudière R., R'y Bridge, Que., p. 57K.
Triarthrus Becki, Green																																				
Hydrocephalus sp.																																				
Bathyurus sp.																																				
Calymene senaria, Conrad																																				
Asaphus platycephalus, Stokes																																				
" Canadensis, Chapman																																				
" sp.																																				
Illænus Milleri, Billings																																				
" Bouchardi, Barrande																																				
" sp.																																				
Æglina rediviva, Barrande																																				
Dalmanites calliocephalus, Green																				?																
" sp.																																				
Cheirurus pleurexanthemus, Green																																				
" sp.																				?																
Encrinurus vigilans, Hall																																				
" sp.																																				
Cyphaspis sp.																																				
Harpes sp.																																				

† In the limestone ridges west of the Cemetery, see p. 81K, the rock consists largely of solid limestone which contains fossils of Calciferous age—scattered pebbles and boulders, sometimes of large size are found in the mass—and these contain fossils of Cambrian (Potsdam) age.—R. W. E.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON

EXPLORATIONS AND SURVEYS

IN PORTIONS OF

NORTHERN NEW BRUNSWICK,

AND ADJACENT AREAS IN

QUEBEC, AND IN MAINE, U.S.

BY

L. W. BAILEY, M.A., Ph.D., F.R.S.C.,

AND

WM. McINNES, B.A., F.G.S.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
WILLIAM FOSTER BROWN & CO.
1888.

ALFRED R. C. SELWYN, C.M.G., F.R.S., LL.D., &c.,

Director of the Geological and Natural History Survey of Canada.

SIR,—The following report is based upon observations made by the authors, with the assistance of J. W. Bailey and W. H. T. Reed, during portions of the summers of 1886 and 1887, in Northern New Brunswick and adjacent areas of Maine and Quebec.

It also embraces a summary of the facts, ascertained from a general review of the entire Silurian system in this section of the Dominion, including its extent, its order of succession, and its relations to the formations which lie below and above it.

The map intended to accompany the present report, and representing the geology of portions of Madawaska county, New Brunswick and Temiscouata county, Quebec, is in the hands of the engraver, and will be issued when completed. It is Sheet No. 17 N.E. of the series of maps on a scale of four miles to an inch, and, as regards New Brunswick, is the last but one of the series.

A tabulated list of the fossils of the region is given in the form of an Appendix by H. M. Ami, by whom the lists of fossils in the body of the report have also been prepared.

The thanks of the authors are due to the Manager of the New Brunswick Railway for the continuation of courtesies extended since the commencement of the survey.

Respectfully yours,

L. W. BAILEY.
WM. McINNES.

FREDERICTON, N.B., February, 1889.

REPORT

OF

EXPLORATIONS AND SURVEYS

IN PORTIONS OF

NORTHERN NEW BRUNSWICK,

AND ADJACENT AREAS IN

QUEBEC, AND IN MAINE, U.S.

Region described.

The areas to be described in the present report lie to the west and north-west of that described in last year's report, and correspond to portions of two sheets of the New Brunswick and Quebec series of geological maps. In the one of these sheets (No. 17 N.E.) the district represented is limited to that small portion of New Brunswick which is included between St. John River and the Quebec boundary, while that of the second (No. 18 S.E.) lies immediately north of and is continuous with the latter, embracing, in addition to a very small part of New Brunswick, a considerable portion of the county of Temiscouata, in the province of Quebec.

Adjacent areas in Quebec and Maine.

Owing, however, to the very peculiar position and relations of the geographical and political boundaries in this region, which gives to that portion of New Brunswick embraced by it, the form of a long, narrow wedge, enclosed between Quebec on the one side and the state of Maine on the other, and having for a considerable distance a width of fifteen or twenty miles, a study of the geological features has necessarily included an examination of the adjacent areas. In the case of the state of Maine, this has been found especially serviceable, as in connection with the numerous streams and lakes which, in the county of Aroostook, are tributary to the St. John, ample and unusual facilities are afforded for the study of the rock formations there met with, and which in their north-eastward extension enter and traverse New Brunswick. On the other hand, the character and relations of the Silurian rocks about the northern boundary of New Brunswick cannot well be understood apart from their representation in the adja-

Comparison with other regions.

cent portions of Quebec, and more particularly as revealed in the sections made respectively by the Metapedia River and Lake Temiscouata, with the intervening streams. For these reasons, and with a view to bringing together, for comparison, all the available data relating to the succession and relations of the Silurian system in this section of the continent, the observations to be given have been extended considerably beyond the limits of the two map sheets to which reference has been made. For similar reasons, little account is taken in the following descriptions of either the interprovincial or international boundaries by which the region is traversed. The geology of only those portions, however, which are included within the territorial limits of Canada is represented in the accompanying maps.

Topographical features.

The topographical features of the region under consideration are deserving of brief notice, not only as being in themselves somewhat remarkable, but also as bearing on the adaptability of the country for settlement, and as helping to elucidate its geological structure.

St. John River and its tributaries.

Most noticeable, probably, among these features is that connected with the position and course of the St. John River and its tributaries. In no portion of its extensive drainage area does this river receive so many and such important affluents as here. Flowing north-easterly from its source in Baker Lake, situated near the western frontier of Maine, and at a distance, measured along the stream, of 460 miles from its mouth, it first reaches New Brunswick at the mouth of the St. Francis, and thence forms the international boundary to a point a few miles above the Grand Falls. Above the St. Francis, which also forms a part of the same boundary, and is a considerable stream, draining some important lakes, the main river has already received upon its northern side the waters of the Big Black and the Little Black rivers, both sufficiently large to be navigable by canoes, while from the southern side it is similarly joined by the still more considerable stream of the Alleguash. This latter takes its rise in a very remarkable system of lakes, of which the most southerly (Lake Chamberlain) approaches so nearly the head waters of the Penobscot, and is so nearly on a level with it, that by the erection of dams, much of the water, at one time tributary to the St. John, has been diverted, for lumbering purposes, into the first-named stream. Below the mouth of the St. Francis, the principal tributaries of the St. John upon the northern side are the Madawaska and the Green River, to which may be added the Iroquois, the Quisibis, the Siegas and the Grand rivers, of less importance than the streams first named, but still large enough to be navigable by canoes. Even the Aroostook may properly be included here, for it drains the same Silurian basin, and has its origin in lakes but little removed from those in which Fish River, the Alleguash and the Penobs-

St. Francis River.

Big Black and Little Black Rivers.

Alleguash River.

Tributaries below the St. Francis.

Aroostook River.

scot have their origin. This close approximation of considerable streams, flowing in diverse directions and often for great distances, is a very peculiar feature of the region, and, taken in connection with the comparatively unsettled character of the country which they drain, the beauty of the scenery, and the abundance of fish and game, has made the whole region famous among tourists and sportsmen. Fish and game

The lakes of the region, already incidentally referred to, are as remarkable as the number and variety of its streams. In Aroostook county, Maine, they are exceedingly numerous, and of all shapes and sizes, but often so situated as to indicate that they are but isolated portions of what were once continuous and much more considerable basins. Of these, the most important, in relation to the present report, are those which form the sources of Fish River, and which, in the form of a chain, embracing Long Lake, Second or Mud Lake, Cross Lake, Square or Sedgewick Lake, Eagle Lake and Nadeau or Upper Lake, occupy a trough roughly parallel with the St. John. This trough in its eastern extremity (in Long Lake) is not over seven miles distant from the St. John. In Quebec, the lakes are less numerous, but among them is Lake Temiscouata, the most considerable of all as regards both extent and depth. This remarkable and very beautiful sheet of water has a total length of twenty-four miles, with a breadth varying from one to two miles, its general form, as accurately surveyed by the Geological Survey, being that of the letter L, with the longer or southern arm somewhat irregularly sigmoid. This longer limb, taken as a whole, has a course almost exactly N.W. and S.E., corresponding on the one side with that of the Madawaska and a considerable portion of the St. John, while on the other, an extension of the same line will be found to coincide with that occupied, at a distance of about forty-six miles, by the deep gorge of the Saguenay. The depth of Lake Temiscouata is itself somewhat remarkable, though less so than has been sometimes represented, accurate and systematic soundings made over its different portions showing that it varies but little from 220 feet.* Lakes of the region. Fish River Lakes. Lake Temiscouata.

As would naturally be expected, the hydrographic features of the district just described are intimately connected with, and in part dependant upon, its orographic features. There are, however, in these relations, many points which are somewhat peculiar, and cannot be readily accounted for, except by reference to the former existence here of conditions and the occurrence of operations somewhat different from those which now prevail. Peculiar features.

*In a note contributed by one of the authors to Science (Vol. VIII., No. 196) it is stated that the depth of the lake is, in some parts, over 500 feet. The statement was the result of a return submitted by a person in our employ who was engaged to make the soundings, who had already made several in our company, and in whom we had every reason to place confidence. Subsequent examinations, however, revealed, to our great surprise and disappointment, that the work thus done, if done at all, was entirely untrustworthy.

Canoe-shaped ridges.

Over the larger part of the area to which this report relates, the country is hilly, though there are few elevations of any considerable altitude. In general, the eminences are in long, canoe-shaped ridges, with easily-flowing outlines, but these are sometimes replaced by serrated crests, or, in the case of transverse river valleys, by bold escarpments. In the southern part of the tract, Green River Mountain, not far from the mouth of Green River, rises somewhat abruptly from a comparatively low country, and constitutes a very prominent object in the landscape. There are also other noticeable hills along the middle and upper courses of the same stream, but it is not until we approach Edmundston that the country begins to acquire a really rugged aspect. It is here that the St. John is joined by its main tributary, the Madawaska, and along both streams, the valleys which they occupy are bordered by a continuous succession of high rolling hills. In the case of the St. John, however, these, except within a few miles of Edmundston, run parallel to the stream, or cross it at very small angles (then usually determining the existence of rapids), while in the case of the Madawaska, its course is almost directly transverse to that of the hill ranges which border it, and which accordingly abut against it in bold and often craggy heights. Again, in the case of the St. John, the larger part of the valley is occupied by the stream itself and its immediate flood grounds, only rarely expanding to include any considerable extent of flat land; but on the Madawaska, the stream, in its present state, occupies but a very small proportion of the entire valley, being rarely more than 200 feet wide, while the valley, which is nearly everywhere flat, is seldom less than a mile in width. The great transverse trough which is thus indicated is, at its northern end, continuous with that of Lake Temiscouata, but here the whole valley is again occupied by the hills upon either side rising abruptly from the lake, as they also sink with almost equal abruptness to great depths below its surface. In the case of Mt. Wissick or the Big Mountain, nearly opposite old Fort Ingalls, they rise almost precipitously to a height of 550 feet, while at a distance of not over 100 feet from the base of the bluff, the depth of water is over 200 feet.

Green River Mountain.

Madawaska and St. John valleys.

Glacial origin of valleys.

From the features above described, as well as from others, such as the direction of glacial striæ, and the nature of the material occupying different portions of the Temiscouata-Madawaska valley, it would seem as though the latter were a great trough of sub-ærial glacial erosion, having throughout, at one time, a depth at least equal to that of the existing lake, but which, with the retreat and melting of the ice eventually became to a large extent filled up.

The nearly uniform and flat contour of the lake bottom, its very gradual or progressive shallowing at the southern extremity, and the

extensive deposits of clay which occupy portions of the valley of the Madawaska, are all in accordance with the view here advocated. It may be added, as bearing further upon the same theory, that while Mt. Wissick, abutting, as stated, directly upon the lake, with a height of over 500 feet, is but a part of a ridge which, in an easterly direction, is traceable with equal prominence for a distance of ten miles or more, on the opposite or western side of the lake, though only a mile distant, no such corresponding ridge is to be met with, nor any trace of the rocks of the mountain, except such as form its basal beds. Finally, it may be mentioned that large boulders, filled with fossil corals similar to those of the limestones of Mt. Wissick, have been observed far down the valley of the St. John, though no beds of similar character are known to occur anywhere in the interval.

Mt. Wissick.

Erratics.

The evidences of glaciation about the shores of the lake are abundant and varied, the surfaces of the slaty rocks which dip into the latter being everywhere smoothed, rounded, furrowed or striated. Some of the effects are doubtless attributable to the mere pressure of the lake ice, but others are far beyond its reach, and must have been produced by an ice-stream or glacier, filling the valley to a much greater depth, and which at the same time ploughed deeply into its bottom. To the action of such an ice-stream or glacier, the origin of the valley is largely to be ascribed. The course of the striæ above the limits of recent ice action varies from S. 45° E. to S. 60° E., the former corresponding with the axis of the lake itself, south of its principal bend. The upper part of the lake, which is very much shallower, corresponds in direction to that of the hills and rock formations which border it; but here another very peculiar feature presents itself in the fact that the movement of the ice, as indicated by the position of the travelled boulders, was to the north and north-east, rather than to the south. Thus above Mt. Wissick, which occupies the angle between the two main limbs of the lake basin, the shores of the latter are strewed with blocks of all sizes, some of them six or eight feet in diameter, which are simply detached masses from the fossiliferous rocks of the mountain, and which must have been transported several miles from their parent bed. This is in accordance with similar facts noticed by the authors on Lake Metapedia, and by Mr. R. Chalmers in other parts of the Gaspé Peninsula.

Glaciation.

Of other facts connected with the Post Tertiary history of the Temiscouata region, it is worth noticing that the other lakes of the district do but repeat, though upon a somewhat smaller scale, the features of Temiscouata itself. Thus the chain of the Squatook Lakes upon one side and that of Cabano on the other, both tributary to Lake Temiscouata, and almost exactly parallel to it, like it are situated nearly at

Parallelism of lake basins.

right angles or obliquely to the rock formations and are of exceptional depth. The same north-west and south-east trends are repeated in the valley of Baker Lake and Brook, in that of the St. Francis River, including Boundary and Glazier Lakes, still further west in the course of the Big and Little Black rivers, and eastward of Temiscouata in the tributaries of the Green River and the Restigouche.

Kames.

The last feature which we shall notice in this connection is that of the occurrence of kames or horse-backs over some portions of the region. Of these, one of the most noticeable is to be seen in the vicinity of old Fort Ingalls, and for a short distance constitutes the foundation of the thoroughfare leading to the latter. It is about half a mile in length, and about thirty or forty feet in breadth at the top, having a somewhat sinuous course, but a general trend nearly S. 20° E., or the same as that of the lake on whose shore it terminates. It is composed chiefly of coarse sand and gravel, and traverses a low flat tract which, in part, at least, is occupied by beds of clay. Other kames, but of less marked character, were observed at other points, especially a few miles above the mouth of the St. Francis, on the Maine side of the St. John.

Character of soils.

The soils of the district under discussion are similar in origin, and hence similar in character, to those of the Silurian tracts further south, which have been described in earlier reports. They would seem, however, to be of less depth than the latter, as well as less calcareous, and hence less well adapted for purposes of agriculture. Along the valley of the St. John, there are many good farms, and excellent land for farming purposes is said to exist over large portions of the country drained by the tributaries of the St. John and Restigouche rivers, but to the north of Edmunston and in the county of Temiscouata, the country is so hilly as to interfere materially with tillage operations, while the shortness of the season and the constant liability to destructive frosts, are serious drawbacks to the settler. The valley of the Madawaska, it is true, is an exception to the generally hilly character of the region, but the sandy and clayey nature of the deposits with which it is filled is equally unfavorable to its productiveness, and though farms are numerous, they are in general of inferior character. The whole of the country east of Lake Temiscouata, and much of that west of it, is still in forest, and is the seat of important lumbering operations.

Formations.

The geology of the region, to which this report relates, embraces, according to our present knowledge, only strata of Silurian and Ardovician or Cambro-Silurian age. As the principal portion, however, of the area occupied by the latter, which extends to the shore of the St. Lawrence, has been only partially examined, and is still under discussion, it is not proposed to consider it here, except so far as it comes in contact with the Silurian system; the present report is therefore essentially confined to the consideration of the latter.

The first systematic description of the Silurian rocks in this portion of America is that contained in the "Geology of Canada, 1863," where an elaborate section is given of these rocks, as seen at the extremity of the Gaspé Peninsula, together with many details of their distribution in other parts of that peninsula, as well as westward in the valleys of the Metapedia, Patapedia and Metis rivers, about Lake Temiscouata and above the upper tributaries of the river St. John. The section at Gaspé, which is unequalled in its extent and clearness of exposure, was justly regarded as typical, and the name of Gaspé series was applied to that portion of the strata there exhibited, chiefly limestones, which was supposed to represent the Silurian system, as distinguished from an overlying mass of sandstones (Gaspé sandstones), which were regarded as Devonian. Subsequently, a further examination of portions of the Silurian district was made by Mr. Richardson (Report of Progress, 1869), and numerous fossils were collected by him as well as by E. Billings, T. C. Weston and others. Still later, in 1882-83 Messrs. Ells and Low, of the geological corps, made additional observations in the interior of the Gaspé peninsula, and the results are embodied in two reports, accompanied by maps showing the distribution of the formations, with large lists of fossils. In one of these reports, the fossils collected were regarded as indicating that a considerable portion of what had been considered as Silurian was in reality Devonian, but this view was subsequently abandoned. Finally, between the years 1883 and the present time, the authors of this report, while pursuing their investigations in Northern New Brunswick, have not only made numerous sections and careful surveys of the Silurian rocks included in that province, but, by extending their observations into the adjacent state of Maine, have obtained much valuable information regarding the succession of the Silurian rocks. The results of these explorations, so far as they relate to the mere details of distribution and lithological characters, have already been given in several preceding reports, with accompanying maps, but, with the exception of two communications made by one of the authors to the Royal Society of Canada, and published in its Transactions, no attempt has been made to institute comparisons or to draw any general conclusions. In the present report, it is our aim to summarize the information now available, in order to show how far it confirms or modifies the results of earlier observers, and to indicate some of its bearings upon general questions of geological history.

Former reports Geology of Canada, 1863.

Richardson, 1869.

Ells and Low, 1882-83.

Bailey in Trans. R. S. C

Gaspé Peninsula.

Gaspé section.

As a basis of comparison, it will be convenient to give here a summary of the succession, as revealed in the typical section of the Silurian rocks at Cape Gaspé. This, condensed from the Geology of Canada, page 391, is as follows:—

1. Grey limestones, in layers from six to eight inches thick, separated by greenish calcareo-argillaceous shale; the limestones abounding in fossils, including, among others, specimens referable to the following genera; *Favosites, Zaphrentis, Dictyonema, Fenestella, Strophomena, Orthis, Rhynchonella, Pentamerus, Spirifera, Athyris, Atrypa, Cyrtodonta, Modiolopsis, Arcula, Loxonema, Bellerophon, Platyceras, Conularia, Orthoceras, Dalmanites, Phacops, Bronteus* and *Beyrichia.* 70 feet.

2–3. Calcareo-argillaceous shales of red and green colors, with nodules and layers of limestone, and remains of marine plants. 260 feet.

4. Grey limestones in thin beds, with separating layers of grey calcareous shale, and including about seven feet of limestone and limestone shale, of which the layers have been in part excessively corrugated and in part disrupted into fragments. Fossils less numerous than in 1. 200 feet.

5–6. Grey or greenish calcareous shales or shaly limestones, sometimes arenaceous, with thinner beds of pure limestone. Fossils—Brachiopods and trilobites. 680 feet.

7. Grey nodular shaly limestones, with some greenish calcareo-arenaceous shales. The only fossils are one resembling *Spirophyton caudagalli*, and *Dalmanites pleuroptyx*.

Thickness and age.

The lowest beds of the above section rest upon black shales, which have been supposed by Prof. Lapworth to hold a position inferior to the rocks of Point Lévis, while those of its highest member are succeeded by arenaceous beds, abounding with fossil plants and forming a portion of the Gaspé sandstone series, of Devonian age. The entire thickness of the Silurian sediments, as given above, amounts to about 2000 feet, and their age, collectively, is regarded as about that of the Lower Helderberg formation. The rocks of the inferior Niagara group, though abundantly represented on the island of Anticosti, appear to be wanting here.

Of the geology of the interior of the Gaspé peninsula, we do not here propose to speak, as we have no personal knowledge of its features, and can add nothing to the information already given in the Geology of Canada and the later reports of Dr. R. W. Ells and his associates. It is, however, necessary to observe that at several points along the south side of the Shickshock Mountains, notably at the sources of the Chatte and Matane rivers, the base of the Silurian system is represented by massive beds, from 50 to 70 feet thick, of white, quartzose sandstone,

Base of Silurian in the Shickshocks.

often vitreous in aspect and speckled with small, red, ferruginous spots. They are directly succeeded by fossiliferous limestones, holding species similar to those contained in the upper part of the Anticosti group, and the two are hence regarded as marking an horizon about that of the Niagara formation. Collections of fossils made by Dr. Ells and his associates, on the Scaumenac and Little Cascapedia rivers (Report of Progress, 1882-83-84), have also been thought to indicate a similar horizon. On the other hand, a considerable area of rocks occurring in the basin of the Casupscal River, and thence extending eastward to and beyond the Cascapedia River, and which also formed a portion of the Gaspé limestone series, as originally defined, were found, by the same author, to contain numerous fossils, indicating their probable equivalency with the Oriskany and Hamilton formations of the Devonian system.

Fossils collected by Dr. Ells.

Thus the boundary, as indicated between the Silurian and Devonian systems in this region, seems to have been determined upon palæontological grounds rather than upon the lithological and stratigraphical evidence, and the evidence would also seem to afford some confirmation of the view that the Oriskany is not only a transitional formation, but more nearly related to the Silurian than it is to the Devonian system.

Palæontological evidence relied upon.

The first observations made by us bearing upon the geology of this region were made during the season of 1888, along the course of the Metapedia River, and about the lake of the same name, from which it flows.

The geology of the eastern side of Metapedia Lake, having been described in the geology of Canada, and represented in the published maps accompanying the report by Dr. Ells, need not be discussed here. Upon the western side, near the head of the lake, the lowest visible Silurian rocks are whitish sandstones, sometimes exhibiting a pinkish tinge or speckled with small red spots. As stated in "Geology of Canada, 1863," p. 414, these rocks are undoubtedly the equivalents of the similar beds on the Matane River, and, if the latter are correctly referred, would represent the upper part of the Anticosti group, or that of the Niagara formation. They may be seen at several points along the margin of the lake, and form the whole of an island near its southern extremity, but in most places they are concealed either by overlying limestones or by drift. The drift contains numerous and often large blocks of the white sandstone, from which the only fossils as yet found have been obtained. In a collection made about two miles above Cedar Hall, the following fossils have been determined by Mr. Ami.

Metapedia Lake.

Fossils in loose blocks.

Fossils from Cedar Hall.

ZOOPHYTA.

Crinoidal Columns.

Zaphrentis or *Streptelasma*, sp. indt. Several casts and impressions of a Zaphrentis-like coral, resembling a species described by Prof. Hall in the 2nd volume of Palæontology of New York.

BRACHIOPODA.

Orthis (*?*) sp.

Pentamerus oblongus, Sowerby. Numerous large casts, which show the position of the internal plates.

GASTEROPODA.

Murchisonia, sp.

Oriostoma, sp. Several casts, which most probably belong to this genus, and resemble closely, depressed specimens of *O globosum.*

TRILOBITA.

Lichas (*?*) sp. A fragment resembling the tuberculated test of a trilobite allied to *Lichas*, but not large enough to warrant accurate determination.

Fossils from six miles above Cedar Hall.

The limestones, which may be seen to directly overlie the sandstones, and which are themselves quite hard and siliceous, are more abundantly fossiliferous, and from beds of the latter, exposed in the large quarries opened during the construction of the Intercolonial Railway, six miles above Cedar Hall station, the following were collected :—

Cyathophylloid coral.
Body-volution of a large gasteropod, perhaps of a *Pleurotomaria.*
Halysites catenulatus.
Crinoidal fragments.
Strophomena rhomboidalis, Wilckens.
Strophodonta varistriata.
Strophodonta Becki ? Hall.
Meristella sp., cf. *M. didyma.*
Atrypa reticularis, L ; very abundant.
Platyceras sp. indt.
Oriostoma globosum, Schlotheim.

The above-named fossils tend to confirm the idea that the beds containing them hold a position corresponding nearly, to that of the Niagara formation. It may be added that at the extreme northern end of the lake, as well as on the way to Sayabec, there are boulders, of a very

large size, of a grey conglomerate, holding limestone pebbles in a sandy matrix. These contain large corals and brachiopods of Silurian type. They repose upon rocks of the Quebec group, and can hardly have travelled to any great distance, but the source from which they were derived is not known.

Strata on west shore of Metapedia Lake.

Along the entire western margin of the lake, the strata present low undulations, the dip rarely rising above 8° or 10°, and no higher beds than those above noted are observed, but near the outlet and along the course of the Metapedia River are numerous sections which appear to belong chiefly to the higher members of the formation. They have not been examined in detail, but so far as seen, they appear to be quite similar to the strata described in previous reports as covering such large areas in northern New Brunswick and Maine. They consist, for the most part, of dark grey, bluish-weathering, calcareous slates, which, however, occasionally include beds of fine-grained, calcareous sandstone, or, less frequently, thin beds of limestone. The strong and highly inclined cleavage planes by which they are everywhere intersected, and the influence of the latter upon their weathering, gives rise to steep hills, narrow defiles, and, in places, to a landscape eminently bold and craggy, suggesting the idea of a highly-disturbed region. The inclination of the strata is, however, in reality, usually quite low, and the same beds are undoubtedly several times repeated through the fifty or more miles of distance which the section covers. Compared with the section at Cape Gaspé, these strata would appear to appertain chiefly to Div. 5-6, but the fact that fossils of Devonian type occur in the valley of the Casupscull, as observed by Dr. Ells, may perhaps be regarded as indicating that the entire series is here represented. As a basis of further comparison, we add here the following list of forms collected in the vicinity of Dalhousie, N B., and now in the cabinet of the University of New Brunswick :—

Fossils from Dalhousie, N.B.

Favosites basalticus.
" *Gothlandicus.*
Halysites catenulatus, L.
Syringopora.
Diphyphyllum.
Zaphrentis.
Fenestella.
Stenopora.
Orthis testudinaria, Dalman, or an allied species.
" *oblata,* Hall.
Strophomena rhomboidalis, Wilckins.
Strophodonta punctulifera, Conrad.

Strophodonta varistriata, Conrad.
Spirifera cycloptera, Hall.
Atrypa reticularis, *L.*
Cyrtina Dalmani; Hall.
Rhynchonella vellicata, Hall.
Athyris princeps ?
Leptocœlia, allied to *L. hemispherica.*
Megambonia, allied to *M. ovoides*, Hall.
Conocardium.
Pleurotomaria, allied to *P. labrosa*, Hall.
Euomphalus sinuatus (?) Hall.
Dalmanites.

The species above named were determined by Mr. Billings, who regarded them as indicating the horizon of the Port Daniel limestones of the northern side of the Bay Chaleur, and as intermediate in age between the Niagara and Lower Helderberg groups.

Low, flat, country.

In conformity with the nearly horizontal attitude exhibited by the rocks along the western shore of Lake Metapedia, the country underlaid by the latter is also, for the most part, flat and relatively low. From the upper half of the lake, a similar, broad, flat and often swampy tract stretches to the westward to and beyond the Metis River. Bordering this tract upon its southern side, and stretching in a direction about west-southwest, a ridge of hills is seen to rise into considerable prominence, forming part of the range of the Notre Dame Mountains. From the abruptness with which these hills begin, and their altitude and boldness of outline, the idea is forcibly suggested that they are portions of an older series, or at least of harder or more highly disturbed strata than those which border them. Several attempts have accordingly been made to ascertain their true nature, but, even in the case of the steeper portions, these have failed so far to reveal any outcrops nor any debris other than that of the ordinary Silurian slates.

Notre Dame Mountains.

Metis and Petapedia Rivers.

The geology of the Metis and Patapedia rivers is given, in considerable detail, in the Geology of Canada, p. 416; we had hoped to have re-examined this section, and to have made more ample collections of the fossils which it yields, but were prevented from so doing from the want of sufficient water in the Metis River. We, however, ascended one of the tributaries of the Metis, the Musquegegish, a stream previously explored, to a point not more than a mile from its source in a lake of the same name. This lake itself is not far removed from the lakes at the heads of the Rimouski and Quatawamkedgwick rivers, and the information which it affords, in connection with that obtained

upon the last-named streams, to be presently described, gives the key to the character of a large tract, about which little was previously known. The rocks of the Musquegegish, as might be inferred from its position, are much like those of the Metis, and are, in places, sparingly fossiliferous.

Sandstones at St. Gabriel.

On tracing the northern border of the Silurian tract to the westward, the white sandstones at the base of the series, which on the Metis are represented only by loose blocks, come again somewhat prominently into view near the eastern extremity of the settlement of St. Gabriel, and about half a mile from where the Rouge stream is crossed by the Taché road. The beds here dip S. 25° W.<20°, and are, as on Lake Metapedia, directly overlaid by beds of dark blue limestone, forming together a series of low bluffs along the road leading around the eastern extremity of Mount Commis. The limestones contain fossils, but they are neither so abundant nor so well preserved as where the same beds come out a few miles to the westward, at the falls of the Big Neigette River. This fall, about 100 feet in height, and the very similar one of the Little Neigette, seventy feet, result from the singular abruptness with which the Silurian rocks terminate along their northern edge, forming an escarpment which constitutes a prominent feature in the landscape, and which is partly continuous with Mount Commis, and extends thence and to the westward for a distance of twenty miles, terminating in the ridge of the Bois Brulé, near St. Blandine. The rocks of the Neigette Falls, which are partly limestones and partly limestone-conglomerates, are chiefly remarkable for the number and the large size of the fossil corals which they contain, the chain-coral (*Halysites catenulatus*) being especially abundant. The limestones are, to some extent, burnt for lime, but are not well suited for the purpose, being quite siliceous and impure. Their dip is S. 80° W.<1°–20°.

Neigette falls.

Silurian escarpment.

Bois Brulé Mt.

On the summit and around the flanks of Bois Brulé Mountain, admirable opportunities are afforded for the study of the strata of which it is composed, and which are here of more than usual interest. On the precipitous northern face of the mountain, the rocks are chiefly hard, grey, calcareous sandstones, the continuation probably of similar beds overlying the limestones at the Neigette Falls. They dip S. 47° E.< 40°, and contain a few large corals, as well as crinoid stems and ribbed shells, but these are mostly poorly preserved. Ledges of similar sandstone also form the summit of the mountain, but on the southern slope, looking towards Ste. Blandine, beds are met with in which the organic forms are both more numerous and more perfect. One bed, consisting of a buff-weathering dolomitic sand-rock, is especially remarkable as containing little besides the remains of large *Pentameri*, the species,

Fossils at Bois Brulé Mtn.

though belonging to the section of which *P. Knighti* is the type, exhibits, nevertheless, specific differences, and is apparently new. In a collection subsequently made, however, by one of the authors, from a light grey impure limestone, several fine and very large individuals of what is undoubtedly the species last-named, were found associated with crinoidal and cystidean fragments, a *Chonetes* (or a form nearly related thereto), a *Merista* (being a young individual, either of *M. subquadrata* or *M. princeps*, Hall), and an imperfectly preserved *Euomphalus*. Mr. Ami suggests these strata may be the equivalents of the Aymestry beds of Great Britain, and perhaps of one of the zones called by the New York geologists Pentamerus limestone. A mile or so to the westward, still other fossiliferous beds appear. One of these is near the foot of the hill on the northern side, in the valley of Bois Brulé River, and is a drab-weathering, argillaceous and shaly limestone, from which the following fossils were obtained by Messrs. Ells and Ami:—

Halysites catenulatus, L.
Strophomena rhomboidalis, Wilckens.
Orthis, cf. *O hybrida*, Sowerby.
" probably *O. calligramma*, Dalman.
" " *O. Davidsoni*, De Verneuil.
Atrypa reticularis, L.
Pentamerus, allied to or identical with *P. oblongus*, Sowerby.
Calymene Blumenbachii? Brongniart.

Coral conglomerate at Ste. Blandine

Another and still more prolific locality occurs directly by the roadside, about a quarter of a mile south of Ste. Blandine Church. The ledges here, which dip. S40°E<40° 50°, may be well called a coral conglomerate, as they are higher in the series, and are literally filled with fossils. From them the following forms have been obtained:

Fossils from Ste. Blandine.

POLYPI.

Favosites Gothlandicus, Lamarck.
Halysites catenulatus, L.
Cyathophyllum, cf. *C. Pennanti*, Billings.
Syringopora retiformis? Billings.

CRINOIDEA.

Numerous fragments of Crinoids.

BRACHIOPODA.

Strophomena rhomboidalis, Wilckens.

Orthis varica, Hall.
" sp. indt.
Rhynchonella nucleolata, Hall.
Spirifera cycloptera, Hall.
" sp., cf. S. *sulcata*, Hisinger.
Retzia or *Trematospira*, sp. indt.
Atrypa reticularis, L.
Merista arcuata, Hall.
" *princeps*, "
" *levis*, "
Pentamerus galeatus, Dalman.
" n. sp.
Tentaculites sp., indt.

GASTEROPODA.

Euomphalus carinatus? Sowerby. A large form with obscure markings. May be *E. rugælineata*, Hall (24th Reg. Rep. p. 186).

TRILOBITA.

Acidaspis sp. indt. Hypostome.
? *Lichas* " "

The above were collected by Prof. Bailey, and determined by Mr. H. M. Ami, who subsequently added the following:—

A stromatoporoid.
Favosites, sp., with small corallites.
Syringopora, resembling S. *junciformis*, Hall.
Impression or cast of a scapular plate of a cystidean allied to *Caryocrinus*.

Relation of the beds.

Owing to the character of the ground, the precise relations of these several fossil-bearing beds are not easily determined. It is certain that the rocks containing the species in the list last given are above and not far removed from the beds which form the summit of Mt. Bois Brulé, while those yielding the species enumerated on p. 18 M represent still lower beds. The white sandstones are not visible here, being probably concealed by the talus on the north side of the mountain, but they are described in the Geology of Canada as seen on the Rimouski River. To the south of the coral conglomerates, the exposures are frequent, consisting chiefly of grey calcareous and buff weathering sandstones, with some limestones, which may be seen for several miles along the road leading back from Ste. Blandine to the Taché road. They dip very regularly S 40° E < 20°—40°, and occasionally hold remains of crinoids and ribbed shells.

Road back from Ste. Blandine.

Quatawamkedgwick and Rimouski rivers.

Northern edge of the Silurian.

From the Rimouski River at Ste. Blandine, six miles in a straight line from the shore of the St. Lawrence, the northern border of the Silurian plateau bends rapidly to the south and west, and, as described in the Geology of Canada, is next prominently seen on Lake Temiscouata. Between these two points, however, there is an interval of fifty miles, and with a view of obtaining more accurate knowledge of the country separating them and of the formations included in the interval, two traverses were undertaken, the one embracing the section drained by the Rimouski and Quatawamkedgwick rivers (the latter a branch of the Restigouche); and the other a similar section afforded by the branches of the Trois Pistoles and Tuladi rivers, the latter connecting with Lake Temiscouata. Mr. McInnes, by whom these traverses were made, thus describes the facts observed.

Quatawamkedgwick river

Along the lower part of the Quatawamkedgwick River, for the first few miles, the strata are a continuation of those seen along the main Restigouche River, between the Gounamitz and the mouth of the Quatawamkedgwick. They consist in the main of grey calcareous slates, with bands, half an inch to six inches in thickness, of impure limestone, and with interstratified beds of hard sandstone.

Anticlinal folds

The sandstones are seen at points three and five miles from the mouth of the river, forming the sides of an anticlinal fold, the lower exposure dipping S.56°E. $< 85°$, and the upper exposure N.46°W$<80°$. Overlying these sandstones, and exposed on the river above and below them, are grey calcareous slates, with limestone bands from half an inch to three inches in thickness; and underlying them, brought up by the fold, are grey calcareous slates again showing the limestone bands, more sparingly, however, and only in the upper beds, near the sandstones. Farther down on the river, within a quarter of a mile of the Restigouche, these sandstones, or beds of a similar character, are exposed again, apparently brought up by a fault; they are in direct contact with the banded states and cut off the beds, which are much bent and twisted at the point of contact, and have white calcite scattered through them in numerous veins and lenticular patches.

Fault (?)

Banded slates.

Grey, calcareous slates, without the conspicuous banding before noted, occur all along the river in a succession of low undulations to and beyond the main forks. The bedding of these rocks is seldom clearly seen, a strong and nearly vertical cleavage everywhere obscuring it; they are crumpled into a series of folds striking N. 50°E. to N. 70°E., but show local twisting of the most fantastic kind, and resemble quite closely the contorted slates which occur along the shore of Temiscouata Lake between Notre Dame du Lac and the foot of the lake.*

*Geology of Canada, 1863, pages 424 and 425.

Hard, dark blue slates, with softer, fissile bands, not differing in any great degree from those seen below, extend up the river as far as the crossing of the boundary line between New Brunswick and Quebec; like the slates described above, they are cut by a nearly vertical cleavage and are folded in a like manner to them; the softer, more fissile portions of the ledges weather out readily, and leave the harder bands projecting in a succession of knife-like edges in the bed of the stream. For a distance of two miles and a quarter below the boundary line, the outcrops seen along the stream dip about N.45°E. $< 30°$–$40°$, indicating the occurrence here of a long dome in the rocks, the summit of which would lie some distance to the south-west of the stream. Above the boundary line no exposures are seen for a mile, or until the first fall is reached, where the following section is exposed, measuring at right angles across the strata which dip N.5°E. $< 90°$:

Strata at provincial boundary line.

Fossiliferous strata.

	FEET.
Dark blue, finely micaceous, shales	10
Shales, similar to above, with bands of light grey, finely micaceous sandstone, with carbonaceous markings resembling plant remains, but too fragmentary for determination	10
Soft, grey, calcareous shales	3
Soft, grey, calcareous shales, and finely micaceous, grey sandstone in thicker beds, with crinoid stems and shells	20
Sandstone in heavy beds, with thin bands of soft, grey shales	25
Sandstone in heavy beds, weathering to a rusty, buff-colored, rotten stone with thin bands of shale, very fossiliferous in certain layers, especially along the junction planes of the sandstones and shales	30
Soft, dark blue shales and beds of sandstone	50
Soft, dark blue shales and beds of sandstone with fossils in certain layers	250
Dark grey shales, forming falls four feet high	10
Same shales	150

A small collection of fossils from this locality, which has been examined by Mr. Ami, contains the following species:—

List of fossils.

Obscure *Psilophyton* or plant like remains.

Numerous crinoidal joints.

Orthis sp., of the type of *Orthis rustica*, Sow.

Strophomena sp., with peculiar vermicular parasitic (?) organisms attached to the outer test of the individual.

Spirifera sp., cf. *S. Nictavensis*, Dawson, and *S. arenosa*, Conrad.

Lichas (?) or some closely related genus of trilobite.

The collection is scarcely sufficient or characteristic enough to state definitely whether the rocks from which it was obtained belong

to the upper portion of the Silurian system or to the base of the Devonian.

Lithological character.

These beds resemble in general lithological character the fossiliferous strata occurring near the edge of the Silurian on the Beccaguimic and elsewhere.*

Beyond this fossiliferous band no exposures are seen in place for a distance of about ten miles along the stream; large angular blocks of a very hard, grit-like, grey sandstone are plentiful at a point about three miles above the boundary line, but the first exposure *in situ* occurs about a mile and a half below the lake, where ledges of finely micaceous, soft, blue slate, with layers of limestone, weathering into depressed bands and nodules, strike N.59°E. At the upper forks, half a mile below the lake, a ledge of the same character occurs, and again about half-way down the lake a similar ledge of highly calcareous, rusty blue slate, of nodular structure, weathering into irregular ridges with pitted depressions between, and with black films along the cleavage planes, forms a reef in the lake, and is exposed on the western shore on the line of strike, which is N.49°E.

Upper forks.

Kedgwick Lake

This lake, known as Kedgwick Lake, is two miles in length and has an average width of about half a mile; it is quite shallow, and the immediate shores are flat and swampy. Low hills wooded with spruce and cedar rise about a mile back from its shores. A stream entering near the head of the lake flows from a smaller lake with the same general features. No rock occurs in place either on the stream or around the shores of the second lake; large blocks of coarse sandstone or fine conglomerate, holding small pieces of black slate, are common about the foot of the lake, and near its head, grey, fine, calcareous, arenaceous sandstone, weathering rusty, pitted in certain layers and slaty in places, similar to that described above as occurring in place on the stream, is strewn over the lake bottom in large angular blocks.

Portage to small lake on Rimouski River.

From this lake, a portage of a mile and a quarter, over a low ridge, wooded with white birch, cedar and spruce, leads to a small lake at the head of the left hand branch of Rimouski River. The only exposures seen on this lake are at the narrows, three-quarters of a mile from its head; they are soft, grey, calcareous slates with narrow black bands, which give to the ledges a ribanded appearance; the beds are considerably twisted, and are cut by a large vein of white quartz. Large angular blocks of the fine conglomerate, mentioned above, holding small pieces of soft, black slate, occur in numbers at this point.

Ribanded slates

The stream draining the lake is very small, and flows through flat,

*The Silurian system of Northern Maine, New Brunswick and Quebec. L. W. Bailey. Trans. Roy. Soc. Can., 1886, Sec. IV., page 38. Annual Report, Vol. I., 1885. page G 14 et seq.

swampy land for about two miles below the lake, shewing no exposures. For part of this distance, however, the stream is choked with large blocks of coarse sandstone and conglomerate, the latter holding pebbles of limestone. Descending the stream, the first exposures, which occur about a mile and a half below the lake, are rusty-weathering, soft, dark-grey slates, with satin-like surfaces and showing fine black banding; the bedding is cut obliquely by an almost vertical cleavage. These beds are followed, at a distance of two miles farther down the stream, by soft, finely micaceous, dark-grey slates; no general dip could be got on account of the violent crumpling to which the beds have been subjected.

Angular blocks on stream.

After leaving the lake, the stream runs in a general north-westerly direction for a distance of about seven miles, it then turns with a sharp loop to the south-southwest, and preserves that direction in a general way for ten miles, to its junction with the right hand branch of the Rimouski River. On the eastern side of the bend no ledges are exposed; near its apex and for some distance to the south of that point, large blocks of hard conglomerate and sandstone are thickly scattered along the bed of the river. The section seen between the northern point of the loop and the Rimouski River supplies the place of that concealed along the upper part of the stream, the strike of the strata carrying them across both sides of the bend; the exposures consist mainly of very highly crumpled, grey, calcareous slates, with bands of limestone and occasional beds of sandstone. Taking up these beds in order towards the north, or in the reverse order to that in which they are seen in descending the stream, we have, two miles above the forks, an anticlinal fold with dark grey slate at the summit, and on either side slates, with interstratified bands of hard sandstone, ten inches in thickness. Following these are dark grey slates again, bent and contorted, dipping south; and beyond, another anticlinal fold, shewing slates with hard sandstone bands two to three inches in thickness, and hard, grey silicious sandstone, with fine, hair-like, black markings and cut by veins of mixed calcite and quartz, and by large veins of rusty-weathering, white quartz. These beds are much twisted up and altered by compression, the slates becoming quite ligniform in structure where they adjoin the beds of sandstone.

General course of the stream.

Section seen on left hand branch.

On the main Rimouski River, strata similar to those above described occur all along down to the great falls. They are mainly grey, calcareous slates, with limestone bands, and with, here and there, interstratified bands of hard sandstone.

Rimouski River beds.

The whole series of rocks above described has been subjected to very violent crumpling, the strata exposed along the main Rimouski River shewing its effects more particularly. The folding is often of the

Crumpling.

most fantastic description, shewing local dips towards every point of the compass and at every angle, but preserves a general parallelism in the trend of the folds, which run roughly north-east in broad curves.

Vertical cleavage.

A fine and strong vertical cleavage, which cuts the slates, strikes in the same direction; this necessarily cuts the planes of bedding at various angles, and renders the finding of fossils in the strata extremely difficult.

Effects of pressure.

The planes of cleavage become co-incident with those of bedding only in close proximity to comparatively thick beds of sandstone, which have proved rigid enough to withstand the cleaving action of the shove, and to induce in the adjoining slates a cleavage parallel to their own bedding; a further effect of the greater resistance of these beds of sandstone is seen in the production in the slates near them of a ligniform structure. The extreme phases of crumpling have occurred near the centre of broad bands of slate, where the twisting and distortion of the beds has been very great, and where a conglomerate, similar to that seen at the mouth of the Seigas stream, on the St. John River,* has been formed.

Formation of conglomerate.

This conglomerate is made up of sub-angular pieces of impure limestone, imbedded in a matrix of calcareous slate; the enclosed fragments are often very considerably rounded, and the rock might in places be readily mistaken for a conglomerate with water-worn pebbles; in other places, however, the method of its formation is clearly shown. It has evidently been formed from slates, with interstratified, harder bands of limestone, which have been subjected to great lateral pressure. The softer slates have bent and stretched under the force exerted, while the harder bands have broken up, and, after having been partially rounded by attrition, have been surrounded by the slates, which have curved around the broken pieces and filled the interstices between them, producing, on a large scale, a structure similar to that induced by flow.

Trend of folds.

The general north-east and south-west trend of the whole series of folds, and the parallelism to these of the planes of cleavage, would indicate the operation of a force acting at right angles to this direction, or from the south-east or north-west, and at right angles to the coast line to the south, and to the edge of the Laurentian Hills to the north.

The description which has been given above of the rocks exposed along the Rimouski River has been carried northward down the river only as far as the head of the Great Falls gorge; the section which the river affords, between the foot of the gorge and the St. Lawrence, has been described in the Geology of Canada, 1863, pages 418 and 419.

* Geology of Canada, 1863, p. 426.

The Silurian age of the rocks described in the above section extending from the Restigouche River westward on its tributary the Quatawamkedgwick as far as the fossiliferous strata above the provincial boundary line admits of little doubt, as, although fossils were found in them only at the one point mentioned, they are evidently, from their lithological character and stratigraphical position, the continuation eastward of the strata exposed along the St. John River. They are therefore considered to be Silurian, and probably of about the horizon of the Lower Helderberg. Silurian age of beds on the Restigouche.

There is less certainty with regard to the age of the rocks exposed along the Rimouski River and extending across the height of land to Quatawamkedgwick; no fossils have been discovered in them between the Taché Road, where the rocks are fossiliferous and of Silurian age, and the fossil-bearing ledges above referred to as occurring near the provincial boundary line. The whole extent of highly disturbed beds intervening cannot therefore, with any certainty, be assigned to a particular horizon, and the question as to whether they are of Silurian age or otherwise is left until the work of another season shall have afforded fuller evidence on the point. The parallel section further to the west, to be presently described, shows no strata further north than the Mt. Wissick ridge, which can be classed with any certainty as Silurian. Doubtful age of the Rimouski beds.

The Quatawamkedgwick River flows in a deep valley about half a mile in average width, and sweeps from side to side of this valley, leaving on either side between the bends, flat land, extending back to the hills which rise along the lower part of the river to a height of from 400 to 500 feet above its bed. The water is exceedingly clear and cold and the current very swift, with no stretches of dead water; fine deep pools, however, occur here and there along its course, which form the spawning beds of large numbers of salmon and trout. Small islands, wooded with balsam poplar, elm and ash, are plentiful along the lower stretches of the river, and the scenery all along is strikingly beautiful. Valley of Quatawamkedgwick.

The appropriateness of the Indian name, Quatawamkedgwick (the river which runs down hill and disappears under the ground), becomes apparent at many points along this part of the river's course, where the water, always swift, seems literally to run down hill, and to disappear under the mountains, towards the base of which it again and again flows, and only turns abruptly off when to all appearance on the point of disappearing beneath them. Derivation of name.

Higher up, the valley gradually becomes narrower, and the confining hills loftier, rising to heights of over 700 feet above the river bed. Elevations of various points along the valley and of many of the Height of hills.

neighbouring hills are given by Mr. Chalmers in the annual report for 1886. The general character of the valley remains the same up to within a few miles of the main forks; above this point, the hills on either side gradually disappear and the country bordering the stream becomes flat and continues so to the lakes which lie at its source.

Watershed.

These are divided from lakes draining into the Rimouski by only a low ridge, and the whole extent of country lying about the headwaters of these rivers is generally of even surface with large areas of swamp and with few elevations rising to any considerable height above the general level. Evidence that this level land which forms the central water-shed was once covered by glacier ice is afforded by the deposits of boulder clay which occur at different points. A deposit of this nature, noted by Mr. Chalmers,* occurs two miles and three-quarters below McDougall's Brook, and is here overlaid by a stratified bed of sand and gravel. Boulder clay was noted at two other points further up on the stream, one of these was at a bend in the river, a quarter of a mile above the crossing of the provincial boundary line, and the other a quarter of a mile below it. At these points the river washes against, and cuts into, a bank of unstratified clay from twenty to thirty feet in height, holding pebbles and small boulders of the local rock with smoothed and flattened sides longitudinally striated; the overlying stratified sands and gravels, which occur in the exposure below, are here entirely wanting, only a thin layer of loam covering the clay. The stream at the crossing of the boundary line is probably about 150 feet higher than at the boulder clay deposit below McDougall's Brook, or, taking the heights of the latter place given by Mr. Chalmers, 570 feet above sea level.

Evidences of glaciation.

Boisbouscache and Tuladi rivers.

Trois Pistoles and Tuladi Rivers.

A second traverse was made across the watershed south of the St. Lawrence, by way of the Trois Pistoles and Tuladi rivers and their branches. The Boisbouscache or left hand branch of the former river was followed from the settlement of St. Jean de Dieu upwards for a distance of eight miles. From this point Lac des Iles at the head of the left hand branch of Tuladi River was reached by a short portage. The road which leads back from Trois Pistoles Station to the settlement of St. Jean de Dieu, a distance of twelve miles, passes over a succession of low rolling hills, rising gradually from the St. Lawrence, and crosses alternately belts of hard siliceous sandstone (so-called Sillery) forming the higher hills, and green and purple slates (so-called Lauzon) occupying the intervening valleys. These rocks

St. Jean de Dieu.

*Annual Report, 1886, page 15, M.

are all very much altered and contorted; they have been treated of at length in the Geology of Canada, 1863, and in the subsequent reports of the Survey by Dr. Selwyn and other writers; further details with regard to them are left for a later report when the structure shall have been more thoroughly worked out; all that will be attempted now will be to describe the exposures observed along the streams traversed on this route. Earlier reports.

Ascending the stream from the settlement of St. Jean de Dieu, the first exposures seen form a low fall about 200 yards above the main road bridge; they are hard, dark grey, compact sandstones, considerably contorted, and dip S. 19° W. <80°. The next exposures, which occur about half a mile beyond, are hard, grey, rusty-weathering, highly altered, nacreous slates, locally much folded, but keeping the same general dip; further on, however, the same slates dip S. 20° E.< 45°–50°. Similar sandstones and hard, grey slates continue in alternating bands beyond this point, preserving the same general strike, but shewing also local dips in various directions and at all angles from horizontal to vertical. The slates in places are banded with green, and are everywhere highly altered and contorted, and often finely cleaved with shining, satiny surfaces along the planes of cleavage. The last exposures seen on the stream occur just at the mouth of a small brook, entering on the left bank, which drains the lake through which the portage to Lac des Iles passes; they are sandstones and soft red and greenish-grey slates, with soapy feel and with limestone bands, two inches in thickness, interstratified. The same slates again appear in a low bluff on the right hand side of the portage, about three-quarters of the way across, dipping S.E.<70°. Section seen along the Boisbouscache.

Lac des Ilets is a small, shallow lake, about two miles and a half in length, and has an average width of a quarter of a mile; the shores are quite low and show no exposures of rock *in situ*. Lac des Iles.

A number of small islands at the narrows, near the head of the lake, are formed of angular blocks of dark grey, hard, siliceous sandstone, which probably occurs in place beneath or near at hand; the nearest exposure of this sandstone seen, however, crops out on the stream (Rivière St. Jean) three-quarters of a mile below the lake, where it dips N.38°W.<65°. A mile below, hard, grey sandstone, composed largely of quartz grains, with some felspar, and with small pieces of black slate, dips N.41°W.<90°; and beds of the same character, but greenish in color and associated with hard, grey slates, crop out on the stream about a third of a mile below, and dip in the reverse direction at a very high angle. A quarter of a mile further down, the same hard sandstones and slates, with hard, very dark grey, splintery shales, dip N.30°W.<85°; these are followed Rivière St. Jean.

about half a mile below, by a repetition of the beds of sandstone seen above, which hold pieces of soft black slate. From this point to within two miles of Lac des Aigles no exposures are seen, then for three-quarters of a mile the stream flows over almost continuous exposures of calcareous sandstone, with white calcite along jointing planes, and calcareous slates with hard, flinty, calcareous bands, half an inch to two inches in thickness. These beds have a general dip, as nearly as could be determined, N.50°W.<80° ; they are, however, very violently twisted and contorted, so that deviations from this general dip are very frequent. The lower quarter of a mile of this long exposure is occupied entirely by the banded slates, which terminate abruptly in a ledge which crosses the river nearly at right angles to its course and forms a fall six feet in height. No exposures appear along the stream from this fall down to the lake, a distance of one mile. A short distance above the fall, boulders of red slate, about eighteen inches in diameter, occur in the bed of the stream, together with larger, well-rounded boulders, perhaps six feet in diameter, of highly calcareous nodular sandstone, with broken bands of limestone, and containing many large corals resembling *Favosites Gothlandicus*.

Fall.

Fossiliferous blocks.

The sandstone of these blocks closely resembles that of the beds of similar character, which make up the mass of Mount Wissick on Lake Temiscouata,* and the blocks themselves are probably derived from the north-eastern end of the ridge of which Mount Wissick forms the south-western termination.

Age of the Boisbouscache River rocks.

Of the strata above described the whole series occurring along the Boisbouscache River is, with little doubt, a continuation and partly a repetition of that observed along the road leading southward from Trois Pistoles station, and the set of beds observed along the Riviere St. Jean, between Lac des Ilets and Lac des Aigles, an extention northward of those which occur along the shores of the northern arm of Lake Temiscouata, and which, as described elsewhere in the present report, underlie the fossiliferous strata of Mt. Wissick. The whole section southerly to the ridge which forms the north-easterly extentation of Mt. Wissick, would thus seem to embrace only rocks of Sillery (Upper Cambrian) age.

Lac des Aigles.

The immediate shores of Lac des Aigles are quite low, and no rock in place was seen on the lake.

Rushes and water lilies grow in profusion around the lake shores, and often extend far out into its waters, which are quite shallow. The stream draining the lake also flows through flat land, and joins the Horton branch of the Tuladi River about half a mile above the junction of that branch and the Squatook branch.

* Geology of Canada, 1863, p. 421.

The Tuladi is a remarkably smooth-flowing river without falls or rapids, with the exception of one small fall just below the first lake and a short rapid above its mouth. Tuladi River.

Fine flats occur at many points along its course, indeed the whole tract of land along the river seems to be of excellent quality. Good land.

The traverse which has been described follows an old Indian route, which once formed one of the main highways of communication between the St. John River and the St. Lawrence. Two of the old camping places on the route, which are now over grown with quite large trees were visited; one of these is situated on a point on the south shore of Lac des Aigles, opposite the mouth of the inlet from Lac des Ilets, and the other is on the left bank of the river at the foot of First Tuladi Lake. The latter place has evidently been a favourite one for the manufacture of flint implements, as the surface over a considerable area is dotted with little piles of flint chips. The material used must have been derived from the drift, as no suitable rock occurs in place in the vicinity. Old Indian route. Flint chips.

The exposures occurring on the lake and at the rapids in the lower part of the river are described in another part of this report.

Lake Temiscouata.

The rocks of Lake Temiscouata have been described in considerable detail, and are given with sections illustrating the relations and probable thickness of the principal beds in the Geology of Canada, 1863, pages 419–425. It is with pleasure that we bear testimony to the general accuracy of these descriptions, which, so far as the lithology of the rocks is concerned, leave little to be desired. A careful review, however, of the admirable but complex section here revealed has enabled us to add very considerably to the lists of organic remains in the beds already known to be fossiliferous, as well as to record their presence in certain portions of the series in which they had not previously been observed; while the exploration of the surrounding country and the comparison of this with districts studied elsewhere, have served to throw new light on points hitherto obscure. The following section is a condensation of that in the Geology of Canada, with such additional information as has been recently obtained. The section begins on the north side of Mount Wissick or Mount Lennox, where the rocks of the Silurian system may be seen to rest unconformably upon those of the "Quebec group":— Lake Temiscouata. Accuracy of section in Geology of Canada, 1863. Condensed section of Mt. Wissick beds.

Greenish grey and black slates, alternating in thin bands, two to three inches wide, with grey or buff weathering dolomitic limestones. These beds occur on the north-east side of a small cove above Mt.

Condensed section of Mt. Wissick beds.

Wissick, and are a part of a similar series of rocks, supposed to be of the same age as those of Point Levis which occupy all the upper part of the lake. They have been subjected to much crumpling, and exhibit considerable irregularity of inclination, their dip, where nearest to the Silurian, being N.40°W.<70°-80°. They have as yet yielded no fossils, and their thickness is unknown.

Measures concealed for about half a mile.

Grey quartzose sandstone, containing white quartz pebbles, mingled with fragments of limestone in a greenish sandy matrix. These grits or conglomerates apparently occupy a space across the measures of about 1,000 feet, and with a dip of S.65°E.<40° would give a thickness of.....642 feet.

White sandstone or quartzite in massive beds. These rocks are grey within, but weather almost snow white, with vitreous surfaces, often drusy with small quartz crystals. Some portions are pinkish or reddish, and others spotted with small red dots. Their thickness, as given in the Geology of Canada, is only 40 feet, but they were found to have a surface breadth of 250 paces, which, with an average dip of 50°, would give a thickness of.....420 feet.

Coarse, shaly and rubbly conglomerate, holding limestone pebbles (with some quartz). They dip S.60°E.<70°, and have a breadth of 60 paces, corresponding to a thickness of.....114 feet.

Dark grey sandstones. Dip S.70°E.<20°. Thickness about....10 feet.

Grey calcareous shales, filled with bands, nodules and lenticular masses of limestone, abounding in fossils. Among these are the following:—*Favosites Gothlandicus*, Lamarck; *Chaetetes* sp. or *Dendropora*; *Zaphrentis* sp.; Crinoidal fragments; *Chonetes*; *Strophodonta varistriata*, Conrad; *Rhynchonella nucleolata*, Hall, *R.* sp. indt.; *Atrypa reticularis*, *L.*; *Meristella* or *Merista*, very abundant, and including three species, *M. bella*, Hall, *M. laevis*, Vanuxem, *M. didyma*, Dalman; *Megambonia* sp.; *Grammysia* sp., resembling *G. Acadica*, Billings; *Orthonota*, sp.; *Cucullella* sp.; *Orthoceras*, with large siphuncle on one side, ten septa in the space of seven centimetres, and seven septa to its own diameter; *Cornulites flexuosus*, Hall; *Calymene Blumenbachii*, Brongniart; *Beyrichia tuberculata*, Kloeden, typical examples, and in great abundance; *Proetus?* sp. indt.

These beds are regarded by Mr. Ami, by whom the fossils have been examined and in part collected, as corresponding to the Chat River limestones, equivalent to the upper part of the Chaleur group, and about equivalent to the lower part of the Lower Helderberg formation. Dip S.65°E.<60°. Thickness about.....10 feet.

Red and green shale, in alternating bands, with green argillaceous sandstones. The dip of these beds where they overlie those last mentioned is S.65°E.<15°, their strong slaty cleavage having an underlay of N.65°W.<80°, but in following them along the precipitous face of the mountain, they are found to fold over and exhibit a dip N.40°W.<40°. They are also broken by a fault. Their estimated thickness is.....125 feet.

Condensed section of Mt Wissick beds

Grey nodular limestones, conspicuously divided by vertical joints, which often present curved surfaces and produce an appearance resembling that of fluted columns. These beds rest directly upon the red and green shales, and are probably arched with them, but towards the southern end of the bluff resume their normal dip S.65°E. at an angle of 50°. The columnar limestones, which contain but few fossils, have a thickness of about 10 feet, and are followed by about the same thickness of finely banded massive limestones, having at the top a zone, from one foot to 18 inches thick, filled with branching corals, chiefly *Favosites*—it also holds shells of *Atrypa reticularis* and *Pentamerus*. This is capped by more columnar limestone, the whole having an aggregate thickness of about..... 50 feet.

Grey hard sandstone, with beds of impure limestone, the sandstone containing remains of *Meristellae*,.....30 feet.

Grey nodular limestone, without observed fossils,.....30 feet.

Grey banded limestone, filled with corals and other fossils, including *Favosites Gothlandicus*, Lamarck; *Strophodonta varistriata*, Conrad, in great abundance and forming the typical representative of the zone; *Grammysia*, sp., resembling *G. Canadensis*, Billings; *? Megambonia mytiloidea*; *Euomphalus*, resembling a species obtained by Dr. Ells from the forks of the Scaumenac river; *Leperditia*, a narrow reniform species, having a length two and a half times its breadth; *Alveolites* (?) sp. indt.; *Zaphrentis*, sp. indt.: *Orthis* sp.; *Rhynchonella formosa*, Hall; *R. Wilsoni*, Sowerby; *R. nucleolata ?* Hall or a very closely allied species; *Merista* sp. *? Pterinea* sp.; *Anodontopsis* sp.; *Megambonia* sp.; *Orthonota* sp.; *Leperditia*, sp.; *Beyrichia Kloedeni*, Sowerby or a variety of that species; *Beyrichia* sp. allied to *B. equilatera*, Hall; *Beyrichia*, a third species, elevated and globose, not recognized as a described form; *Calymene*, like *C. Blumenbachii*, Brongniart.

[Mr. Ami considers these fossils also to indicate the horizon of the lower portion of the Lower Helderberg series. The authors were assisted in the collection of the fossils by Mr. Ami and Mr. W. T. H. Reed.]
Thickness about.....30 feet.

Grey arenaceous limestones and sandstones forming the upper portion of Mt. Wissick, but sloping to the level of the lake, with a dip S.70°E. <13°. These higher beds contain comparatively few fossils, among which are the following: A stromatoporoid form; crinoidal fragments, in abundance; *Chonetes*, sp., a rather arcuate form, smaller than *C. Nova-Scotica*, Hall, and larger than *C. tenuistriata*, Hall, resembling somewhat *C. Melonica*, Billings; *Meristella*, sp. Their supposed thickness is about.....500 feet.

The beds may, therefore, be correlated with the Lower Helderberg or with the Ludlow formation of Britain.

Mt. Wissick.

The eminence of Mt. Wissick, including the above section, is situated on the eastern side of Lake Temiscouta, near the angle between the lower and upper portions. On the western side of the lake and opposite the mountain, the only trace of this great series of beds is to be

found in a few outcrops of fossiliferous shale, occurring on and near the Portage road, about a mile northward of the village of Cabano. There is in this village also a considerable mass of white sandstone or quartzite, bearing much resemblance to that at the base of the mountain, but it equally resembles other great masses of rock a few miles to the north, which have been supposed to represent the Sillery formation of the Quebec group. These have a much higher dip than any of the beds of the mountain, and are probably correctly referred to the older series.

White sandstone at Cabano

Between the highest beds of Mt. Wissick and those of Black Point, the first exposure to the south, there is a sufficient interval for 1276 feet of strata with the dip above given (Geology of Canada, page 421). In the rocks of this point, however, and its counterpart, Burnt Point, on the opposite shore of the lake, not only does the character of the beds become greatly altered, but their inclination is greatly increased, the coarse conglomerates of which they are composed now dipping S.50°E. <50°. Notwithstanding the enormous thickness of these conglomerates, by estimate nearly 1,000 feet, they would appear to be quite local, stretching eastward from the lake for a few miles only, and for a still less distance upon its western side, while there is but little to represent them over other portions of the Silurian area. This fact, in connection with others to be presently noticed, favors the idea that these conglomerates with some of the succeeding beds are older than those of Mt. Wissick and that the interval above alluded to marks the course of an upthrow fault. So far as the conglomerates are concerned, we have failed, after repeated search, to find in them any remains by which their age can be determined*. In the soft, grey, slaty and sandy beds which succeed them, we have, however been more fortunate, and have obtained a considerable number of fossils, which appear to indicate that the beds belong to a lower horizon than those of Mt. Wissick. These fossils were collected (by Messrs. Reed and Ami, with the authors) upon the western shore of the lake just above Pointe aux Trembles, and partly from the hard sandstones of the point itself. From the shales were obtained crinoidal columns with shells of *Leptaena transversalis*, Dalman, a *Rhynchonella*, sp. indt. and also an *Orthoceras* of small size.

Black and Burnt Point conglomerates.

Thickness.

Upthrow fault.

Fossils in shales

In the sandstones were found the following species:—

Pointe-aux-Trembles fossils:

POLYPI.

Streptelasma, sp. indt. A rather large or straight form, showing some resemblance to *Petraia rustica* of Billings.

* Fossils are said to have been obtained from the limestone pebbles of these conglomerates many years ago by Mr. Billings, but so far we have failed to find any.

BRACHIOPODA.

Lingula, sp. indt.
Orthis, sp. indt., apparently allied to *O. hybrida*, Sowerby, or *O. elegantula*, Dalman.
Platystrophia biforata, Schlotheim, var. *lynx*., Eich.
Strophomena, sp., of the type of *S. alternata*, Conrad.
Rhynchonella, sp.
Triplesia ? sp.

GASTEROPODA.

Pleurotomaria or *Platyostoma.*
Murchisonia sp., an apparently young shell, with comparatively large body-chamber, and small acute spire.

PTEROPODA.

Hyolithes (*Theca*) *Forbesi*, Sharpe. A specimen which resembles the species found in the Silurian of Arisaig, N.S., and here identified with *H. Forbesi.*

CEPHALOPODA.

Orthoceras, sp. indt.

These fossils suggest the idea that the rocks from which they were obtained are about the age of the Niagara Limestone.

Volcanic activity.

It is important to notice in connection with the Pointe aux Trembles sandstones the evidence which they appear to afford of contemporaneous volcanic activity. This is, perhaps, partly indicated by the colour of the rock, which varies from green to red and purple, but is more clearly seen in the abundance of epidote with which the rock is charged and, in places, its somewhat amygdaloidal aspect. Much of it is a conglomerate rather than a sandstone, the pebbles and paste being much alike in character, and both somewhat porphyritic. The presence of bands of purplish black jasper is also a noticeable feature.

Graptolites.

The rocks above described, in addition to their somewhat conspicuous display on the shore of the lake at Pointe aux Trembles, are also well seen along the course of the Tuladi River, the first mile of this stream being over the green and reddish sandstones, here dipping S.50°E.<75°–80°, while at the Tuladi Falls and in the rapids above, the rocks are the grey, sandy shales and sandstones, with coarse grey grits, holding fragments of black slates and yellowish weathering dolomite, having a pretty uniform dip of S.65°E.<70°. In black splintery shales near the falls graptolitic fragments were found by Mr. Reed, apparently of the genus *Diplograptus.*

Fossils from First Tuladi Lake.

Following the course of the beds the same strata come out upon the shores of the First Tuladi Lake, where they again contain numerous fossils, indicative of their age. The following were obtained from soft, grey shales, forming low ledges along the western shore of the lake, about half a mile above the outlet, and in a position corresponding to that of the fossiliferous beds of Pointe aux Trembles :—

BRACHIOPODA.

Orthis hybrida, Sowerby.
Orthis flabellulum ? var. ?
Spirifera or *Platystrophia*, possibly *P. biforata*, var. *lynx*, Eich.
Strophomena, sp.
Leptaena transversalis, Dalman.
Rhynchonella, sp.
Pentamerus ? sp.
Leptocœlia, sp.

LAMELLIBRANCHIATA.

Modiolopsis orthonota ? Conrad.
Modiolopsis, sp. indt.
Orthonota solenoides ?
Pterinea, sp. indt., showing coarse reticulate surface markings.

GASTEROPODA.

Bucania stigmosa, Hall. Two typical examples.
Murchisonia Conradi, Hall, or a closely allied species.
Murchisonia, sp., like *M. subulata*, Conrad.
Loxonema, sp.
Pleurotomaria cf. *P. Axion*, Hall, with fine cancellated markings on the shells, which are well preserved.
Holopea, type of *H. Harmonia*, Billings, but much smaller.
? *Turbo Octavius*, d'Orbigny, or *T. carinatus*.

TRILOBITA.

Portion of the pleuron of a trilobite.

These fossils probably indicate as low a horizon in the Silurian system as the lower part of the Niagara formation, or perhaps the Clinton.

Annelid trails.

These shales are followed here, as elsewhere, by sandstones corresponding to those at Pointe aux Trembles. They re-appear also on the south-eastern side of the lake, and are here remarkable as containing numerous tracks or trails of some marine animal, probably of an annelid. These tracks resemble those known from the Silurian rocks of Western

Ontario, as *Harlania* or *Arthrophycus*; also, and in a marked degree, those described by Mr. Whiteaves from Gaspé, under the name *Gyrichnites*. As the Lake Tuladi specimens most probably belong to the genus last named, the name of *G. minor* is here suggested for them by Mr. Whiteaves.

Still further east the same sandstones, with the same stratigraphical relations, and the same semi-volcanic aspect, come out upon and cross the main Squatook Lake, forming in addition to an island in the latter the remarkable hay-stack like mountain, known as the Sugar Loaf or Squatook Peak. No fossils were found in the sandstones of the mountain, but at its base, in a position corresponding to that of the shales described on Tuladi Lake, are numerous loose fragments of shale and sandstone, in which fossils are numerous. They are not well preserved, but among them the following have been recognised:— Squatook Peak. Squatook Lake fossils.

Crinoidal fragments.
Zaphrentis, sp. indt.
Favosites.
Halysites catenulatus, L.
Orthis, sp., of the type of *O. hybrida*, Sowerby.
Strophomena, sp.
Leptæna transversalis, Dalman.
Spirifera plicatella, var. *radiata*, Sowerby.
Goniophora, sp.
Straparollus, sp.
? *Holopea*, sp.

These fossils are of about Niagara or Wenlock age.

The series of rocks above described, extending from Pointe aux Trembles up the Tuladi River to Squatook Mountain, though stratigraphically occupying a position which would seem to make them newer than the rocks of Mount Wissick, are thus throughout characterized by a fauna indicative of a lower horizon. We hence regard the Mt. Wissick beds as having been brought to the surface by a fault running just north of and parallel to the conglomerates of Black and Burnt points, which would thus become the true base of the Silurian system. The further fact that the strata of Mount Wissick rest directly upon rocks of the Quebec group, and have a comparatively low inclination, would indicate that this break occurred prior to the deposition of the Mount Wissick beds, and hence that the lower and upper portions of the Silurian system are here unconformable. Compared with the rocks of the Gaspé peninsula, those of Mount Wissick are evidently the representatives of those on the south side of the Shickshock Mountains, on Stratigraphical position. Fault and unconformity.

the Chatte and Matanne rivers, as also of those on Lake Metapedia, the Metis and Rimouski rivers. In this peninsula, as in Mount Wissick, the lower division of the system appears to be wanting.

Probable age of the slates.

The rocks which immediately succeed the Pointe aux Trembles, Tuladi and Squatook sandstones, referred to the Niagara formation, are the dark grey bluish-weathering and more or less calcareous slates which occupy the whole of the southern part of Lake Temiscouata, as well as the Madawaska River and a large section of the St. John, thence extending east and west over a large portion of northern New Brunswick and Aroostook county, Maine. The position of these slates in the Silurian system has not been certainly determined. At no point has their actual contact with the Pointe aux Trembles sandstones been observed, and though appearing to dip off from these, and conformably so (S.65°E.<70°), they are everywhere so extensively crumpled that but little reliance can be placed upon their attitude. Over the greater part of the area covered by them, they seem to be mostly destitute of fossils, and when these do occur, they are usually too few or too poorly preserved to indicate with certainty the exact horizon of the beds which contain them. The general aspect of these fossils, however, as indicated in earlier reports, is that of the Lower Helderberg group, and this and other facts render it probable that they represent the upper and more shaly portion of the Gaspé limestone series, being possibly the deep-water representatives of the latter. The only points where a lower horizon would appear to be indicated are the vicinity of the Siegas (or Shiguash) River, in Victoria county, N.B., and part of the valley of the Aroostook River, in northern Maine. As each of these localities has afforded us some information not obtained by previous authors, and as they have important bearings upon the geology of the whole region in which they occur, we now propose to give some of the results of their recent exploration.

Section in vicinity of Siegas River, Victoria Co., N.B.

Siegas River conglomerate.

In "Geology of Canada, 1863," p. 426, a section in the vicinity of the Siegas River is given, of which the most remarkable feature is the occurrence of a coarse conglomerate, said to bear much resemblance to that of Black Point on Lake Temiscouata. It is, however, very much thinner than the latter, the conglomerate proper not exceeding fifty feet, and is further characterized, in addition to pebbles of limestone, serpentine and jasper, which are in various positions, by what appear to be disjointed portions of limestone layers from half an inch to four inches in thickness and sometimes four feet long, which lie parallel to the stratification and occasionally curve with it. In following the beds

upon their strike these limestone bands or layers increase in number, and, with only thin, shaly partings, finally coalesce, or nearly so, into a bed, about forty feet thick, of tolerably pure limestone, used for burning; in which, however, each layer is still divided by numerous transverse breaks, into separate blocks. In the features thus described they appear to nearly resemble a portion of the Gaspé section, as described and figured on page 392 of the "Geology of Canada." We have been unable to find any fossils in these conglomerates, though they are stated in the work last referred to to contain them. In the examination, however, of the sandstone beds which are associated with and succeed the conglomerates on the south, we have found a fossil resembling the *Zaphrentis* from Squatook Mountain, together with the remains of an *Orthis* and a *Strophomena*, apparently *S. rhomboidalis*, Wilckens. These fossils, together with the character of the sandstones, which are often coarse and more or less vesicular, and nearly resemble those of Pointe-aux-Trembles, render it very probable that they are the equivalents of the latter, and belong to the lower or Niagara portion of the Silurian system. Their dip, like that of the conglomerates, is vertical (S. 40°–45° E. $< 90°$), and their breadth about a furlong. Beyond these are exposures of blue slates, which, at about the same distance, are succeeded by a second set of limestone beds, much like the first but purer, and which are also in a vertical position, with an exposed breadth of 150 feet. To these limestones succeeds the valley of the Siegas, beyond which there are no exposures as far as Grand River. South of Grand River the rocks are again slaty, grey, green and red argillites, with thin hematitic bands; their dip being N. 40° W. $< 80°$.

Fossils from Siegas River.

Upper St. John and Aroostook Section.

With the several sections of the Silurian basin which have now been given, and which lie wholly within the territorial limits of Canada, we may finally compare still another. This section is parallel to but westward of that last described. It crosses parts of Quebec and New Brunswick, and also a considerable portion of northern Maine. Its comparison with those already given is desirable, not only from the peculiar geographical position of a portion of New Brunswick, which is, as it were, dovetailed between Quebec and Maine, but from the further fact that in the county of Aroostook, in Maine, the facilities for the study of the Silurian system are exceptionally good and help to throw much light upon the same system as developed in adjacent parts of Canada.

Upper St. John and Aroostook section.

In passing to the westward from Lake Temiscouata, much difficulty is experienced from the comparatively level character of the country, and the want of exposures, in determining the character of the underlying rocks, or fixing their proper boundaries. It is, however, quite certain that the northern limit of the Silurian system, as given by Mr. Richardson (Report of Progress 1866-69, page 139) is, both on the Temiscouata Road and again on the St. Francis, somewhat out of place. As regards the first named road, the contact line with the Quebec group is both described and mapped as corresponding nearly to the position of the thirty-fourth mile-post in the settlement of St. Louis de Ha! Ha! Not only, however, are the slates at this point Cambro-Silurian rather than Silurian, but for three miles south-eastward of it great reefs of white sandstone and red slates are exposed to view which are unquestionably a part of the former system; the true line of contact is probably not more than a mile northward of the village of Cabano. So on the St. Francis, the limiting line between these two systems is placed at the head of Pohenegamook or Boundary Lake, whereas its true position, as correctly represented in the Geology of Canada (p. 426), is somewhere near and probably below the foot of the lake. The rocks which border Pohenegamook Lake, even to its southern extremity, are certainly those of the Quebec group, so called; but in exploring the adjacent country, the only beds by which the beginning of the Silurian could be determined were certain whitish-weathering sandstones which outcrop on a small brook in the vicinity of Cabano Portage. These appear to be lying at a very low angle and may possibly represent the white sandstones at the base of Mount Wissick, but no trace of any associated limestones or of any fossiliferous strata could be found, and beyond the fact of their being Silurian, little can be said as to their relations. Still further west similar difficulties were met with upon the Big Black and Little Black rivers, except that upon the latter, which is for the most part very tortuous and bordered by low swampy land, what would appear to mark the northern boundary of the Silurian occurs at its junction with its main or north-east branch about fifteen miles from the St. John River. The rocks at this point consist of dark purplish grey to black and somewhat graphitic slates, associated with beds of hard grey grit or sandstone which are in part conglomerates, and hold numerous fragments of black slate. Their dip is S. 60° E. $< 60°$. These are supposed to be of Silurian age, but differ in important respects from any portion of this system elsewhere seen. We were unable to penetrate above this point upon the Little Black for want of water.

Northern limit of the Silurian.

St. Louis de Ha! Ha!

Pohenegamook Lake.

Cabano Portage

Big Black and Little Black River.

To the south of the line above described, the whole country between the lower half of Temiscouata Lake and the Madawaska River upon the

one side, and the valley of the upper St. John on the other, appears to be entirely occupied by slaty strata. The conglomerates of Black Point and the sandstones of Pointe aux Trembles can be traced, for a short distance only, to the westward of the lake, and unless the former be represented by the beds referred to above on the Little Black are wholly wanting to the westward, as are also the limestones of Mount Wissick. The exposures of the slates on the other hand are numerous, especially along the valley of the St. John where they were frequently observed as high as the Seven Islands, eighty-five miles above Edmundston. They present in this distance but very little variation, except that they occasionally include beds of sandstone and have a nearly uniform bluish-black or dark-grey colour, which, by weathering, becomes greenish, or by action of water somewhat reddish in aspect. They are only slightly calcareous but are not unfrequently micaceous, their dark-green colour being apparently the result of finely disseminated chlorite. Owing to their strong slaty cleavage the true dip is not always easily made out, but when this is distinctly discernable it is usually at pretty high angles and sometimes nearly vertical, or with abrupt and intricate plications. Their western limit was not reached on the main St. John, but from such information as we have been able to obtain we think it probable that this limit is not far from, and has the general course of, the International Boundary, crossing the sources of the Big Black River and the north-west branch of the St. John a few miles west of Seven Islands.

Extension westward of Temiscouata rocks.

Seven Islands.

Limit of Silurian on upper St. John.

Aroostook County, Maine.

The area lying to the southward and westward of the St. John River comprising the county of Aroostook, Maine, is, like the adjacent parts of New Brunswick, largely occupied by slates. They cover the whole of the northern part of that county as seen on Fish River to Eagle Lake, and on the Alleguash for fifteen or twenty miles from its mouth and, with the possible exception of Mars Hill, are the only rocks seen along the International boundary as far south as Houlton; but a few miles to the westward these slates are interrupted by several bands which are quite different in character if not in age, and which are of much interest in their bearing upon the geology of New Brunswick and Quebec.

Aroostook section.

The first of these areas is a trough, or series of troughs, having a generally north-east direction and a length of about thirty miles, extending from Long Lake at the extremity of the eastern branch of Fish River, through Second or Mud, Cross, Square or Sedgewick and Eagle Lakes to Nadeau or Upper Lake on the main or south-western branch of the same

Fish River Lakes.

stream. At various points along the shores of these lakes the rocks are dark grey, bluish-weathering slates, not differing from those which elsewhere characterize the Silurian system, but with these occurs also a tolerably well-defined belt, consisting in part of reddish and chocolate brown shales and in part of grey grits and conglomerates, which are more or less fossiliferous and have associated with them beds of impure limestone, some of which abound in organic remains. The best exposures of these limestones are on Square or Sedgewick Lake (near the middle of its western side) where their existence and fossiliferous character was first made known by the officers of the Maine State Survey in 1862. In the following year a valuable paper descriptive of the organic remains found in this locality, was published by Mr. E. Billings, in the Journal of the Portland Society of Natural History. In addition to criticalremarks upon Silurian and Devonian fossils from various parts of Maine, this paper contains figures and identifications of twenty-eight species, fifteen of which were therein described for the first time. As this work was therefore essentially Canadian, and as the only more recent explorations of the locality have been those of the Canadian survey, and as we have been able in our collections not only to recognize all the forms described by Mr. Billings but to add several additional species, including at least two more forms which are new, we think it but right that the complete list of these interesting and often typical remains should be given here.

Square Lake limestone.

Paper by E. Billings.

Fossils from Square Lake.

CATALOGUE OF FOSSILS FROM SQUARE LAKE (LAKE SEDGEWICK) AROOSTOOK COUNTY, MAINE.

ZOOPHYTA.

Zaphrentis, sp. indt.
Favosites Gothlandicus, Lamarck.

POLYZOA.

Fenestella, sp.

BRACHIOPODA.

Pholidops ovata? Hall.
Orthis discus, Hall.
" *eminens?* Hall.
" *strophomenoides*, Hall.
Streptorhynchus perplanum? Conrad.

Fossils from Square Lake.

Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
" *indentata*, Conrad.
Spirifera macropleura, Conrad.
" *perlamellosa*, Hall.
" *modesta?* Hall.
" sp. indt.
Athyris Harpalyce, Billings.
" *Blancha*, Billings.
Meristella laevis, Vanuxem.
Retzia dubia, Billings.
" *Electra*, Billings.
" *formosa*, Hall. (sp.)
" *Hippolyte*, Billing .
Atrypa reticularis, L.
Rhynchonella Mainensis, Billings.
" *bialveata*, Hall.
" allied to *R. Aspasia*, B., and *R. altiplicata*, Hall.
? Rensselæria Portlandica, Billings.

LAMELLIBRANCHIATA.

Pterinea, sp.

GASTEROPODA.

Platyceras ventricosum, Conrad.
" *tenuiliratum*, Hall.
" *dilatatum*, Hall.
" *retrorsum*, Hall.
" *curvirostrum*, Hall.

CEPHALOPODA.

Orthoceras rigidum? Hall.
Oncoceras, sp. indt.

TRILOBITA.

Proetus Junius, Billings.
" *Macrobius?* Billings.
" n. sp.
Bronteus Pompilius, Billings.
Phacops Trajanus, Billings.
Lichas Billingsi, N. sp.
Leperditia, sp.

No other rocks are seen in immediate connection with these limestones on Sedgewick Lake, but on several of the associated lakes and on the intervening "thoroughfares" are beds which cannot be very far removed from them in age. On Long Lake, the most easterly of this chain of depressions, and which is not more than seven miles from the St. John River, the rocks are chiefly slaty, and much the same in character as on the latter stream, but on a small island near its head include also ledges of soft and rubbly dark grey sandstone, from which was obtained the pygidium of a trilobite. These sandstones are believed to mark the eastern extremity of a belt of rocks which extends all the way from Long Lake to Eagle Lake, but which is best seen upon the latter. The exposures at Eagle Lake are in a series of bluffs which form its eastern shore about a mile below the entrance of the "thoroughfare" from Square Lake, and present the following apparently ascending section :—

Long Lake.

Eagle Lake section.

Brownish red shales and conglomerates. The latter are produced by the enclosure in the shales of numerous small rounded pebbles and one very large irregular mass, 10 feet by 4 feet (possibly a lenticular bed), which are themselves conglomerates or coarse grits, containing numerous particles of green, red and black jasper, as well as serpentine, mingled with the remains of shells, corals and crinoids.

Brownish-red conglomerates, similar to the above, but containing less shale, the pebbles mostly small, and with few fossils.

Hard and fine grey buff-weathering sandstone and grits, showing casts of crinoids on weathered surfaces.

Dark-grey sandstones and shales, much contorted and filled with seams of spar, the joint surfaces often somewhat plumbaginous.

Dark-grey slates, holding obscure remains of plants.

Bright red slates and dark rubbly slates.

Dark-grey, bluish-weathering slates, of the ordinary Silurian type.

All of the above beds have a north-westerly dip, and though not forming an absolutely continuous section, appear to be all members of one group. Similar beds are seen at intervals also along the Square Lake thoroughfare and again on that by which Fish River flows from Nadeau Lake near the road to Fort Kent. They are a part of the series which in the Maine reports is described and mapped as Devonian, and the occurrence in the shales of gritty pebbles containing Silurian fossils (*Favosites*, *Alveolites*, *Nematopora*, *Chætetes* and crinoidal stems), would seem to give some support to this conclusion, but as similar grits are interstratified with the shales and also contain similar fossils, it is quite as probable that all are contemporaneous and all Silurian. It may be added that the whole series bears a most marked resemblance to the beds of the Beccaguimic river, in Carleton county, New Brunswick, (described in Report of 1882-84) and which are undoubtedly Silurian.

Maine reports.

About twenty miles to the south of the depression or series of depressions above described, and drained by the east branch of Fish River, is the approximately parallel east and west depression occupied by the Aroostook. The intervening tract is occupied by comparatively high and broken land which, however, is almost completely intersected by the south-westerly or main branch of Fish River, and which thus serves to reveal to some extent the general character of the rocks composing it. These, as seen at different points on the shores of Nadeau Lake, are somewhat various, some consisting of coarse, reddish-grey conglomerates, holding pebbles of grey and red felsite and red jasper, and having a moderately low dip (N. $<$ 30°) while others are hard grey felsitic and dioritic rocks associated with hard greenish-grey and reddish or purplish jaspery slates with a dip N. $<$ 80°.

Aroostook depression.

Nadeau Lake.

It is altogether probable that the former are of the same age as the conglomerates of Long and Eagle Lakes, and like the latter presumably Silurian, but their relations to the crystalline and silicious rocks on which they rest and from which their material has evidently been derived, would seem to indicate that we have here another older and unconformable formation. From somewhat similar facts observed elsewhere, as for instance on the river Alleguash at Churchill Lake, we are disposed to regard these latter as either Cambro-Silurian or possibly even Cambrian. It may, however, eventually turn out that they represent the very lowest portion of the Silurian system, which in southern New Brunswick presents the same silicious and volcanic character, but which has not been elsewhere observed in the more northerly portions of that province. The reference of the conglomerates to the Silurian receives some confirmation from the fact that midway between Nadeau and Portage Lake coarse-grey, gritty limestones, similar to those of Sedgewick Lake, are again met with and like them contain remains of corals, shells and crinoids. Their dip here is S. 50° E. $<$ 60°. Following them, as the stream is ascended, are slaty rocks which are rubbly and filled with concretionary layers, recalling the beds seen at the eastern extremity of Long Lake. No other exposures are seen on this stream as far as Portage Lake.

Rocks older than the Silurian.

Fossiliferous limestones.

Between the head of Portage Lake and the Aroostook River the distance is ten miles. Neither on the lake nor along this portage have we had any opportunity of making extended examinations. It would appear, however, that about the former the rocks are chiefly trappean, forming a portion of an extensive belt of such rocks which is very conspicious about the upper Alleguash lakes (Churchill and Spider lakes) and about the head-waters of the Aroostook. It includes the somewhat prominent chain of the Aroostook mountains and thence extends eastwardly to and beyond Portage Lake on Fish River. Between

Trappean rocks Ashland.

this lake and the Aroostook at Ashland, the rocks are partly slates and partly conglomerates which are better seen in the valley of the first named stream between Ashland and Presquile.

The strata to be first noticed occur in the village of Ashland. Just opposite the hotel, in this village, is a low ridge of limestone, which was at one time quarried for burning, but is now mostly concealed by soil. These beds were described to us as being abundantly fossiliferous and there is little doubt that, like the Square Lake rocks and like other beds to be presently noticed, they are of Lower Helderberg age. Just south of and beneath them, on the road to Masardis, are other ledges of grey buff-weathering sandstone alternating with grey rubbly shales and holding soft crumbling ochreous bands which are filled with crinoid stems and other organic remains. Among the latter, but poorly preserved, are the following :—*? Atrypa reticularis*, L.; *Orthis;* a lamellibranchiate shell, most probably a *Cypricardinia; Eatonia*, sp., and *Spirifera*, sp.

Fossils on Masardis road.

The course of these beds is a little south of west, and in this direction they run towards the Aroostook River, not far from which, and at a distance of three-quarters of a mile from Ashland, the limestones again crop out on the farm of Mrs. Adams. From these beds the following fossils, of Lower Helderberg age, were collected :—

Fossils from Mrs. Adam's farm.

Stromatopora.
Favosites Gothlandicus, Lamarck.
Polypora Psyche? Billings.
Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
Merista arcuata, Hall, (fine specimens.)
Murchisonia, sp.
Loxonema Fitchi, Hall.
Platyceras, sp.

Aroostook River.

These limestones are not exposed in the channel of the Aroostook, but not far from where they should appear, the right bank of the river, three-quarters of a mile above Ashland bridge, shows ledges of grey and flaggy calcareous sandstones, filled with what appear to be carbonized remains of plants. Their dip is W.<80°. The next rocks seen in descending the stream occur about a mile below the bridge and are a continuation of similar beds, better exposed at the Mill on the Big Machias. They are grey slaty sandstones, so calcareous as almost to deserve the name of limestones; associated with them are bedded grey and buff-weathering arenaceous slates, dipping N.80°W.<70°.

Plant remains.

About one mile and a half further down, the shore shows ledges of red, green and grey slates, forming a low arch, with a dip N.30°W., sinking from 45° to 30°. Similar rocks including there beds of grey, calcareous conglomerate cross the Ashland road not far from the village. To these, at a distance of a quarter of a mile, succeed hard grey sandstones, dipping E.<60°, which, with bluish weathering slates, continue to occur at intervals, as far as a point about three miles above Beaver Brook. The only fossils observed in them were crinoids, contained in soft rusty and gritty beds, much like those in Ashland. Half a mile below the last exposure of these sandstones the next rocks are found to be quite different in character, being very coarse conglomerates, filled with large and well-rounded pebbles of metamorphic rocks, including red syenite, grey quartzite, porphyry and amygdaloid, as well as green and black silicious slates and jasper. The beds are massive, and as indicated by finer layers, dip quite regularly S.80°E.<50°. These conglomerates constitute a very striking feature in the geology of northern Maine, being exposed at various points both north-west and south-east of the Aroostook River, while large boulders derived therefrom are thickly strewed over the adjacent country. On the road from Ashland to Castle Hill, and four miles from the former, where they form somewhat prominent ridges, they may be seen to be overlaid by the grey sandstones and grits, now dipping N.<20°, and forming a portion of a low fold.

Red and green slates.

Coarse conglomerates.

On the Aroostook also, the next succeeding beds, about half a mile below the last exposures of the conglomerates, are sandstones, but here their dip is at a still lower angle, being only 5° or 10° in a S.S.E. direction. In the Maine geological reports both the conglomerates and sandstones are represented as being portions of long belts of such rocks crossing the state, and regarded as of Oriskany or Devonian age. Both the character of the rocks, however, and their organic remains would seem to indicate that their true position is very much lower, and that they are the probable equivalents of the Pointe aux Trembles and Tuladi rocks of the Temiscouata section, or of those of the Seigas River, described above. The sandstones possess the same vesicular or amygdaloidal aspect, are similarly marked by the occurrence of numerous small fragments of black slate, with others of serpentine, and contain, in addition to carbonized vegetable remains, shells which appear to indicate a horizon about that of the Niagara formation. Among these are the following :—

Strata described in Maine reports as Devonian, probably Silurian.

Impression of a coral, resembling *Favosites*.
Impression of a Bryozoon, probably *Callopora*.
Orthis, sp.

Fossils from Aroostook River.

Streptorhynchus subplanm.? Conrad.
Strophomena rhomboidalis, Wilckens.
Spirifera, sp., like *S. radiata*, Sowerby.
Atrypa reticularis, L.
Rhynchonella, sp.
Cornulites, like *C. Clintoni*, Hall.

Beaver Brook to Salmon Brook.

On the great bend of the Aroostook below Beaver Brook, both the conglomerates and sandstones reappear at intervals for a mile or two, their low inclination (from 16° to 30°) and varying direction of dip indicating a succession of low folds. These are still more conspicuously seen in the slaty rocks which then succeed and border the river for the greater part of the distance to Salmon Brook in Washburne. These slates are mostly dark bluish grey, but often have a pale greenish cast, which is heightened by weathering. They include thin layers of grey sandstone, and in places also thin layers of dark-blue compact limestone. These are especially noticeable as presenting precisely the same peculiarity as that already noted in the case of the limestones on the Siegas in New Brunswick, viz., that of their being transversely broken into distinct and separate blocks, as if by a series of vibrations, and leave little doubt that they are a continuation of the same beds. The green and red slates are similarly an extension of those noted on the south side of Grand River, N.B. For much of the distance the folds are so broad and low as to be almost flat, but at times there is an abrupt transition from these to plications of a much steeper and more complicated character. Near the Salmon Brook the slates contain, as first noticed by Dr. Chas. T. Jackson, beds of slaty hematite, another feature in which they resemble those of Grand River, as well as those of Jacksontown, near Woodstock. It is highly probable that, with the latter, they are the representatives of the Clinton group of the New York system.

Limestones of peculiar structure.

Slaty hematite.

Intrusive syenite.

Between the mouth of Salmon Brook in Washburne and the town of Presquile, the banks of the Aroostook, which here flows south-easterly, are mostly occupied by intervales, the only exposure seen being of syenitic rock, undoubtedly intrusive. Between Presquile and the confluence of the Aroostook with the St. John, in which distance the stream does little more than double back upon itself, the exposures are also very few, except in the last four or five miles, where, as fully described in former reports, they consist of highly disturbed calcareous slates, intersected by numerous dykes of trap. On the south of Presquile, however, along the Houlton and other roads leading in that direction, beds are soon met with, which indicate that the silicious and volcanic rocks, already described, to the northward of the Aroostook

Volcanic rocks.

Valley, here come again to the surface, and again break the continuity of the Silurian tract. They are best seen along the road leading through Mapleton, where, after passing a belt of bright red sandstones and conglomerates, which are believed to be of Lower Carboniferous age, and which rest unconformably upon the Silurian slates, we find these latter succeeded, four miles from Presquile, first by a series of grey sandstones, which are more or less vescicular (and which are better seen in the village of Spragueville), and then by grey ochreous rocks, which are both porphyritic and amygdaloidal. The most striking exhibition, however, of these last-named rocks is that to be seen, twelve miles from Presquile, in and around what is known as the Haystack Mountain. This singular eminence, rising abruptly, and on one side almost precipitously, from a comparatively flat country, and constituting a very conspicuous landmark, is itself essentially composed of a pale liver-grey, white-weathering felsite, which is more or less porphyritic; but around its base are heavy beds in which these felsites alternate with coarse amygdaloidal and ash-like rocks, in places carrying considerable quantities of chlorite and jasper. Not far from the mountain there are also exposures of very black and fine-grained flinty slates, but we have had no opportunity of ascertaining their relations or of further investigating this interesting country.

Lower Carboniferous.

Haystack Mtn.

Felsite.

Comparison of the Silurian System of Southern with that of Northern New Brunswick and Quebec.

In the several Reports of Progress for the years 1870-76 inclusive, details of the distribution and distinctive features of the Silurian system, as developed in the southern counties of New Brunswick, have been given by one of the present authors, in connection with Messrs. Ells and Matthew. As these features present many interesting points, both of resemblance and of contrast, with those of the region described in the earlier pages of the present report, it has been thought that a brief comparison of the two and a statement of some of the conclusions thereby suggested would not be devoid of value. It may be added that a further interest has been given to the subject by the observations of Prof. N. S. Shaler, made in 1884, on behalf of the United States Geological Survey, in and about Passamaquoddy and Cobscook Bays, and published in the form of a preliminary notice, in the American Journal of Science, July, 1886. In the following remarks we shall have occasion to refer to some of the conclusions therein arrived at.

Previous reports.

Prof. Shaler on Cobscook Bay rocks.

Among the several localities in Southern New Brunswick characterized by the occurrence of Silurian rocks, there are two in which, from the completeness of the exposures, they may be most advantageously

Typical localities.

studied, and which may hence be regarded as typical. These are the shore of Mascareen peninsula, forming a portion of the eastern side of Passamaquoddy Bay, in Charlotte county, and the southern part of Queen's county. The sequence of strata in each of these, and their parallelism, as explained in the reports referred to above, is given in the following comparative table:—

Sequence of Silurian Strata in Southern New Brunswick.

Comparative table of Silurian strata.

I.—Mascareen Peninsula.		II.—Southern Queen's County.	
Div.	Ft.	Div.	Ft.
I. Grey felspathic slates, about..	400	I. Grey and dark grey slates...	400
II. Grey and black banded silicious slates, with nodular layers.....	620	II. Dark grey and black silicious clay slates, distinctly banded.....	600
III. Grey flaggy sandstones, with some conglomerate. Shells of *Lingula*, *Modiolopsis* and *Loxonema ?* with comminuted vegetable matter.....	350	III. Dark grey and greenish grey (sometimes purplish) sandstones, becoming slaty above.....	600
IV. Red and green slates and sandstones, with diorites and felsites.....	300	IV. Ash grey and greenish grey schistose beds, dioritic and amygdaloidal.....	300
V. Dark grey and reddish porphyritic felsites.....	300?	V. Grey and dark grey, sometimes reddish, porphyritic felsites, with chlorite schist and breccia conglomerate. Thickness 800 feet or more.	

Since the publication of the reports upon which these tables are based, much more numerous collections of fossils from certain of the strata have been made, both in New Brunswick and Maine. As a list of those found in New Brunswick has not yet appeared in the reports of the survey it may appropriately be given here. For the Maine lists reference must be made to the preliminary Report of Prof. Shaler, cited above.

The following fossils have been obtained from Back Bay, in Charlotte county, in beds supposed to be those of Division I. The list is based upon collections made partly by Mr. T. C. Weston in 1869, and partly upon others made subsequently (1884) by L. W. and J. W. Bailey, G. F. Matthew and others.

Back Bay fossils.

List of Fossils from Back Bay, Charlotte County, N.B.

Heliolites, sp. indt.
Obolus Davidsoni ? Salter.
Orthis hybrida, Sowerby.
Orthis uberis, Billings.

Orthis, sp. indt.
Streptorhynchus subplanum, Conrad.
Strophodonta indentata? Conrad.
Strophodonta punctulifera, Conrad.
Strophomena rhomboidalis, Wilckens.
Leptaena transversalis, Dalman.
Spirifera crispa, Hisinger.
Spirifera radiata, Sowerby.
Atrypa reticularis, L.
Rhynchonella, allied to *R. cuneata*, Dalman.
Pterinea, sp. indt.
Euomphalus? with *opercula* associated.
Proetus, sp. indt.
Encrinurus punctatus, Wahlenberg.
Dalmanites limulurus, Green.

Age of Back Bay rocks.

In Pal. Fossils, Vol. III., Part 1 (1884), Mr. Whiteaves expresses the opinion that the Back Bay rocks are possibly of about the same age as the Guelph limestones of Ontario.

Shackford's Head fossils.

The fossils collected by Prof. Shaler are chiefly from Shackford's Head and other points about Cobscook Bay, some of which, with their fossiliferous character, were described in the New Brunswick report for 1871*. From the lists given, which, however, are stated to be incomplete, the horizons represented would appear to include the Lower Helderberg group, as well as the Niagara and Clinton, while in southern New Brunswick the former would seem to be nearly, if not wholly absent. Another recent discovery of much interest in connection with the Silurian system of southern New Brunswick is the finding, by Mr. G. F. Matthew, of the remains of pteraspidian fishes, in banded shales, referred to Div. II. of the Mascareen section, near the Nerepis Hills in King's County. (Can. Rec. Science, Vol. II., No. 4, Oct. 1886., and American Journ. Science.) The fish-bearing beds are regarded by Mr. Matthew as being at least as old as the Lower Ludlow, and probably of about the same age as those holding the *Palaeaspis* of Prof. Claypole.

Discovery of pteraspidian fishes in King's county.

Equivalency of rocks in Northern and Southern N.B.

If now we compare these rocks of southern New Brunswick with those described in the northern part of the same province, and in Quebec and Maine, it will appear that neither in the Gaspé peninsula nor along the south shore of the St. Lawrence have we anything which, either in lithological features or in its contained fossils will correspond to Divisions I. and II. of the first named district, although such equivalency is perhaps to be found in Divisions II. and III. of the

*Geol. Survey of Canada, Report of Progress, 1870-71.

Anticosti group. If, however, the structure which we have described on Lake Temiscouata be the true one, the counterpart of these beds is perhaps to be found in the conglomerates and succeeding slates, more or less silicious, which occur between Black Point and Pointe aux Trembles, and of which the fossils indicate a low zone in the Silurian system. In northern Maine silicious and felspathic slates have also been described as rising from beneath the Silurian rocks on the Alleguash and Fish rivers, as well as south of Presquile, but these are much finer-grained and more nearly resemble some of the beds which, upon the Beccaguimic River in Carleton county, N.B., have been found to contain a Cambro-Silurian fauna. It is interesting also to notice that in northern Maine, as in southern New Brunswick, there are, in association with undoubted Silurian rocks, extensive beds which may be a portion of the same system, altered by contact metamorphism. The most noticeable of these are fine-grained micaceous and gneissic sandstones, with some interbedded slates, which are found on the shores of Umsaskis Lake of the Alleguash River, and which, alike in their texture, in their peculiar purplish or lilac colour, and in the abundance of what are probably imperfectly formed crystals of staurolite, bear the closest possible resemblance to strata found in various parts of New Brunswick, as on the St. Croix River in Charlotte county and in portions of York county. (See Geol. Survey Reports, 1871, 1882-4.)

Contact metamorphism.

In these latter instances the alteration is evidently connected with the proximity of great masses of intrusive granite; and so, in northern Maine, not far from the micaceous and gneissic strata are found extensive tracts of what is also evidently intrusive rock, here consisting, however, chiefly of a rather fine white-weathering quartz-porphyry, which in some places becomes granitoid, and in others epidotic and amygdaloidal. Too little, however, is known of the relations of these beds to enable us at present to speak with any confidence as to their true position.

Intrusive quartz-porphyry.

Division III. of southern New Brunswick, as indicated by its organic remains, may be regarded as the equivalent of the Niagara formation, and consists chiefly of sandstones of grey, greenish and purplish colours. Their equivalents in the north would evidently seem to be found in the rocks of Pointe aux Trembles and the Tuladi River on Lake Temiscouata, the very similar beds of the Siegas River, New Brunswick, and those of the Aroostook Valley, in Maine, the similarity being marked both in their lithological characters and in their contained fossils. In accordance with this view, the underlying conglomerates of Burnt and Black Points, together with the shales which immediately succeed them, may not improbably be regarded as representing the Oneida, Medina and Clinton groups.

Age of Division III.

Age of Black and Burnt Point rocks.

The remaining groups of the Silurian system in southern New Brunswick are remarkable for the abundance and variety of volcanic or semi-volcanic material which they contain, such material being quite noticeable in Division IV., but reaching its maximum in Division V. A further peculiarity characterizing these higher beds is that of their low inclination as compared with the groups below them, and which appear to indicate extensive physical movements as accompanying, and perhaps determining, the igneous outflows which there originated. This latter feature is also paralleled at the north, where, if the views advanced as to the structure on Lake Temiscouata are correct, a similar want of conformity and difference of attitude exists in the two divisions of the Silurian system as there represented. But while in southern New Brunswick these movements would seem to have left the areas affected for the most part above the sea level, the higher members of the system being but slightly represented, if at all; in northern New Brunswick and in Quebec they were followed by a subsidence which, over very extensive areas, led to the origination of marine sediments, including thick beds of coral-bearing limestones,—the lower or calcareous portion of the Gaspé series—and which continued to or beyond the close of the Silurian era. It may be added, that in the red and green shales which underlie the limestones at the base of Mount Wissick, in the somewhat similar beds found about the Fish River lakes, and on the Aroostook River, in Maine, and again near the Grand River and the Beccaguimic River, in New Brunswick, we have what are probably the equivalents of Division IV. of the Mascareen and Nerepis sections; while in such rocks as the felsites and dolomites of the Haystack Mountain, in Maine, that of Moose Mountain, in Carleton county, N.B., or, still better, in the similar rocks so conspicuously developed about the Bay Chaleur, we may likewise have the equivalents of Division V.

Volcanic material in Div. IV. and V.

Unconformity in the Silurian.

The following table, by comparison with those given on page 48 M will serve to make the above relationships more intelligible:—

Supposed Sequence of Silurian Strata in Northern New Brunswick, Quebec and Maine.

Sequence of Silurian strata.

Divs. I. and II.—Grey argillaceous and silicious slates, including (locally) heavy beds of conglomerate. Fossils somewhat numerous in upper part, including shells and graptolites, indicating a low Silurian horizon.

Conglomerates and succeeding slates of Black and Burnt Points, on Lake Temiscouata; felspathic and silicious slates of Fish River and Alleguash River, Aroostook county, Me.? Conglomerates and graptolitic slates of Beccaguimic River, Carleton

Sequence of Silurian strata.

county, N.B. Supposed to be equivalent to the Medina and Clinton groups of New York, Divs. 2 and 3 of Anticosti group, or groups B and B′ of Arisaig.

Division III. A.—Grey flaggy and massive sandstones, with some conglomerate, becoming frequently greenish or purplish, and more or less amygdaloidal. Fossils rather numerous, including corals and shells, as well as worm-tracks and comminuted remains of plants.

Sandstones and conglomerates of Pointe aux Trembles, Tuladi and Squatook Rivers, Quebec; similar beds of Siegas River, New Brunswick; sandstones and conglomerates of Aroostook county, Me.; similar beds of Beccaguimic River and other parts of Carleton county, N.B.

Niagara formation, or Wenlock group.

B.—Lower sandstones, shales and limestones of the Gaspé peninsula. Similar sandstones and limestones of the head waters of the Chatte and Matane rivers, Metapedia Lake, Metis and Rimouski rivers, and lower part of Mount Wissick. Fossils numerous, marine.

Supposed to be equivalent to the Guelph formation of Ontario.

Divs. IV. and V.—Red and green shales of Cape Gaspé; red and green slates and sandstones of Mount Wissick; similar slates on Fish River (Eagle Lake) and Aroostook River, Maine; red and green slates of Grand River and Carleton county, N.B.; often including argillaceous iron ores. ? Felsites and associated trappean rocks of Campbellton and Bay Chaleur, Moose Mountain, New Brunswick, Haystack and Spider Lake, Maine.

Division VI.—Grey, often nodular or columnar limestones, abounding in fossils.

Upper limestones of Cape Gaspé; middle and upper rocks of Mount Wissick, regarded as equivalents of the lower portion of the Lower Helderberg.

Fossiliferous limestones of Square Lake and Ashland, Me.; Lower Helderberg.

Fossiliferous limestones of Carleton county, N.B.

Fossiliferous slates and sandstones of Metapedia River, Restigouche, Victoria, Madawaska and Carleton counties, N.B. Similar slates, etc., of Aroostook county, Me. Lower Helderberg?

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE

SURFACE GEOLOGY

OF

NORTH-EASTERN NEW BRUNSWICK

TO ACCOMPANY QUARTER-SHEET MAPS 2 N.E. AND 6 S.W.

BY

R. CHALMERS.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., ETC.,
Director of the Geological and Natural History Survey of Canada.

SIR,—Herewith I beg to submit to you my report on the surface geology of the district embraced in the two quarter-sheet maps, 2 N. E., and 6 S. W., north-eastern New Brunswick, being the result of a detailed examination of it made during the season of 1886. These sheets, coloured to show the character and distribution of the surface deposits, will accompany this report.

My grateful acknowledgments are due to K. F. Burns, M.P., W. J. O'Brien, Collector of Customs and W. H. Chisholm, Superintendent of the Caraquette Railway, Bathurst; also to Chas. E. Fish and Dr. A. C. Smith, Newcastle, for information and various acts of kindness. The late G. A. Blair, Chatham, and Miss Andrews, Bathurst, likewise kindly furnished me with lists of barometric readings taken at the meteorological stations under their charge.

I have the honour to be,
Sir,
Your obedient servant,
R. CHALMERS.

OTTAWA, April, 1887.

REPORT

ON THE

SURFACE GEOLOGY

OF

NORTH-EASTERN NEW BRUNSWICK,

To Accompany Quarter-sheet Maps 2 N.E. and 6 S.W.

Area explored.

The detailed investigations of the surface geology of New Brunswick were continued during the past season (1886) and the areas embraced in the two quarter-sheet maps, 2 N.E. and 6 S.W, adjoining the district examined during the previous season, were explored as carefully as time and circumstances would permit. These areas include the country on both sides of Miramichi Bay as far east as Shippegan and Miscou islands on the north, and Point Escuminac and Point Sapin on the south; also the chief part of the district drained by the North-West Miramichi River and its affluents, and by the Nepisiguit River. A large portion of this region is still forest-clad however, and consequently the present description, so far as it relates to topography and surface geology in the interior, is only of a general character. The chief points elucidated by the season's investigations are of much interest, both as regards the glaciation and the distribution of the surface deposits, and the results are confirmatory of previous observations made in this and contiguous areas, as will be shown in the sequel. Reference will here be made to the main facts noted:—Chief among these is the existence of pre-glacial or pre-quaternary rock debris, or gravels and sands, occupying considerable tracts, especially upon the Pre-Cambrian and Middle Carboniferous areas. The distribution of this débris and gravel is very difficult to trace, as they are usually masked by later deposits; but they appear, so far as they have been observed, to be thickest in the coastal districts and thin out irregularly towards the limits of the Carboniferous rocks to the west, re-appearing however, in the unglaciated areas of the interior, upon the Cambro-Silurian and Pre-Cambrian belts. The relations of these materials to the rocks underneath, as well as to the overlying surface deposits, have been carefully

Summary of main facts noted.

noted wherever exposures occurred, and a description of them will be given further on. Another subject of consideration was the enormous quantities of boulders strewn over all parts of the area under discussion, apparently derived from the more crystalline portions of the Cambro-Silurian and Pre-Cambrian rocks referred to. The absence of marine terraces in all places higher than the 150 to 175 feet contour line above sea level, indicating that the early Post-Tertiary subsidence did not exceed that limit, also afforded a question for study. Not less important perhaps, was the investigation with reference to the extensive peat bogs and sand dunes occurring here. The great development of the former near the coast, especially on Miscou and Shippegan islands, at the mouth of Tabusintac River, and at Point Cheval and Point Escuminac was noted ; and the extensive accumulations of blown sand skirting the shores, forming beaches, islands, etc., also came under review. These peat bogs and dunes are still in process of formation. The intervals and terraces along rivers, which on the North-West Miramichi and its tributaries have a considerable breadth, were likewise examined and their peculiar features investigated. Aneroid measurements of the heights were made at all accessible points, and surface contours, generally, carefully observed. The limits of the forest-covered tracts and of those portions overrun by fires, especially the great Miramichi fire of 1825, were traced ont approximately and mapped. The old Indian camping grounds at Tabusintac and Derby were also visited and a few relics found. Special attention was given to the character of the soil and its relation to the underlying rock formations. Details regarding each of the above topics will be found in the following pages.

Topographic Features.

Chief topographic features.

The chief topographic features of the region under examination were given in report G G (Annual Report, 1885), and are comparatively simple when viewed in their general aspect. They consist of a highland region in the west, underlaid by the Pre-Cambrian and Cambro-Silurian rocks, and a level, or gently sloping plain in the east occupied by Carboniferous sediments. Minor irregularities diversify the surface of the central and eastern portions of the district however, many of which, as for example, that part of the low valley of the main South-West Miramichi River included in the map, the valley of the North-West Miramichi from Red bank to Portage River, and that of the North-West Millstream, etc., extend transversely to the main slope. The larger river valleys are all of pre-glacial origin. Where they pass through Carboniferous rocks these valleys are comparatively shallow, having been largely filled with fluviatile and marine deposits. During

the later Tertiary period, the region stood at a higher level than at present; for there is evidence that at the confluence of the North-West and South-West Miramichi rivers they flowed along channel bottoms then which are upwards of 100 feet below the existing sea level now, (see p. 14 GG Annual Report, 1885). The upper portion of the main North-West Miramichi and of its chief affluents, and also the Nepisiguit have all cut deep trenches into the older rocks, and produced some remarkable topographic features in the area drained by them. The tract of country occupied by the Pre-Cambrian here is high and rugged, the general level above the sea being not less than 1200 to 1400 feet. Mountains loom up on every hand, 1500 to 2000 feet high,* with valleys between them extending in all directions. In these lie numerous small lakes. Viewing the country from some crowning peak, it has an extremely mammillated appearance, and may be said to resemble a sea of hills. Much of it having been denuded of its forest-covering by fires, and presenting only bare, boulder-strewn acclivities and peaks, its sterile features are thus brought prominently into relief. So varied and irregular, indeed, are these that no adequate description of their countless diversities of form can be given. The original table land, if such it ever was, has been intersected in every direction by valleys of erosion. No traces of glaciation were observed, apparently all the excavating and sculpturing which fashioned these ancient hills having been effected by subærial disintegration. In the valleys and on some of the slopes of this Pre-Cambrian area, especially along the Nepisignit, the original forest still remains, but fires and the lumberman's axe are every year making further encroachments on it.

Evidence regarding elevation of region in later Tertiary period.

General elevation and description of Pre-Cambrian area.

Non-glaciated character.

The areas occupied by Cambro-Silurian rocks are of somewhat less elevation than the Pre-Cambrian, and have by no means as rugged a surface, being rolling and the hills having long sweeping outlines. In the vicinity of the Nepisiguit, and, indeed, in the whole region between that river and the Little South-West Miramichi the general elevation of the Cambro-Silurian, especially of that portion lying between the two Pre-Cambrian belts, is 900 to 1000 feet, with occasional summits rising to 1500 feet. The south-western band of these rocks bordering the Carbonifirous area is, however, much lower and less rugged, and contains many tracts of good land. (For a graphic description of this interior region, see Dr. Ells' report (Report of Progress 1879-80).

Description and height of Cambro-Silurian belts.

In the Carboniferous area the surface does not anywhere rise higher than 500 or 600 feet above the sea, and the larger portion included in the maps only from 150 to 200 feet (see 200 feet contour line). This tract has likewise been subjected to prolonged denudation. Wide,

General features and elevation of Carboniferous area.

* The elevations are all above sea-level, unless otherwise stated.

low, east-and-west valleys are characteristic features, especially in the area between the Baie des Chaleurs and Miramichi, and undoubtedly owe their origin to subaerial and glacial erosion. Most of these are traversed and drained by the rivers and streams of the district. In the areas between river valleys and also about the heads of the small streams, where the drainage is insufficient, shallow peat bogs are of common occurrence.

Rivers and Lakes.

Character and age of principal rivers.

The two principal rivers of the district, viz., the Nepisiguit and North-West Miramichi exhibit somewhat different features. The latter has numerous branches ramifying to the west and north, and drains, in proportion to its size, a much larger area than the Nepisiguit. Its wide, drift-filled valley in the lower part, and its silted up estuary (see Annual Report, 1885, p. 14 G G) afford evidence of its being the older of the two. It is probably of pre-Carboniferous date. The Little South-West, its chief affluent, and the swiftest river in northern New Brunswick, appears, from the large quantities of drift material occupying its valley, to have been at one time a larger river than the main North-West. A noticeable feature of the North-West Miramichi, probably due to peculiarities in the mode of drainage, is its wide shallow channel, especially in that part of its course traversing the eastern belt of the Cambro-Silurian and the Carboniferous rocks. The region around the head-waters of this river being mountainous, and largely denuded of forest, the snow every spring is more rapidly melted there than farther down where it passes through a forest-clad tract. Hence floods from the upper part of the river are precipitated into the lower reaches, widening the channel, and often overflowing the flats bordering it. Summer and autumn floods act similarly when they occur, as they occasionally do, the rainfall of the region about the head waters of the river being then likewise more rapidly drained off. Hence large quantities of detritus from above are deposited along the lower part of the river's course, where the country is comparatively low and flat, partially filling its channel, and causing the waters to spread and erode the banks and intervales bordering it.

Singular features of N. W. Miramichi.

These peculiarities in the North-West Miramichi seem to be the result of the disappearance of the forest in the region about its head waters. During the melting of each winter's snow, or during other floods, it thus rises above the normal height and soon runs out, so to speak, very little of the precipitation being held in the lakes and tributaries there as a reserve supply. The summer level of this river is consequently very low, considerably lower I am informed now than previous to the devastation of the forests.

In reference to the Nepisiguit, the observations of the past season appear to confirm the conclusions arrived at in report G G (Annual Report, 1885), viz., that in the lower part of its course, *i.e.*, from the Narrows downwards, its present channel is of modern date, regarded from a geological point of view, and may have been formed chiefly in the Post-Tertiary period. Nepisiguit probably of Post-Tertiary age in lower part.

The other rivers of the district exhibit no features requiring special mention, except, perhaps, Napan and Black rivers, which have valleys widely and deeply filled with marine deposits capped with alluviums. During the emergence of the land from the early Post-Tertiary subsidence, the waters of the main South-West Miramichi must have partly flowed out in this direction carrying sediment and probably boulders thither, as much of the material constituting the surface deposits here seems to have been derived from the region drained by that river. The finer material has, however, been partially remodelled since by the sea.

Classification of the Surface Deposits.

The following deposits were met with in the district included in the quarter-sheets 2 N E, and 6 S W. the series being in descending order: Classification of deposits.

M 3

Alluviums, or Recent Deposits.

Fresh-water. (*a*)	*Marine.* (*b*)
1 Decayed vegetable matter, or vegetable mould,	1 Estuarine flats,
2 Peat bogs,	2 Salt marshes,
3 Lacustrine and fluviatile marshes,	3 Sand dunes,
4 River flats (intervales)	

M 2

Stratified Sands, Gravels and Clays.

(*a*)	(*b*)
1 River terraces and kames of river valleys.	1 Saxicava sand and Leda clay
2 Stratified inland gravel, sand and clay.	

M 1

Glacial Deposits.

1 Boulder-clay or till, boulders and erratic blocks.

Pre-glacial.

1 Rock-debris *in situ* (gravel, sand, etc.)

Pre-Glacial Rock Debris, Gravels, Etc.

Pre-glacial rock debris, &c., character and mode of occurrence of.

Among the more remarkable phenomena characterizing the surface deposits of the district are beds of rotted rock *in situ*, chiefly in the form of gravel and sand. These are most abundant in the tracts bordering the Gulf shores, but are found also on the higher grounds of the interior. The materials consist of gravel, containing pebbles and boulders wholly of local rock, and occasionally beds of sand, and are unstratified except where they have not been sufficiently decomposed to obliterate the stratification of the original rock. They rest upon the surface of the unabraded rock beneath, which is generally uneven and covered with fragments of the underlying strata in process of decay. Usually these gravels do not exceed a foot or two in thickness, often less; but sometimes they are five feet or more. They are, however, for the most part overlain by stratified deposits of subærial or aqueous origin. The included pebbles and angular debris are largest and most numerous in the bottom and become smaller and more intermixed with gravel and sand towards the surface, *i.e.*, have apparently undergone greater decomposition, the further they are from the solid rock beneath. In some of the sections examined near the coast the rock surface had a sort of mammillated appearance, showing that the corroding action had penetrated more deeply in some spots than in others. No foreign boulders exist among this debris or gravel, those which occur being angular and lying longitudinally parallel to the rock strata beneath, even when embedded in loose material, thus showing that they are really portions of the original rock *in situ* not yet decomposed. Indeed, in every instance they were found to belong to the underlying rocks. The following sections will illustrate the actual position of these gravels in the series and their relation to the other deposits, especially on the coastal area.*

1. On the main post road between Chatham and Richibucto, about two miles south of Black River bridge, a section of the surface beds is exposed in a gravel pit. The series is as follows in descending order:—

Sections showing relations to other dedosits.

1. Loamy material, partly composed of decayed vegetable matter with lenticular seams of whitish or greyish sands in the bottom ..... 3 to 6 inches

* Sir J. W. Dawson recognized thick beds of decayed rock at Les Eboulements (Notes on the Post-Pliocene Geology of Canada, *Can. Naturalist*, 1872). Dr. G. M. Dawson has observed beds of quartzite shingle in the Bow and Belly River country which appear to be pre-glacial (Report of Progress, 1882-83-84). R. G. M'Connell also describes deposits under the name of the "South Saskatchewan gravels," which are probably of similar origin (Annual Report, 1885). Pumpelly, Hunt, Whitney, Winchell and others have directed attention to similar beds in different parts of the United States, and Darwin, Selwyn and Hartt have referred to them as occurring in Brazil. In Europe like phenomena have been observed; and in Australia Dr. Selwyn recognized the subaerial decay of the rocks there, and noted the absence of lakes in non-glaciated regions.

2. Gravel and sand, unstratified, containing flat, angular pieces of rock embedded therein, apparently *in situ*. 1 ft. 6 inches
3. Rotted rock, with loose pieces of the underlying sandstone in their natural situation, but with a little gravel and sand in the interstices..... 4 to 5 feet
4. Grey sandstone showing still less decomposition and apparently passing into the usual stratified or bedded Middle Carboniferous rocks beneath..... 1 to 2 "

The height of these beds above sea level is about 80 feet.

2. Behind the village of Nelson, on the road leading to the back settlements, the following series appears in a cutting:—

1. Stratified sand and gravel..... 12 to 15 inches
2. Boulder-clay, chiefly gravel, but with sufficient clay to cause it to bake hard on exposure..... 6 to 12 "
3. Decomposed or rotted rock, chiefly gravel, unstratified, the fragments of rock 1 to 3 inches long and mostly *in situ*..... 12 to 18 "
4. Grey sandstone (Middle Carboniferous), crumbling and decaying, *in situ*.

Height of these beds about 100 feet above the sea.

3. At Nepisiguit bridge, near the town of Bathurst, another section of these deposits exhibits the following series (descending):—

1. Sandy or gravelly soil, loamy in places, containing pebbles of foreign as well as of local rocks..... 3 to 6 inches
2. Stratified gravel, including pebbles and boulders. Among these are travelled boulders, 1 to 2 feet in diameter, glaciated. Bulk of material, however, belonging to local rocks..... 12 to 15 "
3. Till, or debris of local rocks, which appears to have been shifted and acted upon by ice. It contains angular pebbles and boulders apparently transported some distance. Pieces of the Lower Carboniferous (underlying) rock, 3 to 9 inches in length, lie under and also enclosed in the lower part of the till with more or less gravel and clay in the interstices..... 2 to 3 feet
4. Decomposing Lower Carboniferous rocks *in situ*.

Evidently the ice of the glacial period, in its eastward passage over the surface of the Middle Carboniferous area here, thinned out and was not of sufficient thickness or weight to displace or remove the whole of the pre-existing decayed rock material. The loose shales or pieces of rotted rock underneath what appears to be boulder-clay are one to two feet deep in places, below which they become more solid, *i.e.*, contain less gravel and sand in the interstices, until they gradually change into the usual Carboniferous rock of the district.

M I. Glacial Deposits.

Boulder-Clay or Till.

Boulder-clay. Boulder-clay is abundant in river valleys and on slopes in the interior of this district, but is seldom met with near the coast. The North-West Miramichi valley, from where the Intercolonial Railway crosses it, up as far as Portage River and probably further, is lined almost continuously on both sides with till, and it was also seen on the slopes of the minor valleys in numerous localities. Apart from its occurrence in these, however, it does not anywhere form an unbroken sheet, usually appearing in lenticular masses. In a number of places it rests upon pre-glacial rock-debris, as shown in the foregoing sections, and is almost invariably overlain by stratified deposits. It is evident also that till in considerable quantities was thrown into the river valleys and depressions during or at the close of the ice age, partly filling them and producing changes in the drainage. This partial blocking up of the water courses held up the waters of even the larger rivers in many places, especially those of the North-West Miramichi and its affluents, to a height of 80 to 100 feet above their present level. In the vicinity of Redbank a drift-dam of this kind existed in the Post-Tertiary period, causing the formation of terraces which will be described on a following page.

Whence derived. In all cases, the till, wherever observed, seems to be largely derived from pre-existing rotted rock belonging chiefly to the underlying formations in each particular locality, but somewhat changed in mechanical consistency and appearance by glacial action. In certain places upon the Carboniferous area this change was seen to be only partially effected, and the flat pebbles and pieces of sandstone or slabs were sometimes only partly turned over or disturbed, while the intermixed clay had, in its bluish-grey, unoxidized aspect, every resemblance to boulder-clay.

Localities where observed A few of the more noteworthy localities where till was observed may here be specified.

On Miscou Island, on the north-east side of Miscou harbour, and on the east side of Shippegan Island till occurs. It is overlain in both places by Leda clay and Saxicava sand. If the till here is dueto land ice, the land has probably been as high, if not higher, than at present when it was laid down. A slight subsidence would submerge these islands, scarcely any part of them at present rising more than 25 to 30 feet above sea level. This till is constituted chiefly of boulders and debris of local rocks.

Hospital and Sheldrake islands, in Miramichi estuary, are largely covered with till.

A bed of till occurs at the mouth of Black River, also another on the west side of the mouth of Bay du Vin River. These contain glaciated boulders.

Boulders striated while held in upper portion of till.

On the road leading from Upper Chatham to Napan River, and on the main Chatham and Richibucto road just south of Black River bridge, also on the road going through the back settlements from Nelson to Barnaby River station, till was seen in several places with glaciated boulders embedded in its upper part. Some of these boulders seem to have been striated while in their present position by ice which moved over them from west to east. They lie longitudinally in this direction with the upper glaciated side sloping gently to the west as in Fig. 1. Pre-glacial debris was observed to underlie them in two of these places.*

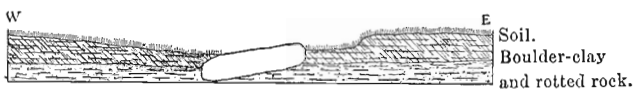


FIG. 1. SECTION SHOWING POSITION OF STRIATED BOULDERS IN DRIFT.

Till is found in the South-West Miramichi valley in numerous places within the limits of the map. Heavy banks, chiefly of till, occur near Derby Junction and at the confluence of the South-West and North-West rivers, rising above the general level of the valley, (referred to on page 28 G G, Annual Report, 1885).

At the mouth of North-West Millstream, till, partly filling the valley of that tributary, was seen resting on glaciated rock surfaces (see List of Striæ No. 7).

Till was observed in several places along the road leading up the south side of the Little South-West Miramichi; and just above Redbank to the east of the main North-West a bed of till, abundantly intermixed with boulders, was seen.

Remarks on striated boulders.

In reference to the glaciated boulders embedded in the upper part of the till or pre-existing rock debris, referred to above, the question arises were their upper surfaces really striated while they were held in their present position by the enveloping material (boulder-clay, gravel, etc.) as the ice passed over the district. The parallelism of the striæ upon them with those on the rock surface of the district in which they occur, as also the attitude of the boulders themselves with respect to the abrading agent, tends to support this view, rendering it probable that the phenomena are similar to those described by Mr. Hugh Miller as observed in Scotland. There is abundant evidence in the presence of

* Phenomena of this kind were first observed in Canada by Sir J. W. Dawson, see The Post-Pliocene Geology of Canada, *Canadian Naturalist*, 1872.

striæ on rocks *in situ* and till and other transported boulders from the interior that ice passed over the country here from west to east; but it would seem that even when the glaciers had attained their maximum thickness they must have thinned out on the particular district where these boulders were thus left, and perhaps disappeared altogether before reaching the present coast line, except in the valleys. Pre-glacial debris of subaerial origin occurs in sheets under them in most places where sections are exposed, affording proof that the ice cannot have been thick or of great weight. It seems reasonable to infer, therefore, that the ice moved over the surface of the decayed rock material, eroding and displacing only its upper part, striating the rocks where they were nearest the surface or most exposed, and also the upper surface of these boulders at the same time.

Boulders and Erratic Blocks.

Boulders and erratics whence derived.

Boulders, derived from the Cambro-Silurian and Pre-Cambrian rocks of the interior, consisting chiefly of granite, gneiss, felsite, trap, etc., from five feet in diameter downwards, are found profusely scattered over the surface of the whole Middle Carboniferous area and also embedded in the deposits. Associated therewith, and in certain places largely predominating in numbers, occur others derived from the underlying rocks. Upon the surface of the Pre-Carboniferous rocks of the interior, boulders are likewise strewn in immense profusion, and bear evidence, so far as observations have extended, of having, in some places, been transported limited distances from the parent rocks to the west.

How transported.

Near the coast, especially below the 200 feet contour line, the present distribution of boulders seems to have been effected by floating and shore ice, etc., as well as by glaciers. A greater number of those properly called erratics are seen upon the surface here, and apparently they have been subjected to greater wear, being, as a rule, more rounded and with the striæ in most instances defaced. Planed sides are still however, characteristic features of these. Sparingly interspersed among them are a few which seem not to belong to this district, and the parent rock of which is unknown. These are always found on or near the present shores.

Greater abundance on north side of Miramichi estuary.

Boulders of crystalline rocks seem to be more abundant on the southern than on the northern side of the Miramichi estuary. The cause of this is difficult to explain, but it is probably due, in part at least, to the fact that during the Post-Tertiary submergence, river and coast ice carrying boulders would be more likely to be driven against the shores of the southern side of Miramichi Bay by the prevailing north-east and north-west winds than in any other direction, and thus deposit them.

Along the shore to the east of Escuminac Point, granite boulders three to five feet in diameter were seen on the top of the peat bog and sand beaches there. They appear to have been recently pushed up by the impact of coast ice, or, perhaps, thrown up by the waves during heavy storms. Boulders on top of peat.

Glacial Striæ.

The following striæ were observed during the past summer in the areas mapped. The courses are referred to the true meridian and the elevations to sea level. List of striæ.

No.	LOCALITIES.	COURSES.	GENERAL SLOPE OF SURFACE.	APPROXIMATE HEIGHT.
	GASPE PENINSULA, QUE.			
1	On a ridge at Newport, half a mile from the shore, occur glaciated rocks, but no distinct striæ. Stoss-side to the N.W.	S.E.	S.E.	165
2	Along main road east of bye-road leading to Point Maquereau Light House. Striæ (These are on the eastern slope of a ridge running out to form Point Maquereau).	S. 85° E.	S.E.	250
	GLOUCESTER COUNTY, N.B.			
3	At E. Smith's, Middle River settlement. Striæ	N. 46° E.	E.	250
	NORTHUMBERLAND COUNTY, N.B.			
4	Behind Nelson village, on second concession lots. Striæ	S. 83° E.	E.	150
5	Behind Upper Chatham, about half way between the Miramichi and Napan rivers. Striæ (These correspond with the striæ noted at Beaver Brook station, Intercolonial Railway, and at Rogersville station; also with those seen in the valley of the South-West Miramichi at Indiantown (see report G G, p. 22, Annual Report, 1885, Striæ Nos. 64 and 66).	S. 83° E.	E.	125
6	At North-West Millstream, near bridge on road along main river. Striæ, covered with a thick bed of till..... (These striæ agree in direction with others at the head of this stream, (Nos. 60 and 61, report G G just cited,) and show that a small local glacier moved down the North-West Millstream valley, debouching into the estuary of the main North-West).	S. 22° W.	S.	25

General Conclusions respecting Glaciation, Boulder Distribution, Etc.

The conclusions deducible from the foregoing facts may be briefly stated as follows:—

General glaciation of district.

1. The ice of the glacial period moved from the west down the main slope of the district towards the Gulf of St. Lawrence, carrying large quantities of debris from the Cambro-Silurian and Pre-Cambrian rocks of the interior and strewing it over the whole surface, as pointed out in report GG (Annual Report, 1885). The glacier or glaciers were guided in their movements by the more prominent topographical features and especially by the river valleys, but thinned out or finally disappeared before reaching the present coast line, no evidence being afforded that they debouched into the sea anywhere, except, perhaps, in estuaries. And the undisturbed pre-glacial debris met with on the low coastal tracts shows either that the ice did not reach these, except in a very thin sheet passing very lightly over them, or that these tracts were submerged during the greatest extension of the ice. The boulder-clay overlying the pre-glacial debris and the striated boulders over which the ice has apparently moved, may also be cited as proofs of its diminished power and weight when moving over this particular district.

Secondary systems of glaciers.

2. A minor or secondary system of local glaciers followed the smaller valleys at a later stage, as indicated by the striæ and till found along the North-West Millstream (see List of Striæ, No. 6). The glacier producing these seems to have flowed into the open estuary of the North-West Miramichi. To render this possible it is evident that the land must have then stood at a somewhat lower level than at present, and the estuary referred to would consequently be wider. Glaciers of this kind probably belonged to the close of the glacial period and may have been contemporaneous with the deposition of the Leda clay.

Boulder distribution.

3. The distribution of boulders near the coast, especially below the 175 feet contour line, is the result of two causes which may thus be stated:—First, these boulders, or the majority of them, were carried down to the coastal area, more especially along the valleys, by glaciers and river ice during or at the close of the ice age. On the submergence of this coastal tract, coast and floating ice acted upon these and the till, the sea washing away more or less of the finer and lighter materials, leaving the boulders exposed. These were then rolled about or carried hither and thither by pan or shore ice. Erratics from foreign parts may occasionally have been landed on these shores by the same agencies. Other causes no doubt supervened, but these will serve to explain the occurrence and anomalous distribution of so many boulders from the interior on the surface near the coast.

M 2. Stratified Sands, Gravels and Clays.

Stratified Inland Gravel, Sand and Clay (fresh-water).

General description of inland stratified deposits.

Deposits of this kind are of considerable thickness above the 200 feet contour line, more especially upon the Lower and Middle Carboniferous and Cambro-Silurian rocks. Those overlying the former constitute an almost unbroken sheet, the general characteristics and composition of which have been given in previous reports. The whole series covering the surface in the district is, in descending order, essentially as follows:

1. A thin, somewhat irregular layer of loam, or more generally decayed vegetable matter, together with more or less material formed from subaerial erosion. Underneath this, or constituting a portion of the same stratum, especially upon the surface of the Middle Carboniferous area, occur lenticular seams of fine-grained grey or white sands. The peculiar character and colour of these sands are probably due to the deoxidation of the iron in them through the chemical action of the rain-water and the decayed vegetable matter overlying them.* Cultivation, by mixing these sands with the soil or subsoil, causes them to disappear. Land shells are sometimes found in the layer of vegetable matter. A fuller description of this deposit will be given in the sequel, under the head of *Vegetable Mould.*

2. Stratified sand, gravel and clay of varied thickness, the clay usually forming the lowest member and often in lenticular sheets. The pebbles in the gravel are almost always of local rock, although along river valleys they have been transported considerable distances. The colour of these sands and gravels, and of the upper portion of the clay also, is generally of a brownish or yellowish tint, due to the oxidation and hydration of the original materials. The lower limit of the weathered zone is often sharply defined in the clay beds.

3. Boulder-clay or till in patches on hillsides and in valleys, the distribution being irregular and the thickness variable. It includes travelled boulders from the west and south-west.

4. Pre-glacial debris, or gravels and sands. These occur irregularly upon the higher grounds of the interior, thinning out to mere loose pebbly beds, as observed in the tract about the head-waters of the North-West Miramichi.

* "The organic matter carried down by the rain-water reduces the iron salt from a peroxide to a protoxide, which the free carbonic acid present converts into a carbonate: and this salt being soluble is removed by the same surface waters, leaving the upper part of the sand or gravel colourless or often white. Or, it may sometimes be that the humic acid in the soil removes the iron as a soluble humate." "When the humous acids can freely attack the hydrated peroxide of iron they remove it in solution and the decomposed rock or soil is thereby bleached. This is common where pine trees grow on ferruginous sand."—(Prestwich's Geology, Vol. 1, p. 143.) (Geikie's Text-book of Geology, p. 438.) (For further information on the geological action of the humus acids upon sands, gravels, etc., see paper by A. A. Julien, Proc. Am. Association for the Advancement of Science, 1879, pp. 339-350.)

How derived.

The origin of these inland fresh-water deposits was briefly discussed in preceding reports. They appear to be derived in the first place from the decomposed materials of the underlying or subjacent rocks. Afterwards, glacial erosion, river and atmospheric action, combined with that of an organic nature, have produced such changes in them, more especially in the uppermost portion, as to partially stratify them, and give them their present character and composition.

River Terraces and Kames of River Valleys.

River terraces.

River terraces of varied width are developed along the North-West Miramichi and Nepisiguit rivers, and, indeed, skirt all the streams of any size in the district. Their general features and relation to the rivers which they accompany have been discussed in former reports. Along the streams traversing the low flat Carboniferous area, none worthy of note were observed; but as we pass up the river valleys into the older series of rocks they become more noticeable. The localities and elevations of a few of the principal ones met with along the North-West Miramichi and Nepisiguit rivers may here be mentioned. The heights given have reference to the rivers at the nearest point.

Commencing with the Nepisiguit we find:—

Heights and localities where they occur.

1. At Middle Landing Narrows a terrace on the north bank 45 to 50 feet high, or 95 feet above sea level.

2. At Grand Falls a wide one occurs also on the north side 60 to 70 feet higher than the river above the falls, or about 315 feet above the sea. It is composed of water-worn gravel and sand with a covering of loam.

3. Just above the mouth of Nine Mile Brook a terrace lies on the north bank 50 to 65 feet high. It has probably been formed by a damming of the river at the Narrows five miles below, the intervening valley having then been a post-glacial lake into which the gravels, etc., composing the terrace were thrown.

4. Near Taylor's Brook there is a long terrace, or high narrow intervale on the north side of the river 6 to 10 feet above it.

Other terraces occur at numerous places, especially wherever the banks jut out opposite re-entrant angles or bends of the river, but most of them are narrow and irregular. Viewing them correlatively, however, they indicate that the Nepisiguit flowed 50 to 75 feet above its present bed in early post-glacial times.

The North-West Miramichi, and more especially its tributary the Little South-West, exhibits a number of beautiful terraces, some of which may here be briefly described.

5. On the south side of the main North-West, in the triangular tract opposite the mouths of Portage and Tomogonops rivers, wide terraces border the valley above the 200 feet contour line. Their height above the river is 50 feet and upwards. The materials are, however, all detrital. A capping of loam upon them forms good soil.

6. High terraces, probably of marine or estuarine formation, skirt the Little South-West as far up as the head of the settlement, 12 miles from its mouth. At the latter point the river bed is 150 to 175 feet above sea level, and many of the terraces are 50 to 75 feet higher. Further up they become less conspicuous, but are, nevertheless, above the usual height of the terraces found along other rivers in northern New Brunswick. They are all composed of very coarse, well-worn material, the result, no doubt, of erosion from the rapid flow of this river, the descent in the lower part of its course alone being not less than 10 feet per mile, further up being much greater.

Remarkable erosion and terraces at Square Forks.

A remarkable illustration of the post-glacial erosion effected by rivers and accompanied by the formation of terraces may be seen at the Square Forks of the Big Sevogle. The two main branches of this river here unite in a rocky gorge about 30 feet deep, which is almost in a straight line. At right angles to this the river runs off below through another rocky gorge somewhat as shown in the diagram (Fig. 2.)

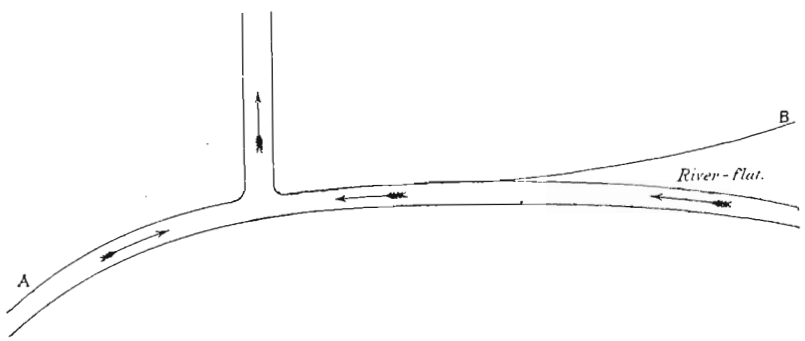


FIG. 2. PLAN SHOWING PORTIONS OF ROCK GORGES AT CONFLUENCE OF THE TWO BRANCHES OF BIG SEVOGLE RIVER.

The two branches of the Sevogle have either met at a different point and had a different pre-glacial channel from their confluence downward, or existed as separate streams. From the point B in Fig. 2 down to the present confluence of the river with the North-West there is a wide, terraced valley (see map) strewn with water-worn gravel, which may have been its former course. A damming of this pre-glacial valley at B by drift during the ice age would probably cause the excavation of the gorge below the Forks.

Kames.

River-valley kames are but poorly developed in this region. Small ones were noted in several places however, and a marked one at the confluence of the Little South-West and main river. It appears to be the residual portion of a terrace eroded on both sides by these two rivers.

Leda Clay and Saxicava Sand (marine).

Leda clay and Saxicava sand, mode of occurrence of.

The Leda clay is rather poorly represented in the district under consideration, the detrital material resulting from the erosion of the Carboniferous sandstones being chiefly in the form of sand and gravel. In consequence of this, marine fossils are rarely found in the surface deposits here. The Saxicava sand is very widely distributed and of considerable thickness in the areas skirting the coasts and river estuaries. From the elevation of the terraces composed of it (marine terraces) in the Miramichi valley the extent of the earliest Post-Tertiary subsidence can be approximately estimated. A few of the more noteworthy of these may be described. The elevations are in all cases above sea-level :—

Terraces occur on both sides of the mouth of Little South-West Miramichi River at a height of 85 feet above sea level. They cover an area of several square miles, and are composed chiefly of Saxicava sand. No fossils.

At the confluence of the Big Sevogle and main North-West River a terrace 118 feet high was observed. It appears to be entirely formed of sand and gravel.

One to two miles up Big Sevogle River another was seen on the south side, 160 to 170 feet high, which is also composed of sand and gravel and without fossils.

Opposite the mouth of Portage River a terrace skirts the main North-West on the south side; height 150 feet.

On the road leading from Chatham to Richibucto, near upper Bay du Vin P O., terraces appear at heights of 120 and 140 feet.

A number of others were noted which it seems unnecessary here to enumerate. Co-ordinating all the facts relating to the marine terraces they show a Post-Tertiary subsidence of 165 to 175 feet in this district.

Sections showing character of materials.

To illustrate still further the composition of the terraces about the mouths of rivers, and in estuaries, as well as the general character of the deposits below the 175 to 200 feet contour line, the following sections will here be given. One examined behind Nelson village is described under the head of PRE-GLACIAL GRAVELS, ETC. Another exposed at Tracadie River is as follows, in descending order :—

1. Gravel and sand, with a few pebbles of local rocks. When these are flat and uniform they lie with their longest axes in a horizontal position Thickness.... 15 to 18 inches.
2. Grey sandy clay..... 1 to 3 "
3. Sand and clay in irregular, alternating bands: clay seams 1 to 6 inches thick. Whole thickness..... 1 to 2 feet.
4. Clay and sand, clay predominating; seams regular... 2 to 3 "
5. Sandy band, with a few thin strata of clay. Total thickness not known. Exposed in bottom of pit..... 3 "

The clay in this section is of a reddish-grey colour, and in all cases sandy, *i.e.*, nearly a loam. Both sand and clay are invariably free from pebbles. From their situation with respect to the Tracadie River these deposits are undoubtedly estuarine, although deriving the materials largely from the river. No fossils were found in them.

Near Caraquette the succession was also found to be as follows in descending order:—

1. Gravel, coarse and angular, and packed with sandstone pebbles and small boulders, also mostly angular, and lying with their longest axes in a horizontal position, the whole irregularly stratified and resembling rotted rock *in situ*. Thickness variable..... 1 to 3 or 4 feet.
2. Sand, fine and without pebbles or gravel and comparatively loose. Thickness likewise variable ..... 1 to 3 "
3. Clay, sand and gravel, forming a hard-pan, containing fragments of the underlying rock but little removed from their original position. Thickness variable.
4. Rubbly, broken up, decomposing rock.

General succession of marine deposits.

The succession of these deposits as observed in a great number of sections below the 200 feet contour line is closely similar to the above, and may be generally stated as follows, in descending order: (1) Gravel mixed with sand, overlain in uncleared and uncultivated ground by vegetable mould; (2) sand of varied consistency with clayey, or mixed sandy and clayey strata; (3) clay, with sandy seams, and (4) rotted rock *in situ*, or boulder-clay. On the slopes near the coast between the mouths of rivers, where little or no detrital material from these was deposited, the series consists of (1) loam, or decayed vegetable matter, under which are sand, gravel and occasionally clay; (2) boulder clay, but this member usually absent, and (3) pre-glacial debris, or gravel resting on decomposing Middle Carboniferous sandstones. As already stated, very little pure clay occurs in the stratified portion of these beds, owing no doubt to the arenaceous character of the rocks from which they are derived.

As a rule the thickness of these deposits does not exceed five to ten feet, often less, and the surface is always even. The stratified sands, gravels and clay have been pretty fully described in preceding reports.

M 3. Fresh-water Alluviums.

River-flats, or Intervales.

Intervales.

Along the main North-West Miramichi River and its affluent the Little South-West flats of considerable extent occur and form fine tracts of farming land. Between Redbank and Portage River large portions of these are cleared and cultivated, yielding hay in abundance. Nearly all the adjacent terraces are, however, still forest-clad.

The intervales along the Nepisiguit and other rivers of the district are narrow and of little value in an agricultural point of view. No clearings of any consequence have been made upon them.

In regard to the mode of origin and character of these intervales it may be remarked that the detailed descriptions of similar deposits given in preceding reports apply equally well to those observed in this district, and, therefore, it is unnecessary to dwell further on them.

Lacustrine and Fluviatile Marshes.

Fresh-water marshes.

Many of the small lakes of the interior are bordered by marshy tracts consisting of boggy or peaty matter, but of such limited width that they cannot be shown on the maps. Similar marshy selvages skirt the rivers in places where the flow is sluggish and permits the deposition of the finer particles of matter held in suspension by the waters. These marshes are usually covered with a dense growth of ericaceous plants, rushes, carices, marsh grasses, etc., and form retreats for the aquatic fur-bearing animals.

Peat Bogs.

Peat bogs, where formed.

Formations of this kind are extensively developed near the coast of the Gulf of St. Lawrence, especially on Miscou and Shippegan islands and near the mouth of Tabusintac River; also at Point Cheval and Point Escuminac. In these localities they seem to owe their growth to the peculiar climatic conditions of the region bordering the Gulf. The proximity of the ocean modifies the extreme summer heat prevailing inland, rendering the air moister and more favourable to the continued existence of mosses and other plants peculiar to these deposits. In the interior there are also numerous peat bogs upon the Lower and Middle Carboniferous areas, but they are generally thin and of smaller extent. Usually the latter are found to occupy shallow lake basins which are bordered, and occasionally wholly covered, with a scrubby growth of hacmatac and black spruce. A remarkable feature of the bogs near the coast is the great number of small ponds dotting their surfaces. These ponds have perpendicular sides of peat, and vary

Favorable conditions for their growth.

in size from a few square yards to a quarter of an acre or more. Their mode of origin is not apparent, but it is probably due to the continuous growth of mosses, etc., around little pools which occupied a former surface, the pools preventing the growth of mosses underneath them, while around them the height continued to increase year after year. For the most part these peat bogs are treeless, but are covered with plants belonging chiefly to the following species,—rose-bay, Labrador tea, two species of vaccinium, the huckle-berry, leather-leaf, andromeda, and along the shores overhanging the drier banks, the crowberry, etc. Brief descriptions of the largest of these bogs will now be given.

Ponds in peat bogs, how originating.

Descriptions and localities.

1. The principal peat bog in the district occurs on Miscou Island and covers fully half of its entire area. It occupies a shallow basin in the Middle Carboniferous rocks here, portions of the rim of which, as well as of the sand and peat, are being eroded by the sea. The surface of the bog is 15 to 20 feet above high tide level in the centre, while the bottom, which is full of the roots of shrubs and small trees *in situ.*, seems to be below that of the lowest tides and wherever visible appears to rest on gravel and sand. The bog, as already mentioned, is dotted all over with ponds, which form favourite resting places for the wild geese and brant in their passage over the region every spring and fall. Cranberries abound on it.

Miscou bog.

2. A peat bog about three miles long and one and a half wide was seen on the eastern side of Shippegan Island, which also rests on a hard-pan of gravel and clay. The surface is 10 to 15 feet above the sea and is likewise destitute of trees. Numerous ponds were also observed on it. In the bank the peat is 10 feet thick, the bottom descending below high tide level.

Shippegan.

3. The neck of land between St. Simon inlet and Pokemouche harbour (see map) is formed of peat. Similarly to the two beds just described it is considerably higher in the central part than at the margin, but nowhere is more than 10 to 15 feet above high tide level. A part of this bog is on sheet 3 S E. Immense quantities of cranberries grow upon it.

St. Simon.

4. South of Tracadie River, near Point Barreau, (see map) a peat bog borders a lake, both being surrounded by a tamarac swamp.

Tracadie.

5. An extensive bog occurs on the west side of Tabusintac River; length about three miles, width two miles. Its general features are the same as those described. It is also a favourite resort for wild geese, brant, etc., every spring and autumn.

Tabusintac.

6. On the east side of Point Cheval a bog was also seen which thins out on the northern margin over an old sand beach. The following section of the beds, in descending series, may be instructive:—

Point Cheval.

1. Peat, dark brown in colour, containing a few roots of small trees and shrubs and abundant remains of mosses, 5 to 7 feet.
2. Dark, almost black peat, filled with stems, roots and rootlets of small birch, cedar and hacmatac trees, and heath plants. Numerous stumps of trees *in situ* occur in the bottom of the peat, and the roots penetrate, or more generally spread out over, the underlying sand. Some of these stumps are a foot in diameter..... 2 to 3 "
3. Pure, fine-grained sand, rusty and dark in upper part, into which the roots referred to sometimes penetrate a few inches. Apparently continuous with and forming part of present beach, but must be older, as it descends below sea level in places. A sharp line of demarkation between this and last member of the series. Drift-wood and sticks three to six inches in diameter appear to have been strewn over the old beach before it became covered with peat.

The surface of this bog is 10 to 15 feet above high tide level, and the bottom of the central part, so far as could be observed, sinks below the lowest ebb tides.

Point Escuminac.

7. Another large and interesting peat deposit was found at Point Escuminac (see map), referred to in Dr. Ells' report (Report of Progress, 1879-80). It is highest in the middle and likewise dotted over with numerous small ponds. From the examination made around its margin it seems to occupy a basin also, the central part of which is below high tide level. This gives it a thickness of 20 feet or upwards. Mr. Philips, light-house keeper, Point Escuminac, informed me that he found it 24 feet deep in one place. Like those already described it is almost treeless, but covered with heath plants. A section of the peat and underlying beds, taken near the Light-House, is as follows, the series being descending :—

1. Peat ... . 7 to 8 feet.
2. Sand, coarse and gravelly, chiefly derived from the underlying gravel, but with more or less beach sand and foreign pebbles ; the whole partially stratified..... 6 to 9 inches.
3. Gravel *in situ*, derived wholly from underlying sandstones or shales. Thickness variable.
4. Grey, Middle Carboniferous sandstones or shales.

Burnt log in peat.

Among the numerous stumps, trunks of trees and sticks in the bottom layers of the peat, or between divisions 1 and 2, a log partially burnt was observed. It is part of the trunk of a spruce tree, and has been split and shattered before it was thrown up here by the sea. About seven feet of it project out of the bottom of the peat. Three spots on one side were charred and hollowed out slightly by fire. The stumps and roots in the peat bottom around it are *in situ*.

This burnt stick is similar to many other shattered ones lying upon the existing beaches and seems to have reached its present site before the peat began to grow. Its exposure now is caused by the wearing away of the edge of the peat by the sea. Whether it is any proof of the occupancy of these shores by human beings before the growth of the peat beds, remains to be considered.

Peat beds affording proof of slight subsidence of region since commencement of their growth

A study of all the phenomena connected with these peat beds leads to the conclusion that a slight subsidence must have taken place in this district since the commencement of their growth. The bottom of these deposits seems to be at least 10 to 15 feet below high tide level in some places, and from their proximity to the coast the basins occupied by them, if emptied of peat, would be inundated. were the relative levels of the sea and land the same when the peat began to grow as now. Hence this coast area must have been 10 to 15 feet higher, if not more, with respect to the sea then. Moreover, the fact that the bottom of these peat bogs, wherever exposed, is invariably found to contain stumps of trees *in situ* of species now growing in swampy tracts near the coast, at a height of 10 to 25 feet above sea level, corroborates the same view. On the other hand the sand beaches now covered by peat around the borders of the basins enclosing it, upon which logs, sticks, stumps, etc., have apparently been strewn by the tides before the peat grew on them, indicate that the change of level cannot have been much greater than that stated above.*

These bogs appear to be still increasing in height and breadth. The sea has, however, broken through the barriers of sand and earth which enclosed the peat basins originally, exposing their margins in certain places to its erosive action. Elsewhere they are protected by sand banks recently formed. Their economic value will be referred to further on.

Vegetable Mould, or Decayed Vegetable Matter.

Vegetable mould, how formed.

Upon the surface of the forest-clad areas and also on newly-cleared lands, a layer of material occurs often two inches or more in thickness, consisting largely of dead leaves, rotten wood, remains of herbaceous plants, etc., the lower portion of which, at least, is decomposed into humus. This was referred to on a previous page. As the soil undergoes

* There are evidences of one upward and two downward movements of the land in northern New Brunswick during the Post-Tertiary period. First, a subsidence which apparently commenced in the glacial period, the maximum of which was reached about its close or soon afterwards. The land then stood about 200 feet below its present level relatively to the sea. The lower Leda clay appears to have been laid down at this stage. An upward movement followed, during which the upper portion of the Leda clay and the Saxicava sands were deposited, this movement continuing till the land had again risen 10 to 25 feet, or perhaps more, above its existing level with respect to the sea. The peat and marl beds were then formed, and a second slow subsidence began which has probably been in progress until recently.

Causing fertility.

cultivation, this matter becomes disseminated through it and disappears to a large extent. The fertility of newly-cleared lands, especially uplands, depends almost wholly on its presence.* These often yield crops for three years in succession without manure of any kind; but on undergoing cultivation by the plough they deteriorate and without the application of fertilizers, become, in a short time, comparatively valueless. These remarks have reference more particularly to tracts which are underlain by sand and gravel, as wherever clay beds or alluviums occur, the original fertility of the soil is much longer retained. This decayed vegetable matter seems to be more abundant in the soils of river-flats, owing to the quantities carried down by the rivers and deposited thereon from time to time as they were in process of formation. Accordingly these soils contain a considerable proportion of humus. In the interior of the district under consideration most of the hills and mountains are devoid of any organic matter in the scanty soil covering them, and often exhibit only bare rocks or shingly slopes which support a thin dwarfed growth of trees.

M 3. Marine Alluviums.

Sand Dunes.

Sand dunes, why abundant in the district.

Sand dunes are of unusual extent in this district, considering that they are merely marginal deposits. This is no doubt due to the fact that the sandstones of the Middle Carboniferous area, along the coast of which the dunes occur, have, in the process of disintegration, supplied greater quantities of arenaceous material than other rocks. From the immense beds of sand forming islands and beaches, in the Miramichi Bay, it is evident the denudation of the estuarine borders and coast has been enormous. The Miramichi River appears to have been the chief instrument in effecting this, but every stream flowing into this part of the Gulf of St. Lawrence has, no doubt, carried down greater or less quantities of sandy detritus.

Localities where dunes occur.

The character of these sand dunes was described in preceding reports. It will be sufficient therefore to briefly mention the localities of such as are known to occur in the district.

* The existence of this superficial layer has hitherto been overlooked; but in the study of the surface deposits of this district it became evident, from its thickness in many places and its relation to the seams of whitish or greyish sands underneath or associated therewith, that it was necessary to recognize it as a member of the series. In the natural forest-clad condition of the country it forms an almost universal layer, continuous with the peat beds, which indeed may be considered as a thickening of this vegetable layer in particular localities by the additional growth of mosses, etc. For the present therefore it is classed provisionally with the fresh-water alluviums.

At the north point of Miscou Island, and extending half its length on the north-west side, a wide beach occurs, consisting of ridges parallel to the shore line, the surface being five to eight feet above ordinary high tide level (see map). The inner, or first-formed ridges, are now clothed with trees (white spruce, white birch, etc.) Spruces nine inches to a foot in diameter and 20 to 30 feet high are common, becoming smaller and more scattered towards the more recently formed portion of the beach. The ridges are all about the same height, no change of level being indicated during their formation. Walrus bones occur in the oldest of these, although the living animal is not seen in adjacent waters now.*

Dunes skirt the whole eastern coast of Miscou Island, almost closing its harbour on that side, and stretching along the north-east part of Shippegan Island nearly to Pigeon Hill.

At the entrance to Shippegan harbour (east side) sand dunes extend along the shore, and thence nearly to Barreau Point (see map), enclosing Pokemouche and Tracadie lagoons.

All the islands in Miramichi Bay, except Hospital, Sheldrake and Vin are formed of sand. They have each a nucleus of dry gravel or rock *in situ* similar to that of the adjacent mainland, however, around which the sands have collected. Ridges and mounds formed by the winds and waves are characteristic features of these dunes. Their area seems to be increasing, and extensive shoals surround them. Most of these dunes are clothed with a dwarfed growth of trees or shrubbery in the central of nucleal part.

Nuclei of gravel or rock in some dunes.

Salt Marshes.

Salt marshes occur in small patches at Tracadie lagoon, also at Tabusintac, Neguac, etc. The only ones large enough to map were seen on the western side of Point Cheval and at the mouth of Black River, also on the inner side of Vin Island (see map). On all these hay in considerable quantities is annually cut. At the mouth of Dennison's Brook, and inside of Huckleberry lagoon (east side), as well as in other localities, small marshes were also noted. For previous descriptions of salt marshes see reports of 1885 and 1886.

Salt marshes, where found.

* Settlements are said to have been founded here in the 17th century by the French for the purpose of capturing the walrus or sea-cow. Such an exterminating war was waged against this marine animal that it soon became extinct in this part of the Gulf. It is claimed that there may still be seen the ruins of the post of the Royal Company of Miscou, which was founded in 1635 for the prosecution of walrus fishing etc., and for a time derived a great revenue therefrom. The island takes its name from the mission of St. Charles de Miscou, established here at an early date by the Jesuits. For further information see Perley's Reports on the Fisheries of New Brunswick and Hind's Preliminary Report on the Geology of New Brunswick, 1865.

Estuarine Flats.

Estuarine flats, great breadth of.

Estuarine flats occupy areas of greater or less breadth in Miscou and Shippegan harbours and in Pokemouche and Tracadie lagoons. In the mouths of the several rivers debouching into Miramichi Bay, and also among the islands which occupy it, wide expanses of sand, called "sandbars", are either laid bare at ebb tides, or covered only with a few inches of water. These usually support a dense growth of marine plants.

The general character of these formations was discussed in previous reports, and it is therefore unnecessary to go into further details regarding them.

Agricultural Character, Sylva, Etc.

General agricultural character of the district.

The agricultural character of the district under consideration presents no new features, except such as have been incidentally mentioned in previous pages of this report. The soils and subsoils bear, perhaps, a closer relation to the underlying rocks than in the coastal areas of the Baie des Chaleurs basin, and are likewise deeper, usually masking the strata completely everywhere, except on the Pre-Cambrian belts. Even where the surface is strewn with boulders foreign to the particular locality, the great bulk of the deposits belongs to the underlying rocks. The denudation which the region has undergone has carried away much of the finer material from the higher grounds and slopes, however, often leaving only a coarse gravelly or shingly soil. In the valleys there is usually a thick deposit of clay, gravel and loam, and wherever the latter is found, the soil is rich and productive.

Soils upon the Middle and Lower Carboniferous Rocks.

Soil of Carboniferous area above 200 feet contour lines.

The general character of these soils as met with in the Baie des Chaleurs district was described in some detail in my last report (Annual Report, 1886), and the remarks therein respecting them, especially as occurring in eastern Gloucester, are also applicable to those of the district now under discussion. On that part of it above the 200 feet contour line, the soil, more especially on the drier grounds (leaving out of consideration the vegetable layer usually occupying the surface), is a dry stony gravel or sand with an admixture of clay in certain localities. Where the sand and gravel predominate, it is exceedingly porous and light, but where clay prevails it generally has a hardpan underneath, and, if flat, is often wet and swampy. This hardpan, which is almost impervious to water, consists of fine sand and clay, with more

or less gravel intermixed, and is in some places stratified, in others a true till. It is found in flat districts or in low inland valleys where it is often covered only by the vegetable layer referred to on a previous page, which is here thicker than upon the ridges. Where there is sufficient slope to afford good drainage, the clay soils are usually fertile, but as they are wanting in organic and calcareous matter they require frequent applications of fertilizing material to render them productive. The low flat or undulating tracts, however, need, besides this, a proper system of draining. Without it, except in very dry seasons, their productiveness is much less than that of the drier grounds.

Soil of Carboniferous area below 200 feet contour line.

Below the 200 feet contour line the soil is, generally speaking, much superior to that inland. The surface has usually a gentle slope towards the Gulf shores and on this account is better drained, while along many of the river valleys, alluviums prevail. Bay du Vin, Black River and Napan valleys, more especially the latter, contain land of excellent quality, the upper portion of the soil partaking somewhat of a loamy consistency. On the north side of the Miramichi estuary, from Newcastle to Bartibogue, the coarser material of the surface deposits only seems to be left upon the slopes, although immediately bordering the coast there are strips of good land. Further north, between Bartibogue and Tabusintac, the coastal area is generally low and wet, but contains some arable tracts. The back settlements here are, however, located upon good dry soil. Between Tabusintac and Tracadie a wide sandy plain occurs, mostly unsettled, but around the latter place and at St. Isidore, excellent tracts of farming land are found.

Shippegan and Miscou Islands have but few settlers, and these devote most of their time to fishing. The land is low, and most of it poor and wet.

Returning to the Miramichi River, we find many fine tracts of land occupied and in a good state of cultivation upon the Middle and Lower Carboniferous areas along the North-West and South-West branches. The slopes afford good drainage and the soil is deep and capable of being raised to a high state of fertility by judicious and careful tillage.

Improvement of soil.

For the improvement of the soils overlying the Carboniferous area, lime appears to be the great *desideratum*. Considerable quantities of it are now applied in a slaked state. Near the coast of the Gulf and along the estuaries, inexhaustible supplies of mussel-mud are obtainable, which contains a large percentage of lime and constitutes a valuable fertilizer. This material is, however, only used yet to a limited extent.

Flora or sylva.

The flora of the district occupied by the Carboniferous rocks is closely similar to that described in report M (Annual Report, 1886) as occurring in eastern Gloucester. the distribution of the species in

New growth since Miramichi fire of 1825.

certain localities being, however, somewhat different, especially within the area burnt over by the great Miramichi fire of 1825. Outside of that area, hemlock, black and white spruce, fir, black, white and yellow birch, maple, beech, poplar, white and red pine, etc., are the principal trees on the drier grounds. On the swamps and intervales, cedar, hacmatac (larch), ash, elm, balsam-poplar, etc., occur. There is, generally speaking, a heavy growth of wood, except where the original forest has been destroyed by fires. Within the area overrun by the great Miramichi fire referred to, a growth of trees has sprung up which is in some respects different from that destroyed. Large groves of poplar on the damp grounds, and white birch, maple and beech on the drier, were especially noticeable, each of these growing in spots to the almost entire exclusion of any other tree. Upon the sandy and gravelly tracts, however, groves of red pine and black spruce are the prevailing forms, while along dry river banks, white spruce is the most abundant tree. The latter has attained, since the fire, a thickness of 12 to 15 inches above the roots. Hacmatac (larch) is common in bogs. The hemlock does not seem to have grown again after its destruction. In general the young growth of trees forms a dense forest.

Character of Soil upon the Cambro-Silurian Belts.

Soil of Cambro-Silurian area, quality of.

Of the two belts of Cambro-Silurian rocks crossing the district, that adjoining the Carboniferous is the lowest and contains the best lands. Many parts of it are boulder-strewn, but along the Nepisiguit, the main North-West Miramichi and Big Sevogle (see Dr. Ells' reports, Reports of Progress, 1879-80 and 1880-81-82) there are some tracts containing excellent soil. North of the Nepisiguit, about the headwaters of Little and Pabineau rivers, there are also areas of fine land, well suited for agricultural purposes but still in a wilderness state.

Trees upon it.

On the north-western band of these rocks the land is higher and appears to be more boulder-strewn. Both are still largely covered with a heavy growth of birch, maple, beech, spruce, pine, etc. The river valleys are generally pretty wide and contain flats with excellent soil.

The wide terraces along the Big Sevogle (see map) are clothed with a dwarfed growth of red and Banksian pine 10 to 20 feet in height. The flats support elms, poplars, etc. Strange to say, the last mentioned trees, even within the limits of the great fire of 1825, seem, in many places, to have escaped its ravages.

Soil upon the Pre-Cambrian Rocks.

Soil of Pre-Cambrian rocks, general sterility of.

Reference has already been made to the great amount of rock debris strewn over the surface of that part of the country occupied by these rocks, and its consequent general sterility noted. The mountain summits and flanks often exhibit little else than a mass of loose boulders and coarse shingle, the result of ages of disintegration. Along the foot-hills and in the valleys, however, there are limited areas of cultivable soil, while narrow intervales and terraces usually skirt the rivers. A considerable part of this district has been overrun by forest fires, and the covering of trees thus destroyed has never been replaced. Isolated clumps still occupy the lower portions of the slopes in places, however, and shroud the valleys and ravines.

Settlements, where located.

The settlements within the Miramichi district are chiefly confined to the tracts bordering the coasts and estuaries. This is more especially the case on the north side of the river, as on the south side, in addition to the coast settlements, there are a number of others along the tributaries and behind the towns, as will appear on the map. Many of the latter are in a thriving condition, the general agricultural character of the country here being very good.

Indian Encampments.

Indian camping grounds.

Old Indian camping grounds, in which flint arrow-heads, chips, bones and teeth of animals, etc., occur, were observed at the mouth of Tabusintac River and on the banks of the South-West Miramichi a few miles above Derby Junction. There seems to have been a burial ground in rear of the camp site at Tabusintac, human remains and a copper kettle having been found there.* A leaden crucifix, an iron hatchet, and other evidences of the intercourse of the early French settlers with the Indians were also discovered. A number of the relics were collected by Dr. A. C. Smith, of Newcastle, and Dr. Baxter, of Chatham, and forwarded to the Natural History Society of New Brunswick and a paper relating to these pre-historic remains appeared in *Bulletin* No. V. of that Society. An examination of this Indian camp site during the past summer, in company with Dr. Smith, elicited the following facts:—The site of the encampment is only three to five feet above high tide level, and the sea is washing away the bank. Fig. 3 represents a geological section of the beds—*a*, millstone grit; *b*, the same partially, and in the

Relics found.

* The human remains were supposed to be those of an Indian, and were buried three feet deep in the river's bank in rear of the camp-site.

a, Sandy loam. *b*, Rotted rock. *c*, Middle Carboniferous sandstone.
FIG. 3. SECTION AT INDIAN CAMP-SITE, TABUSINTAC RIVER.

upper part wholly, decomposed from subærial action; and *c*, a sandy loam apparently formed from the further oxidation of the underlying gravel or sand and mingled with more or less recent sand thrown up by the sea. Only in division *c* do the relics occur. Division *b* appears to have been undisturbed, and there is no evidence of a submergence since the deposition of the Saxicava sands, (of which in reality *c* may form a part) or from the commencement of its occupancy by the Indians, as inferred by the writer of the article in the *Bulletin* just cited.

How entombed. The entombment of the relics in division *c* has been effected partly, perhaps, by the *rejectamenta* of the Indians, but principally by atmospheric action and tillage, none appearing deeper in the soil than the plough could cover them. From the numerous stone chips, unfinished arrow-heads and others of more perfect form, as well as the relics showing contact with the early European settlers just referred to, it seems probable that the Indians occupied this camp site continuously from a very early period until recently. About the year 1860 they are said to have left it never to return.

MATERIALS OF ECONOMIC IMPORTANCE.

Economic materials. The materials of economic importance known to occur in this district have been incidentally referred to in preceding pages, and are brick-clay, fine sand, gravel suitable for roads, ballasting railways, etc., peat and bog iron-ore, the latter in small quantities.

Where found. Brick-clay of marine formation (Leda clay) is found in great abundance along the estuary of the Miramichi, and brick-kilns are in operation at Chatham, Newcastle and Nelson. The one at the last mentioned place is the largest and the bricks manufactured there are reported to be of excellent quality. Sand beds (Saxicava sand) occur in proximity to these brick yards, affording supplies of sand suitable for brick and mortar. Both Saxicava and recent sands of the finest quality for the purposes mentioned are abundant almost everywhere along the coast of this district (see p. 26 N, this report,) for description of sand dunes).

Gravel adapted for the purposes referred to was met with in the vicinity of Chatham, Douglastown, Newcastle, Bartibogue and numerous other localities.

Peat is abundant and of great thickness and excellent quality. Should this article ever be required for fuel in northern New Brunswick, or for any other purpose, there is here an almost inexhaustible supply. The particular localities where the larger peat bogs occur, together with brief descriptions of them, are found on pp. 22-25 N, (this report.)

Bog iron-ore was observed on the south side of Tracadie River in small quantities. It was also noted on the North-West Miramichi in the vicinity of Chaplin Island. Clay associated with it and coloured therefrom is, at the latter place, used as a red paint for the outside of buildings.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

THE

MINERAL WEALTH

OF

BRITISH COLUMBIA.

WITH AN ANNOTATED LIST OF LOCALITIES OF MINERALS OF ECONOMIC VALUE.

BY

GEORGE M. DAWSON, D.S., F.G.S.,

Associate Royal School of Mines.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1889.

To Dr. Alfred R. C. Selwyn, C.M.G., LL.D., F.R.S.
Director of the Geological and Natural History Survey of Canada.

Sir,—In 1877, I prepared, in connexion with the Government Surveys for the Canadian Pacific Railway, a general note on the Mines, and Minerals of Economic Value of British Columbia, which was published in the Railway Survey Report for that year, and was afterwards reprinted, with some additions, in the Report of Progress of the Geological Survey for 1877-78. Since that time great changes have occurred in respect to the aspects of mining in British Columbia, and important additions have been made to our knowledge of its mineral resources and geology. In view of these, and the increasing interest now manifested in the development of the natural resources of the province and the numerous enquiries constantly received on that subject, it appeared to be desirable to place the available information respecting its mineral wealth in the hands of the public in a summarized form. With this object in view I began the revision of the publication first referred to, but soon found that in order to obtain a reasonably satisfactory result, it would be necessary practically to rewrite the whole. The work has, in consequence, assumed proportions larger than were at first contemplated. I have had an opportunity of personally examining most of the important localities here described. Other places have been examined by yourself, by the late Mr. James Richardson and by Mr. Amos Bowman. For a few which have not been visited by any member of the staff of the Survey, information has been drawn from other trustworthy sources.

I have the honor to be, Sir,

Your obedient servant,

GEORGE M. DAWSON.

Ottawa, *March* 1, 1889.

NOTE.—The ton referred to throughout this report is the ton of 2000 lbs., unless otherwise stated.

THE

MINERAL WEALTH

OF

BRITISH COLUMBIA.

By GEORGE M. DAWSON, D.S., F.G.S.

Object and plan of report.

The object of this publication is two fold. It is, in the first place, intended to serve, in some measure, as an exponent of the mineral wealth of the Province to which it refers, to provide an answer of a general kind to the enquiries now so frequently made on this subject, and to collect for this purpose in a convenient form brief summaries of the facts contained in the several official reports on the geological features of the Province, with specific references to the pages in which they are treated of at greater length. In the second place, it is designed to place in the hands of the 'prospector' or miner a convenient synopsis of facts, with a list of localities likely to be of interest to him. In the endeavour to carry out this second purpose, it has been considered advisable to add notes on such general principles, and to advance such suggestions, as from my study of the geological features of the Province, (dating from 1874) appear to be of importance, and likely to be of service at the present time in guiding the search for or exploitation of its metalliferous deposits. In further pursuance of this object, some facts resulting from late practice and investigations in other mining regions are alluded to, and their application to the problems of development in British Columbia is briefly noted.

The treatment of the various subjects included in this publication is necessarily more or less unequal, and no one can be more fully alive than the writer to its incompleteness in many respects. While the important developments now in progress in the Province appear to call for the present publication, it is to be anticipated, that within a short time anything that can now be said regarding vein-mining will be relegated to a position of merely historical interest.

Acknowledgements.

In connexion with the preparation of these notes, I have had occasion to apply to several gentlemen for information, which has been

readily and cordially supplied. I am under obligations particularly to Messrs. G. M. Sproat and A. W. Vowell, Gold Commissioners for Kootanie District; to Mr. G. B. Wright, and for some special notes to Mr. R. D. Atkin, J. W. McKay, J. F. Allison, S. Robins and Hon. R. Dunsmuir. Much assistance has also been received from Mr. Amos Bowman, and in the matter of assays and analyses from Mr. G. C. Hoffmann.

General Physical Features.

Area and position of British Columbia.

The Province of British Columbia, with an area of 390,344 square miles, includes a length of over 800 miles of the Cordillera belt of the West Coast, a region of mountains and of geological disturbance, which in this part of its extent has, between the Pacific Ocean and the elevated western margin of the Great Plains, a breadth averaging about 400 miles. This great mountain region extends north-westward and south-eastward, and constitutes the effective cause which has produced the similar trend of the Pacific coast between the same parallels of latitude. It represents the northern continuation of the most important metalliferous area of the United States, essentially repeating its main orogrophic features, though presenting also some notable differences of a general kind as well as many local peculiarities.

The Cordillera belt.

The Cordillera belt, in British Columbia, may be described as comprising four great mountain systems or principal axes of uplift and geological disturbance, which are, in the main, nearly parallel to each other and to the coast,—the Rocky, the Gold, the Coast and the Vancouver ranges.

The Rocky Mountains.

The Rocky Mountain Range proper, is the furthest inland, and has an average breadth, in its southern part, of about sixty miles, but is decreased near the Peace River to forty miles or less, and apparently loses its importance and regularity locally where cut through by the Liard, though recovering both still further to the north-westward. Near the 49th parallel, several summits occur in this range which exceed 10,000 feet in height, but northward, few attain this elevation till the head-waters of the Bow River are reached. About the sources of the North Saskatchewan and Athabasca, the range appears to culminate, and Mounts Brown and Murchison occur, with reputed heights of 16,000 to 13,500 feet respectively. Near the Peace, few summits exceed 6000 feet, so far as known. Though more or less extensive snow-fields occur in many places, true glaciers are found only about the heads of the Bow, North Saskatchewan and Athabasca. Some of the valleys penetrating this range on the east,

are lightly timbered or in part prairie-like in character, but, as a rule, the mountains are thickly wooded wherever sufficient soil exists for the support of trees, and owing to the greater rain-fall on the western slopes of the range, the forests are there often very dense.

Rocks of the Rocky Mountains.

Crystalline schists and granite, are scarcely known in any part of the Rocky Mountains between the 49th and 60th parallels, the ranges being built up chiefly of a great series of Palæozoic rocks, extending from the Cambrian to the Carboniferous, with a total thickness of more than 28,000 feet in the Bow River region. There are also, however, more or less isolated basins of rocks of Cretaceous age, which rocks were evidently at one time continuous with those of the same age in the eastern foot-hills and Great Plains. In these basins, beds of bituminous coal and of anthracite are found. Deposits of copper-ores and of galena are so far the most important metalliferous minerals discovered in association with the older rocks of this mountain system.

Valley to south west of Rocky Mountains.

The south-western side of the Rocky Mountain Range, is defined by a very remarkable, straight and wide valley, which can be traced uninterruptedly from the 49th parallel to the head-waters of the Peace,—a distance of 700 miles or more. This valley is occupied by the upper portions of several of the largest rivers, including the Kootanie, Columbia, Fraser, Parsnip and Finlay. Gold-placers have been found and worked at a number of points along this valley, and important discoveries of various ores are now being made in its vicinity near the Upper Columbia and Upper Kootanie. It is naturally adapted to become a main line of communication between the southern and northern portions of the Province, near its eastern boundary.

The Gold Range.

The next mountain system to the south-west of the Rocky Mountains, is referred to under the general name of the Gold Range, though really a complex and somewhat irregular mountainous belt, which includes several more or less distinct and partly overlapping ranges. The Purcell, Selkirk and Columbia* ranges constitute its southern part, while to the north it is represented by the Cariboo Mountains, and still further northward,—after an important interruption,—by the Omenica and Cassiar mountains. These mountains are, generally speaking, less rugged in detail than the Rocky Mountains, including extensive areas of high, rolling plateau-country, and supporting in their southern and more massive portion, numerous glaciers and wide snow-fields. The highest summit so far actually measured is Mount Donald, on the line of the Canadian Pacific Railway, 10,645 feet. The forests of the Purcell, Selkirk and Columbia ranges are dense and tangled, and these mountains are much more difficult to traverse, and even less perfectly explored

* The name Gold Range is often specially applied to that here spoken of as the Columbia Range.

than the corresponding portion of the Rocky Mountains. Granites and crystalline schists of great age are abundant in the Gold Range, together with great masses of Palæozoic rocks, respecting the structural relations of which very little is as yet known.

Principal metalliferous belt.

The Gold Range, as a whole, doubtless constitutes the most important metalliferous belt of the Province. The richest gold-fields are closely related to it, and discoveries of metalliferous lodes are reported in abundance from all parts of it which have been explored. The deposits already made known are very varied in character, including highly argentiferous galenas and other silver-ores and auriferous quartz veins.

InteriorPlateau of British Columbia.

Between the Gold and Coast ranges, lies a region, which for purposes of description, has been named the Interior Plateau of British Columbia, having an average width of one hundred miles and a mean elevation of about 3500 feet. Its height, on the whole, increases to the south; while northward, it falls gradually toward the group of large lakes and the low country about the head-waters of the Peace. This has, over a considerable part of its area, been covered by wide-spread flows of basalt and other volcanic rocks in the later Tertiary period. It is now traversed in various directions by a system of deep, trough-like valleys of erosion, generally occupied by streams and rivers. Water standing at an elevation of three thousand feet above the present sea-level would flood most of these, and would divide its surface into a number of islands, while a large tract of country about the 53rd and 54th parallels of latitude would be completely submerged. In some places the plateau is pretty level and uniform, but many portions of it attain an elevation much exceeding the mean above stated, and it is usually only when broadly viewed, and in contrast with its bounding mountain ranges, that its character as a plateau is apparent. Its main area is practically closed to the north, about latitude 50° 30′, by the ends of several intercalated mountain ranges, in which many of the summits attain a height of 8000 feet. Nearly coincident with the 49th parallel, is a second transverse mountainous zone, formed in the same way, the only orographically important gap in which is that found in the vicinity of the Okanagan River. The southern portion of the Interior Plateau includes much open country, constitutes the best grazing region of British Columbia, and affords besides some good agricultural land. To the north, with increasing moisture, it becomes generally forested, but embraces large areas which are suitable for eventual agricultural occupation.

Geology of the Interior Plateau.

The Tertiary rocks of the Interior Plateau hold, in many places, beds of lignite or of coal. Where not concealed by the later rocks, the formations preponderantly represented belong to the Palæozoic age.

These include very notable developments of materials originally volcanic in origin. The geological structure is scarcely less complex than that of the mountain regions, and much yet remains to be done toward its elucidation. The Interior Plateau also presents some important granitic areas, and, particularly toward its south-western border, limited basins of Cretaceous rocks. As a metalliferous region, it is destined to take high rank, particularly I believe in respect to the precious metals, though its ores are too varied in character to admit of description in a few words. Placer deposits of gold have been worked in a number of widely separated localities, and platinum is abundant in the Similkameen region.

The Coast Ranges of British Columbia.

The Cascade Range of Oregon and Washington is largely composed of erupted volcanic materials, to which its characteristic features are due, though these materials rest upon a basis of older rocks. Its course is north-and-south, and it is definitely terminated in the vicinity of the International boundary. Near the mouth of the Fraser River its place is taken by a new mountain system, geographically and geologically distinct, in the composition of which volcanic ejectamenta play no prominent part. This forms the third member of the Cordillera in British Columbia, and under the name of the Coast Ranges, pursues a direct north-westward course for over 900 miles, forming throughout this distance the bordering mountain-zone of the continent. The Coast Ranges have an average width of about one hundred miles, and consist of numerous constituent ridges and minor mountain axes with varied trends, frequently separated by deep parallel and transverse valleys. The average altitude of the higher summits is between 6000 and 7000 feet, while some exceed 9000 feet. Glaciers are of frequent occurrence, and large in size, in the northern portions of the Coast Ranges. The mountains are, as a rule, densely forested and extremely rugged, the flora of their seaward slopes being that characteristic of the West Coast and coördinated with its great humidity, while on north-eastern flanks the forest resembles that of the inland ranges.

Rocks of the Coast Ranges.

Geologically, the Coast Ranges owe the greater part of their elevation to a period later than the Cretaceous, of which formation patches are found in them at great heights. The rocks consist chiefly of grey granites and granitoid materials, with which are associated gneisses and other crystalline schists, as well as Palæozoic rocks resembling some of those of the Interior Plateau. In association principally with the last-named rocks, gold-placers occur locally. Copper- and iron-ores are frequently found, and rich silver-ores have been discovered.

The name Vancouver Range, may be applied as a general one to the fourth great mountain-axis, which, in a partially submerged condition,

The Vancouver Range.

appears in Vancouver and in the Queen Charlotte Islands, and is continued southward nearly to the Columbia River by the Olympian Mountains of Washington Territory. The islands of the Alaskan archipelago have, on the map, the appearance of constituting a northern continuation of the same mountain system, but I believe that they may be more appropriately regarded, from an orographic point of view, as forming a partially submerged lateral expansion of the Coast Ranges. The highest mountain of Vancouver Island—Victoria Peak—reaches an elevation of 7484 feet, while there is a considerable mountainous area in the centre of the island, which surpasses 2000 feet in average altitude. Several summits in the Queen Charlotte Islands exceed 4000 feet.

Rocks of the Vancouver Range.

The Vancouver Range, while still to a considerable extent formed of crystalline rocks like those of the Coast Ranges, is principally composed of stratified rocks of Palæozoic and Triassic age, and is flanked in places, both on Vancouver and on Queen Charlotte Islands, by Cretaceous rocks, which are here important because of their coal-bearing character. The areas underlain by these rocks are in general comparatively low, and hilly rather than mountainous, while a large tract of level land, based upon the Tertiary formation, occurs in the north-east part of the Queen Charlotte Islands. Gold-placers have been worked in several places on Vancouver Island, but few ever attained much importance. Iron, copper and lead ores and gold-bearing quartz are also known to occur in connexion with this mountain-axis, but up to the present time the coal deposits have proved to be vastly its most important feature.*

General Notes on Mineral Deposits.

Similarity of rocks in different parts of Cordillera belt.

The general correspondence of that portion of the Cordillera belt included in British Columbia with that of the western portion of the United States, in some parts of which mining operations of the first importance have been in progress now for many years, has already been alluded to. No feature of the geology of the continent is more remarkable, than the general persistence of certain zones of similar rocks in a direction coincident with that of the Cordillera itself,—a circumstance in part due to the original similarity in conditions of depo-

* In connexion with the foregoing outline of the ruling physical and geological features of the Province, it should be stated that while these features are moderately well known in the southern portion of the Province, and as far northward as the 56th degree of latitude, and that while in connection with the Yukon expedition some accurate information has been obtained for the extensive northern portion; there yet remains a large region, chiefly included between the 56th and 58th parallels, which, though touched upon here and there by the gold miner, is yet almost unknown geographically and geologically.

sition of sediments, and in part to their equal participation, at a later date, in changes produced by like metamorphic agencies. The similarity thus observed, in a series of geological zones parallel to the general direction of the Pacific Coast, is here more striking than the continuity of the constituent orographic uplifts of the mountain-belt, and contrasts very markedly with the diversity of rock-formations found to occur where this belt is crossed at right-angles. While metalliferous deposits individually are inconstant, and even the best defined lodes can be followed, in the vast majority of cases, for but a moderate distance, their character is found to depend fundamentally upon that of the enclosing or adjacent rocks, in which, under the required local dynamic and other agencies, these deposits are found to recur with nearly identical features. It is not intended here to discuss the resemblances and differences of the various rock-series met with in the corresponding region in the Western States with those of British Columbia, but it may be mentioned, that the metalliferous districts of the Province may with advantage be compared by the miner with those which have already been more fully developed in each corresponding portion of the Cordillera region to the south, and that from such rational comparisons, useful indications may be derived in the present early stages of the development of the mines of British Columbia.

Continuations to the southward of various mountain ranges.

The Rocky Mountains proper, as defined on a previous page, can scarcely be traced southward, with identical characters, further than the main head-waters of the Missouri, beyond which the eastern ranges of the Cordillera become more lax and irregular. The Gold Range may, however, be followed further in a southerly direction, being continued by the Cabinet, Cour D'Alaine and Bitter Root mountains, for about 300 miles. The Interior Plateau of British Columbia represents the Great Basin of Utah and Nevada and the great plains of the Columbia, and combines to some extent the features of both, though differing markedly from the first in the fact that it is not here self-contained as to its drainage, and from the second, in the diminished importance of its Tertiary lava-flood. It has already been stated, that the Coast Ranges of British Columbia are not continued to the south of the International Boundary. They resemble the Sierra-Nevada more closely than they do the Cascade Mountains of Washington Territory and Oregon, and hold a similar relation to the Interior Basin with that held by the Sierra. While, however, the Sierra owes its elevation to a time immediately antedating the Cretaceous, the main uplift of the Coast Ranges of British Columbia occurred at or after the close of that period. The Vancouver Range, again, dating from the same period with the last, is not traceable south of the Columbia River, beyond which, in Oregon and California, the Pacific is bordered by a

range of coast hills, which, from a geological point of view, are of very recent origin.

Auriferous rocks of British Columbia and California compared.

In California, the principal auriferous territory coincides with the run of a certain belt of slaty and schistose rocks, which occurs on the western flank of the Sierra-Nevada; these rocks being referred by their contained fossils, to the Triassic and Cretaceous divisions of the geological scale. In British Columbia, while rocks of Triassic age are largely developed, and in some cases with characters identical with those of the Californian gold-bearing rocks, no such persistent belt of these rocks is found in connexion with the Coast Ranges, where (from what has just been said of the resemblance of the two mountain systems) it might, from analogy, have been sought for. While local occurrences of rich gold-placers are known, in association with slates probably of Triassic age, on both sides of the Coast Ranges, the main auriferous territory in the Province is found to align itself on the Gold Range; and the original deposits of gold, from which the placers have been supplied, are already known to exist in different series of rocks widely separated in age and ranging all the way from the Triassic to the Cambrian. While, therefore, there is no single well developed gold-producing region, as in California, the area and mass of the rocks throughout which deposits of gold may be hopefully looked for, is here greatly increased. The circumstances would also warrant the belief, that the mode of occurrence of gold in its original matrix might differ from that found to the south, and in particular that this might be more varied. So far as investigation has gone such a belief appears to be well grounded, and it would seem, that to a very considerable extent, the natural laws of this mining field must be worked out independently.

No Tertiary Coast Ranges in British Columbia.

In correspondence with the absence of the Tertiary Coast Hills of California, in which, under peculiar conditions of mineralization, the cinnabar ores of that State are developed, it is observable that in British Columbia no really important deposits of mercury have yet been discovered. It is by no means improbable that mercury-ores may yet be developed in the Province, but if so, it cannot be in any continuation of the Californian cinnabar belt, and the conditions of such deposits may be expected to prove unlike.

Coal-bearing Cretaceous rocks of British Columbia.

Another and very important point of diversity, is found as respects the Cretaceous rocks of the southern and northern coast regions. In California and Oregon, the mineral fuels which have been found and worked are lignites of Tertiary age and of an inferior value. Similar fuels are known on the coast of British Columbia, but the rocks of the Cretaceous here assume the *rôle* of a coal-bearing series and yield coals of excellent quality, which more than hold their own in competition with all other fuels employed on the Pacific.

Still another noteworthy circumstance of difference, and one which is applicable to practically the entire area of the Province when it is contrasted as a whole with the Pacific States, is that which has been produced by the general spread and movement of ice over this region, during the Glacial period. The changes thus effected in the distribution of surface materials and directions of drainage have most important bearings on the question of placer-mining. They have also encumbered the surface of considerable tracts with "drift" deposits, which, while tending to produce a more fertile soil, largely conceal the indications to which the prospector generally trusts in more southern latitudes. At the same time, a great part of the oxidised upper portions of metalliferous veins, together with the atmospherically decayed country-rock associated with these, has been removed, thus often obscuring the outcrops of such veins, which would otherwise be well marked; and in the treatment of certain classes of ores, rendering it necessary to begin work from the first with machinery and processes which in some other regions are only required after considerable depths have been attained. Effects of glaciation.

These conditions, brought about by action during the Glacial period, are amongst those which, in my opinion, have most tended heretofore to retard the development of metalliferous mining in British Columbia. Other circumstances which have operated in the same direction are; the densely wooded character of a great part of the country, the fact that the rivers are suited for navigation only in detached reaches, the remoteness from the coast of the richest and best known placer-mining districts, and the cost of labour, supplies and machinery, which may be regarded as in part concomitants, in part direct results of these. Owing to the inaccessibility of the country, it has, till very recently, been prospected and exploited by the placer-miner alone, who has been deterred by no difficulty from reaching the most remote spots in which rumour, or reasoning of his own, lead him to expect the existence of the precious metal. Little knowledge or effort was expended in the search for metalliferous veins. Many such deposits supposed to be of value were, it is true, located, and time and money which could ill be spared, often uselessly spent upon them, leading only to discouragement. Even where the indications met with were altogether favourable, the original discoverer generally found that the capital and knowledge required for their development were not at his command, and it was difficult to interest those capable of dealing with such mines in a region which they could not easily visit and become familiar with at first hand. With regard at least to the whole southern portion of the province, however, all this is now happily changed. Causes which tend to retard development.

While speaking of causes which have hitherto stood in the way of vein-mining, it must also be mentioned, that not the least important of Exaggerated values.

these has been, and still is, the fictitious or exaggerated value too frequenty placed upon entirely undeveloped discoveries. While it is manifestly right that the discoverer should be properly remunerated, it should be remembered that a mere surface shewing, however promising, generally requires the expenditure of a large sum before its true value can even be ascertained, and that till thus developed it is unreasonable to expect a large payment for any mining claim.

Importance of British Columbia as a metalliferous region.

In preceding paragraphs, particular attention has been drawn to certain notable differences between the better known and more fully developed regions of the southern part of the Pacific Slope and those of the province of British Columbia, chiefly as a note of caution against the rash assumption of complete uniformity in conditions too often made without due investigation. The salient fact of the general identity of the structural features of the Cordillera region south and north, however, remain, and is such, that from this alone, even without taking into consideration the numerous and important discoveries already made, we should be justified in predicting an eventual great development of metalliferous mining in the Province. It has already been stated, that British Columbia includes a length of over 800 miles of the most important metalliferous belt of the continent, and adding to this the northern extension of the same belt, beyond the 60th parallel, we find that within the boundaries of Canada its entire length is between 1200 and 1300 miles. This, as I have elsewhere noted, is almost precisely equal to the whole length of the same region included by the United States from our southern line to the northern boundary of Mexico, and after having enjoyed, exceptional opportunities of investigation, I feel no hesitation in recording my belief that the northern moiety of the Cordillera will ultimately prove to be susceptible of a development corresponding in importance to that which has already been attained in the southern.

Rise and progress of mining.

British Columbia first rose from the position of a fur country to the rank of a colony, on the discovery of gold upon the Lower Fraser in 1858. Its subsequent history, for a number of years, is substantially that of the sudden rise and subsequent slow decline in importance of placer gold-mining. Coal mining has, however, concurrently, advanced slowly but steadily till it has obtained its present pre-eminent position. Such historical facts as appear to be important to the appreciation of these industries are touched on later in connexion with them. With respect to vein-mining proper, we have as yet to chronicle merely the first steps, but in the southern part of the Province the completion

Present position.

of the Canadian Pacific Railway, has at length afforded the necessary impetus in this direction, and it is very gratifying to find, as an immediate consequence, that this part of the country is rapidly beginning to

prove its valuable character and to justify the confidence which those best able to form an opinion on the subject have always felt, and frequently expressed. Everything which has been ascertained of the geological character of the Province as a whole, tends to the belief that so soon as similar means of travel and transport shall be extended to what are still the more inaccessible districts, these also will be discovered to be equally rich in minerals, particularly in the precious metals, gold and silver. In the southern district, for which information is most complete, praiseworthy efforts are now in progress at a number of widely separated localities, toward the exploitation of ores, which, in many cases, have already been proved to be of an exceptionally valuable character. Here at least, we have every reason to believe that we are on the point of witnessing the inauguration of an era of mining activity of the most important kind.

PUBLICATIONS BEARING ON GEOLOGY, ETC., OF BRITISH COLUMBIA.

List of reports cited.

The operations of the Geological Survey of Canada, were first extended to British Columbia in 1871, when the former colony became a province of the Dominion. Since that date a number of reports bearing on the Province have been published by the Geological Survey, which are here enumerated, as frequent reference is made to them on subsequent pages:—

Report of Progress 1871–72.—*Selwyn:* Journal and Report of Preliminary Explorations in British Columbia. *Richardson:* On the Coal Fields of the East Coast of Vancouver Island, with a map of their distribution. Appended notes by *Dawson* (*J. W.*) and *Hunt* on Fossil Plants and on Coals.

Report of Progress 1872–73.—*Richardson:* On the Coal Fields of Vancouver and Queen Charlotte Islands, with a map of the former; an Appendix by *Dawson* (*J. W.*) on Fossil Plants; another by *Billings* on Mesozoic Fossils; and a third by *Harrington* on the Coals of the West Coast.

Report of Progress 1872–73.—*Richardson:* On Geological Explorations in British Columbia.

Report of Progress 1874–75.—*Richardson*: On Explorations in British Colnmbia.

Report of Progress 1875–76.—*Selwyn:* Report on Explorations in British Columbia, with sketch-map of route and appendices by *Macoun* on Botany; *Whiteaves* on Fossils; and *Le Conte* on Coleoptera.

Dawson (*G. M.*): Report on Explorations in British Columbia; Appendix by *Scudder* (*S. H.*) on Tertiary Fossil Insects.

Report of Progress 1876–77.—*Dawson* (*G. M.*): Report on Explorations in British Columbia, chiefly in the Basins of the Blackwater, Salmon and Nechacco Rivers, and on François Lake, with a coloured Geological map.

Dawson (*G. M.*): Report of a Reconnaisance of Leech River and vicinity.

Dawson (*G. M.*): General Note on the Mines, and Minerals of Economic Value of British Columbia, with a list of Localities.

Richardson: Report on the Coal Fields of Nanaimo, Comox, Cowichan, Burrard Inlet and Sooke, British Columbia, with a coloured Geological map.

Scudder (S.H.): Additions to the Insect Fauna of the Tertiary Beds at Quesnel.

Report of Progress 1877-78.—*Dawson (G. M.):* Preliminary Report on the Physical and Geological Features of the Southern Portion of the Interior of British Columbia, with a coloured Geological map.

Report of Progress 1878-79.—*Dawson (G. M.):* Report on the Queen Charlotte Islands, with two coloured Geological maps and sketches of Harbours. *Appendix A.*—On the Haida Indians of the Queen Charlotte Islands. *Appendix B.*—Vocabulary of the Haida Indians. *Appendix C.—Whiteaves:* On some Marine Invertebrata from the Queen Charlotte Islands. *Appendix D.—Smith (S. J.):* Notes on the Crustacea from the Queen Charlotte and Vancouver Islands. *Appendix E.—Macoun:* List of Plants from the Queen Charlotte Islands. *Appendix F.*—Meteorological Observations. *Appendix G.*—Notes on Latitudes and Longitudes.

Report of Progress 1879-80.—*Dawson (G. M.):* Report on an Exploration from Fort Simpson, on the Pacific Coast, to Edmonton, on the Saskatchewan, embracing a portion of the Western part of British Columbia and the Peace River Country, with a map in three sheets, with Geological Indications. *Appendix I.—Macoun:* List of Plants collected in the Northern part of British Columbia and the Peace River Country. *Appendix II.*—Meteorological Observations. *Appendix III.*—Note on Latitudes and Longitudes of the Region from the Pacific Coast to Edmonton.

Dawson (G. M.): Note on the Distribution of some of the more important Trees of British Columbia, with a map.

Report of Progress 1882-84.—*Bauerman (H.):* Report on the Geology of the Country near the Forty-ninth Parallel of North Latitude, West of the Rocky Mountains, from Observations made 1859-61.

Annual Report, 1885.—*Dawson (G. M.):* Preliminary Report on the Physical and Geological Features of that portion of the Rocky Mountains between Latitudes 49° and 51° 30′, with two coloured Geological maps.

Annual Report, 1886.—*Dawson (G. M.):* Report on a Geological Examination of the Northern part of Vancouver Island and adjacent coasts, with a coloured Geological map. *Appendix I.—Whiteaves:* Note on some Mesozoic Fossils from various localities on the coast of British Columbia. *Appendix II.—Macoun:* List of Plants from Vancouver Island and adjacent coasts. *Appendix III.*—Meteorological Observations.

Annual Report, 1887.—*Dawson (G. M.):* Report on an Exploration in the Yukon District, N.W.T., and adjacent Northern portion of British Columbia, with an index map and a detailed map in three sheets, with Geological indications. *Appendix I.*—Note on the Distribution of Trees. *Appendix II.*—Note on the Indian Tribes. *Appendix III.—Macoun:* List of Plants *Appendix IV.*—Zoology. *Fletcher (J.):* List of Lepidoptera, etc. *Appendix V.—Adams:* Notes on Rock-specimens. *Appendix VI.*—Meteorological Observations. *Appendix VII.*—Astronomical Observations.

Bowman: Report on the Mining Region of Cariboo. Part I.

Besides the reports above enumerated, which are contained in the

annual volumes of the Geological Survey, the following special reports bearing on British Columbia have been issued by the Survey:—

Mesozoic Fossils. Parts I., II. and III., by J. F. Whiteaves. *Report on the Polyzoa of the Queen Charlotte Islands* by T. Hinks' *Comparative Vocabularies of the Indian Tribes*, by W. F. Tolmie and G. M. Dawson.

Various contributions to the geology of the Province and to the knowledge of its minerals, including several short reports by Mr. A. Bowman, are also to be found in the Annual Summary Report of the Geological Survey, and numerous analyses of ores and minerals are included in the Contributions from the Laboratory of the Survey from 1871-72 to date.

From the Annual Reports of the Minister of Mines of British Columbia, from 1874 to date, much valuable and detailed information may also be obtained.

In the following pages, placer gold-mining is given the first place, as it forms the natural introduction, from a historical stand point, to mining in general.

The Discovery of Gold.

Original discovery of gold in the Queen Charlotte Islands.

The first authenticated discovery of gold within the limits of what is now the province of British Columbia, occurred at Mitchell or Gold Harbour, on the west coast of the Queen Charlotte Islands. This discovery created considerable interest at the time, but was in no way connected with the Fraser River excitement, and general commencement of placer-mining, which occurred later. As, however, the matter is of some historical interest, and as several versions of the affair have been given, the following notes derived from Mr. J. W. McKay, who was conversant with all the circumstances, at the time, are inserted here.—The first gold was a nugget accidently found by an Indian woman on the beach in 1851. After a part had been cut off, it was taken by the Indians to Fort Simpson and sold there, weighing, as received, between four and five ounces. The nugget was then sent by the officer in charge, to the Hudson Bay headquarters at Victoria. The Company in the same year sent the brigantine *Una* to the place of discovery, where a quartz vein seven inches wide and traceable for eighty feet was found, and reported to contain twenty-five per cent. of gold in some places. Some of the quartz was blasted out and shipped, but the brigantine was lost on the return voyage, at Neah Bay, near Cape Flattery, in the month of December. In January, 1852, a U. S. brigantine, named the *Orbit*, which was on the rocks in Esquimalt Harbour, was bought by the Company, registered under the British flag, re-named the *Recovery*, and sent north with thirty miners in addition to the ships company, the

miners going 'on shares' in the venture. Three months were spent in getting a cargo of the quartz, which was eventually sent to England, the miners receiving $30 a month each as the result. Meanwhile, the discovery having become known, several little vessels from San Francisco followed the *Recovery* to the Queen Charlotte Islands, and H. M. S. *Thetis* was sent from Valparaiso to keep order. The deposit proved, however, to be quite limited, and these vessels, as well as the *Thetis*, shortly left. Soon after, a vessel named the *Susan Sturgiss* arrived, and the captain (Rooney) collected a quantity of the quartz which had been discarded by the *Una* expedition, and taking it to San Francisco, realized $1400 on it. A second trip made by this vessel in the same year, ended disastrously, the vessel being captured by the Indians at Masset, and the crew kept as prisoners for some time till released by the Hudson Bay steamer *Beaver*. It would appear that gold to the value of about $20,000 may have been obtained from this little vein, while an estimate as high as $75,000 has been made.

Discovery of gold-placers.

It is now difficult to ascertain under what precise circumstances the first discovery of gold placers on the mainland of British Columbia occurred. Little attention was at first given to accounts of the finding of small quantities of gold, and at a later date, when gold mining sprung into importance, numerous stories respecting its discovery were invented or exhumed.* One statement, is to the effect that the Hudson Bay Company's agent at Kamloops had bought gold from the Indians as early as 1852, but, if correct, the amount purchased must have been very small. In 1855, a servant of the same Company discovered gold near Fort Colville, a short distance south of the International boundary, and moderately rich diggings began to be worked in that vicinity. It seems certain that the epoch-making discovery of gold in British Columbia, was the direct result of the Colville excitement. Indians from the Thompson River, visiting a woman of their tribe who was married to a French Canadian at Walla-Walla, spread the report that gold, like that found at Colville, occurred also in their country, and in the summer or autumn of 1857, four or five Canadians and half-breeds crossed over to the Thompson, and succeeded in finding workable placers at Nicoamen, on that river, nine miles above its mouth. On the return of these prospectors the news of the discovery of gold spread rapidly. It is also probable that their arrival on the Thompson caused the Indians to take an interest in gold-mining, for we read in a despatch of Governor Sir James Douglas, that from October 6, 1857, to the end of that year, three hundred ounces of gold had passed through the hands of the Hudson Bay Company, this amount being all, so far as known to Douglas, which had been obtained.

Gold first obtained.

* See Bancroft's Works. vol. xxxii, chapter xx.

Douglas speaks of the region including the Lower Thompson, from which the gold came, as the "Couteau Country."

Influx of gold-seekers.

Nearly ten years previously, in 1849, gold had been discovered in California, and that country was swarming with a cosmopolitan population of gold-seekers; thus when the discovery of gold in the north became known and authenticated by the exhibition of the gold itself, an extraordinary migration followed. Between March and June, 1858, from 20,000 to 23,000 persons arrived by sea from San Francisco in Victoria, and converted that place (first founded by the H. B. Company in 1843) from a quiet village of 200 or 300 inhabitants, into a city of tents. At the same time, many miners (estimated by some at 8000 in number) reached British Columbia by overland routes from the south. A large proportion of those who arrived at Victoria never got so far as the mouth of the Fraser River, their objective point, and so great were the natural difficulties and the resulting disappointment experienced, that all but about 3000 of this promiscuous migration returned to California before the following January. The inland country was entirely without routes of communication, by nature a singularly difficult one, and unprovided with means for the support of a large population. Meanwhile, by the more fortunate and energetic, the development of its wealth had been fairly inaugurated. The auriferous river-bars in the vicinity of Hope and Yale on the Lower Fraser being the most accessible, were the first to be worked, and the return of gold began to assume important dimensions. The actual shipments made from Victoria during the first five months of work in 1858, are stated as below *.—

First shipments of gold.

June	$ 6,000
July	45,000
August	45,000
September	164,000
October	283,000
	$543,000

Progress of Placer Gold-mining.

It is impossible here to follow the further progress of gold discoveries in British Columbia in detail, though such facts relating to discovery and former mining, as appear still to possess importance as guides to future development, are mentioned in connexion with the several dis-

* According to Macfie, Vancouver Island and British Columbia; London, 1865, p. 72. There are said to have been 4000 miners along the Fraser between Hope and Yale, in November, 1858. At Hope 400, and at Yale 1300.

tricts and localities to which they relate.* A few words must suffice to indicate in a general way the progress of the army of gold-miners, the outlines of the topographical features of the Province previously given, serving to acquaint those not personally familiar with it, with the salient features of the regions which were thus rapidly overspread.

Progress of mining 1858 to 1860.

Before the close of the working season in 1858, some of the adventurers who had come overland from the south, had pushed onward in face of extraordinary difficulties,—resulting not alone from the roughness of the country itself but combined with the want of supplies and occasional overt hostility of the Indians,—as far as Fountain, a short distance above Lillooet on the Fraser, and by the line of the Thompson to Tranquille River on Kamloops Lake. In the following year a renewed advance brought a number of miners to the Quesnel River, and in 1860, rich diggings were found at The Forks of the river and over 600 Whites were at work on its length, while Antler Creek was discovered and some work done upon it by a few score men,—thus fairly entered on the extremely rich central region of Cariboo. Also in this year, good placers were found on the Similkameen, in the southern part of the Province.

Theory of the miners.

The theory formed by the miners who first worked the fine 'flour' gold of the Fraser below Yale, was that this gold had its origin in richer deposits toward the sources of the great river, and though this theory was only very partially correct as regards the origin of these particular deposits, it none the less served as the impelling force which led to the opening up of the Cariboo district.

Early discoveries in Cariboo.

In 1861, Williams and Lightning creeks, Cariboo, the two most celebrated in the annals of British Columbian placer-mining, were discovered, and in this and the following year most of the other rich creeks in Cariboo became known. The first gleanings from the old Cariboo stream-courses were notable. It is estimated that gold to the value of $2,000,000 had been got out by a population not exceeding 1500 before the end of 1861. In consequence of those finds a second important migration of miners and others towards the Province commenced before the close of 1861, which continued in greater or less volume till about 1864. A series of letters from a correspondent of the "Times" contributed largely to this result, and extended the area of interest to very wide limits, bringing adventurers from England,

* A mass of information respecting the historical and other features of gold-mining in the Province is contained in Bancroft's Works, vol. xxxii, History of British Columbia. The details there collected may be consulted with advantage, and have been frequently referred to in connexion with localities mentioned in later pages of this report. It must be added, however, that many of the statements quoted by Bancroft must be accepted with caution, having been derived often from the newspapers of the time, and other sources not always trustworthy, but which it has naturally been impossible for the compiler to check, and many of which call for an intimate local knowledge of the country, even to properly correlate.

Canada, Australia and New Zealand. A party of men even set out for Cariboo from Eastern Canada overland, in 1862. Of this party several members lost their lives in the mountains, but some eventually reached their destination.

A further consequence of the Cariboo excitement was to depopulate almost completely the other mining camps in the Province, even those which were yielding a good average return for work, some promising localities lying untouched for years afterwards, or falling entirely into the hands of the Chinese and Indians.

Discoveries on Wild Horse Creek and Leech River.

In 1863, however, rich placer deposits were found on Wild Horse Creek in the Kootanie region, the extreme south-east portion of the Province. These caused considerable local excitement at the time. and were somewhat extensively worked in the following year and thereafter, notwithstanding the attraction of Cariboo. In 1864, Leech River, in the southern part of Vancouver Island not far from Victoria, was discovered to be auriferous, and in 1865 a number of miners from the Kootanie district were prospecting and working in the neighboring Big Bend (of the Columbia) country, the report of their success resulting in the Big Bend excitement of 1866. This subsided almost as quickly as it had arisen, the number of men who rushed to the place being much too great for the opportunities of work.

Gold on Peace River and Omenica.

Though miners from Quesnel, following the routes employed by the Hudson Bay Company, had reached and worked with some success on Peace River as early as 1861, it was not till 1869 that the richer deposits of the feeders of the Omenica Branch of that river near lat. 56° were discovered, and the Omenica excitement did not attain its height till 1871. In 1872, the rich northern mines of the Cassiar district, on the head-waters of the Dease, were brought to light, and a general migration in that direction occurred, which, in 1873, led to the almost complete abandonment of Omenica.

Cassiar and Yukon.

The discovery of the Cassiar mines carried the miners to the vicinity of the 60th parallel, the northern boundary of the Province. Gold was next found in paying quantities on the tributaries of the Yukon, still further to the north, in 1880.* No such rush has occurred to this district as happened in the case of some of those previously mentioned, but in 1886, the miners were at work as far north as lat. 64° 30′ having found 'coarse' gold there on Forty-mile Creek.

Granite Creek.

Granite Creek, a tributary of the Similkameen was found to yield rich diggings, in 1885, and though it has not proved to be as important as at first hoped, it has led to renewed activity in its vicinity.

* Whymper states, however, in 1869, that gold had been found in minute specks by employees of the Hudson Bay Company before that date. Travels in Alaska and on the Yukon, 1869, p. 227.

Region of the principal gold deposits.

While it may now be safely affirmed that gold is very generally distributed over the entire area of the province of British Columbia, so much so that there is scarcely a stream of any importance in which at least 'colours' of gold may not be found, the enumeration of the principal discoveries of important mining districts, shows very clearly, that most of these are situated along the system of mountains and high plateaux which comprises the Purcell, Selkirk, Columbia and Cariboo ranges and their north-western continuations, lying to the south-west of the Rocky Mountain Range properly so called, and parallel in direction with it. Of all the gold-producing districts that of Cariboo has proved the richest and the most continuously productive.

Yield of Gold.

Explanation of table annexed.

The first part of the annexed table, extending to the year 1875, was originally prepared in Victoria by Mr. Charles Good (then Deputy Minister of Mines and Provincial Secretary) and the writer, in the winter of 1875-76. It was first published in the Annual Report of the Minister of Mines for 1875, and has since been republished annually in the same report, with the necessary additions. It is based throughout on the amounts of gold shipped by the banks, express and other companies from Victoria, this being the best available means of ascertaining the yearly product. It has from the first been impossible to ascertain the amount of gold annually taken away in private hands, largely by Chinese, and no account was obtained of the gold carried south from the Kootanie and Similkameen county, which did not pass through Victoria. To allow for these amounts, an addition of one-third is made to the amount actually known to have been exported, up to the year 1877. In some of the earlier years it is probable that this addition is an under-estimate, while the reverse may hold in the case of the years immediately preceeding 1877. Subsequent to the year 1877, an addition of one-fifth only has been made in the British Columbian report. It will thus be apparent that the figures given can only be accepted as a near approximation to the actual yield.

Under the year 1887 a small quantity of bullion obtained from a quartz mine is added, but the amounts are otherwise entirely due to placer-mining.

TABLE shewing the actually known and estimated yield of gold; the number of miners employed; and the average earnings per man, per year from 1858 to 1888, in the Province of British Columbia. Gold product of British Columbia.

YEAR.	Amount actually known to have been exported by Banks, &c.	Amount added to represent gold carried away in private hands.	Total.	Number of Miners employed.	Average yearly earnings per man.
	$	$	$		$
1858 (partial return.)	543,000	.....	*705,000	3,000	235
1859	1,211,304	1-3rd 403,768	1,615,072	4,000	403
1860	1,671,410	" 557,133	2,228,543	4,400	506
1861	1,999,589	" 666,529	2,666,118	4,200	634
1862	1,992,677	" 664,226	2,656,903	4,100	648
1863	2,935,172	" 978,391	3,913,563	4,400	889
1864	2,801,888	" 933,962	3,735,850	4,400	849
1865	2,618,404	" 872,801	3,491,205	4,294	813
1866	1,996,580	" 665,526	2,662,106	2,982	893
1867	1,860,651	" 620,217	2,480,868	3,044	814
1868	1,779,729	" 593,243	2,372,972	2,390	992
1869	1,331,234	" 443,744	1,774,978	2,369	749
1870	1,002,717	" 334,239	1,336,956	2,348	569
1871	1,349,580	" 449,860	1,799,440	2,450	734
1872	1,208,229	" 402,743	1,610,972	2,400	671
1873	979,312	" 326,437	1,305,749	2,300	567
1874	1,383,464	" 461,154	1,844,618	2,868	643
1875	1,856,178	" 618,726	2,474,904	2,024	1,222
1876	1,339,986	" 446,662	1,786,648	2,282	783
1877	1,206,136	" 402,045	1,608,182	1,960	820
1878	1,062,670	1-5th 212,534	1,275,204	1,883	677
1879	1,075,049	" 215,009	1,290,058	2,124	607
1880	844,856	" 168,971	1,013,827	1,955	518
1881	872,281	" 174,456	1,046,737	1,898	551
1882	795,071	" 159,014	954,085	1,738	548
1883	661,877	" 132,375	794,252	1,965	404
1884	613,304	" 122,861	736,165	1,858	396
1885	594,782	" 118,956	713,738	2,902	246
1886	753,043	" 150,608	903,651	3,147	287
1887	578,924	" 115,785	693,709	2,342†	296
1888	513,943	102,788	616,731	2,007	307

Total known and estimated yield of gold, 1858 to 1888	54,108,804
Average number of miners employed yearly	2,775
Average earnings per man per year	622

* Waddington's estimate.

† Exclusive of a number of men working on or prospecting for quartz.

Changes made in table as here published.

In comparing the years 1858, 1862 and 1863 of the above table with the same years as represented in the table as formerly published, it will be observed that the amount of gold is increased. This arises from the circumstance that some additional returns of exports, not accessible when the table was first prepared, have now been taken into consideration. These returns are to be found in Macfie's Vancouver Island and British Columbia and in Bancroft's Works, Vol. XXXII. There appears to be no doubt of the authenticity of these returns, and their addition brings the average earnings of the miners employed in the years in question into better correspondence with the number of the miners and with what is known of their success at the time.

Fluctuation in gold yield.

The most noticeable point brought out by the table is the great yield of gold resulting from the discovery and early years of working in the Cariboo district, and the gradual and scarcely interrupted decline in the product of the placers which has since occurred. The gold-yield also, however, shows a fluctuation from year to year, particularly when it is considered in connexion with the number of men actually at work. This depends not alone upon the uncertainty of the deposits worked and the development or otherwise of new fields, but also to a considerable extent on varying climatic conditions, some seasons being very unfavourable to placer-mining on account of floods or prolonged high water.

Gold Mining Districts.*—*Placer.*

Fraser and Thompson Rivers.

Character of the Fraser.

The Fraser carries to the sea a great part of the entire drainage of the interior of British Columbia. At its mouth, the great quantity of detritus which it has brought down has formed an extensive delta. Followed up to the vicinity of Hope, its valley becomes defined by bordering mountain-ridges which gradually converge to the mouth of the cañon at Yale. This lower part of the valley must be regarded as an ancient salt-water inlet which has been filled up by the material transported by the river, the harder and older rock-bottom of the valley being generally covered to a great depth. Between Yale and Boston Bar, (nearly opposite North Bend on the Canadian Pacific Railway,) it breaks through the axis of the Coast Ranges, flowing in a series of

* For administrative purposes, and in connexion with mining, the following districts are recognized by the Government of British Columbia.—Cariboo, Cassiar, Omenica, Lillooet, Yale, West Kootanie, East Kootanie. Some of these districts are very extensive, and the term district is here employed in a more restricted, if somewhat less definite sense, as a convenient one under which to group the various metalliferous occurrences. Thus the Cariboo district technically includes the Parnip River and upper part of the Peace River, while from the point of view of placer-mining, these are more appropriately treated of under the heading Omenica.

wild rapids through a ragged gash in the mountains. Along the sides of this cañon a scarcely passable goat track existed when the gold-miners first arrived on the scene. Beyond Boston Bar, the valley becomes a direct and deep north-and-south furrow all the way to Fort George in latitude 54°. The southern part of this portion of the valley cuts obliquely through the inner tiers or flanking ridges of the Coast Ranges, but its northern and upper part is excavated in the plateau of the interior, to the east of these ranges. From the point of view of the gold-miner, the Fraser may be regarded as a gigantic ground-sluice. Its valley, originally excavated in Tertiary times, in the rocky substratum of the country, was subsequently, during the glacial period, largely filled with drift material; through which, at a still later date, the river has had to re-excavate its bed, leaving great series of terraces or "benches" along its banks in many places, as this was gradually accomplished. A portion of the gold now found in its bed and banks has without doubt been worn out of its rocky matrix directly by the action of the river and its immediate tributaries, while another portion may have been derived from the glacially transported drift materials. The first-mentioned moiety may be supposed to include the 'coarse' gold, the last must be in great part 'fine' gold.

Origin of the gold.

A great proportion of all this gold, from whatever source derived, has been gradually concentrated in the river-bottom by the action of the stream, while in many places paying deposits have been left upon the surfaces of 'benches' at various levels, or buried beneath their material, each such 'pay streak' representing some portion of a former bed of the river which has been left behind as erosion progressed. Thus when the work of 1858 and 1859 began, the miners obtained, with comparative ease and in a short time, a large quantity of gold. How much gold has been obtained from the Fraser and the lower part of the Thompson it is impossible to ascertain, but it may be stated that practically the entire output of the Province for 1857 and 1858, with the greater part of that for 1859, was derived from this river, and by far the larger portion from that part of the Fraser extending from Hope to the mouth of the Quesnel. The aggregate yield for these early years alone cannot be placed at less than $1,700,000.

Distribution and quantity of the gold.

The mode of working these gold deposits was comparatively a simple one. The so-called 'bars' were nothing more than portions of the river-bed, which, being left bare at low water, could be reached by the miner. They varied in richness not only in different parts of the length of the river, but also in correspondence with the local relation of the currents and set of the stream. They were worked generally to but a very limited depth, being often merely skimmed over, in con-

Character of deposits.

Mode of working.

sequence of the trouble from water and the cost of removing any considerable thickness of non-remunerative material to reach deeper underlying 'pay streaks.' Most of the work was accomplished with the primitive rocker, and in 1858 no other means was employed on that portion of the river below Yale. At Yale, and further up, even in that year, sluicing was resorted to in some places, and a number of short ditches were constructed for the purpose of bringing water to the places worked. There were also, from the first, certain 'dry diggings' recognized and worked; these being auriferous layers in river-flats or benches which were above the high-water mark of the stream. When the exciting discoveries in Cariboo district became known, the Fraser was almost abandoned, long before its placers had ceased to be remunerative, but since that time more or less desultory work along the Fraser and Thompson has never ceased. A great number of the high benches have been in part superficially worked, and have in some cases yielded excellent results. In the bed of the river itself, at each season of flood, a partial re-arrangement of material occurs, and additional supplies of gold are brought in by the wearing away of the banks, a feature having important bearings on the probable successful application of hydraulic mining to some of these deposits.

Partial abandonment of the Fraser.

Though no longer exceptionally rich, the bars and benches of the Fraser seem to afford a practically inexhaustible supply of gold. Had no further discoveries occurred in the north, the Fraser would not so soon have been deserted by the energetic white population, but with the gradual improvement in methods of mining would have been made to yield a vastly greater amount of gold than it has yet produced. Nothing illustrates this fact more forcibly than the table given below of the annual yield of the river during late years. Hill's Bar, near Yale, has probably afforded more gold than any other single locality on the Fraser. It was estimated to have produced in all, (to 1875,) not less than $2,000,000 worth of gold from a total area of less than half a square mile. (Report of Minister of Mines of B. C., 1875, p. 17.) Its position at the foot of the very rapid portion of the Fraser, where the river first frees itself from the cañon and expands to a greater width, with a slacker current, is a suggestive one in respect to the origin of its gold. Instances of the yield of other bars are given in connexion with their enumeration on page 115 R, *et seq.*

Hill's Bar.

Partial statement of value of gold derived from the Fraser River and some of its tributaries, approximately as included in the list of localities, pp. 115 R *to* 119 R, 1874 *to* 1888.

1874	$ 55,000
1875	50,000
1876	42,000
1877	37,000
1878	14,000
1879	54,000
1880	93,300
1881	75,184
1882	70,200
1883	73,000
1884	122,934
1885	123,700
1886	157,000
1887	126,000
1888 (partial, not including Lower Fraser)	90,160

Yield of the Fraser.

The above table is derived from the returns in reports of the Minister of Mines of British Columbia. It is, unfortunately, very imperfect, even for the years which it professes to represent. It is more than usually difficult to obtain returns from the Chinese and Indians, in whose hands a large part of the work done here is. In addition, the returns for the several years are not strictly comparable, and do not in most cases include all the several localities referred to in the title. No returns appear to have been obtained from the Lillooet region in some years, and in others a portion of the upper part of the river is included in Cariboo district. I believe it would not be excessive to estimate the yield of the Fraser, including the Main Thompson River, Bridge River, and the Lillooet country at $100,000 per annum since 1860, which would give a total yield from that date to 1888, of about $2,900,000.

Future prospects of work.

It scarcely I believe admits of doubt, that extensive and successful mining enterprises based on the application of the hydraulic method of working, will yet be instituted along a great part of the length of the Fraser valley, while dredging or other methods by which the materials of the bottom may be obtained and treated, may also be profitably employed. The great extent of the bench or terrace deposits of the valley, with the excellent opportunity of disposing of the waste, offer exceptionally favorable conditions for hydraulic work, and tributary streams with a sufficient quantity and head of water for mining purposes are not wanting.

Importance of recording observations on placers.

On a subsequent page, a list is given of the principal bars and diggings which were formerly worked along the Fraser River. This list is as complete as the available information permits, both in regard to the names and positions of the bars, and in respect to their yield and the quality of the gold. It may be objected, that as many of these deposits have now ceased to be continuously worked, such a list possesses merely a historical interest. This, however, is far from being true. It is of importance, not only as a guide to the selection of localities for hydraulic or other similar systematic work on a large scale, but also as affording a clue to the places of origin of the gold, and in directing the search of the explorer who is in quest of paying deposits of gold in its original matrix.

'Coarse' and 'fine' gold.

It is unfortunate that so much of the practical information obtained by the early miners is now irrecoverably lost, but an examination of that which I have been able to obtain is sufficient to lead to certain general conclusions. Nothing has been more certainly ascertained in connexion with placer-mining in general, than that the 'coarse' or 'heavy' gold, unless under very exceptional conditions, does not travel far from the place of its origin, even in very rapid streams. 'Scale' or 'flour' gold may, however, be transported to great distances by a river such as the Fraser, before it finds a final lodgment, or becomes reduced by attrition to invisible shreds.

Fine gold on the lower river.

The lowest bar on the Fraser which was found to yield remunerative returns, was Maria Bar, about twenty-five miles below Hope, and nearly opposite the mouth of the Chilliwack River. Thence to Hope, and in the neighborhood of that place, all the gold found was 'flour' gold, of great fineness. In ascending from Hope to Yale, however, it was observed that the bars became richer and the gold was often not so fine. It is highly probable that all this gold was transported by the river itself, and that none of it has a local origin.

Runs of coarse gold.

From a point on the river a few miles below Boston Bar (or about sixteen miles above Yale) to Sisco Flat, a short way below Lytton, a distance in all of about twenty-five miles, rich deposits of 'heavy' gold were worked. Further up the river is a second run of 'heavy' gold, the limits of which cannot now be so well defined, but which appears to have extended from a point about half-way between Lytton and Foster's Bar, to some little distance above Fountain. Here nuggets of some size were occasionally unearthed, and there were some exceptionally rich diggings. On the Thompson, the vicinity of Nicoamen, where the original gold discovery occurred, has always been noted for its 'coarse' gold.

Connexion of coarse gold with rock-formations.

On comparing the portions of the Fraser River thus found to yield 'coarse' gold with the rock formations of the country, it is found that

the first described run of 'coarse' gold corresponds almost exactly with that portion of the valley which is excavated in certain schistose argillites and micaceous and other schists of dark colour to which the name of Anderson River series has been provisionally assigned. It must, however, further be remarked that a series of Cretaceous argillites, conglomerate and sandstones which have probably been deposited in a still earlier hollow excavated along the out-crop of the soft rocks of the Anderson River series, also runs parallel to this part of the river, on its east side; and that while it is probable that the gold has originally been derived from the Anderson Rivers eries, a portion of that now found in the river may have been obtained by the robbing of Cretaceous placers contained in these later rocks. This is rendered all the more probable, by the fact that the second run of 'coarse' gold again corresponds with a similar trough of Cretaceous rocks, in the bottom of which, though the occurrence of the Anderson River schists is known in some places, (as near Lillooet), these older rocks are not extensively exposed by the present river.

Coarse gold at Nicoamen.

Near Nicoamen, on the Thompson, the 'coarse' gold is found along a portion of the river which follows the junction of granitic rocks with the edge of a great thickness of Tertiary rocks, chiefly of volcanic origin. I have supposed that the gold may here occur in a disseminated form in some of the volcanic rocks or may possibly have been robbed from Tertiary placers occurring beneath the volcanic part of the series.

Guidance in search for gold-ores.

The 'coarse' gold is, in any case, on these rivers, distinctly in association with certain geological conditions which offer a fairly certain clue as to the rock-formations in which it should be sought for, either in the form of lodes, or in a disseminated state in certain beds. The precise location of exceptionally 'coarse' gold in certain bars and benches, making due allowance for a certain amount of movement down stream, should further give an indication of the actual localities in which the search for gold in its matrix may be engaged in with the greatest prospects of success.

Belt of gold-bearing rocks.

It may further be observed, that gold has been found on the Anderson River, on Lillooet River and on Bridge River, all nearly on the line of strike of the Anderson River series and the overlying Cretaceous rocks, in such a manner as to mark out pretty distinctly the course of an auriferous belt to the east of, and parallel with, the axis of the Coast Ranges.

Cariboo District.

The Cariboo district,* entered by the miners in 1860, has ever since produced the greater part of the gold of the Province. It has proved to be one of the best 'placer-mining camps' ever discovered, and though most of the heavy runs of gold on bed-rock, so far found, may now be considered as worked out, its capability as a field for placer-mining of one kind or other, is by no means exhausted, and the very limited area within which some of the richest finds have occurred, encourages the belief that no great difficulty will eventually be found in tracing these alluvial deposits to their sources.

Physical characters of the Cariboo district.

The fifty-third parallel of north latitude passes through the centre of the Cariboo mining district, which may be described as a mountainous region, but is perhaps rather to be regarded as the remnant of a great high-level plateau, with an average elevation of from 5000 to 5500 feet, dissected by innumerable streams which flow from it in every direction, but all eventually reach branches of the Fraser River. These streams, falling rapidly about their sources over rocky beds, descend into great V-shaped valleys, and, with the lessening slope, the rock becomes concealed by gravel deposits, which increase in thickness and extent till the valleys become U-shaped or flat bottomed, and little swampy glades are formed, through which the stream flows tortuously and with gentle current. The steep-sloping banks of the valleys are densely covered with coniferous forest, of which comparatively little has been destroyed by fire, owing to the dampness of the climate at this great altitude. The surface of the broken plateau above is often diversified by open tracts, affording good pasture in summer; and the whole country is more or less thickly covered by drift or detrital matter, concealing the greater part of the surface of the rocky substratum.

Progress of mining.

As in all new gold-mining districts, the shallower placer deposits, and gravels in the present stream-courses first attracted attention, but with the experience of California and Australia, it was not long before the 'deep-diggings' were found to be far the most profitable. Williams and Lightning creeks have, so far, yielded the greater part of the gold of Cariboo. They were known from the first to be rich, but have been found specially suited for deep work, in having a hard deposit of boulder-clay beneath the beds of the present water-courses, which prevents the access of much of the superficial water to the workings below. By regular mining operations, the rocky bottom of the valley is followed beneath fifty to 150 feet of overlying clays and gravels, the

Deep mining and old channels.

* This term is here used in a restricted sense, being applied to the mining region, and not to the much more extensive electoral district of the same name.

course of the ancient stream being traceable by the polished rocks of its bed, and the coarse gravel and boulders which have filled its channel. In the hollow of the rocky channel the richest 'lead' of gold is usually found, but in following the rock-surface laterally, side-ground, rich enough to pay well, is generally discovered for a greater or less width. The old stream-courses of the Cariboo district are found to have pursued very much the same directions that their present representatives follow, crossing often from side to side of the valley with different flexures, and occasionally running through below a point of drift material projecting into the modern channel, but never, I believe, actually leaving the old valley or running across the modern drainage system, as is so often the case in the deep placers of California and Australia.

Deep mining on Williams and Lightning Creeks.

The most important deep work was carried out in the old pre-glacial and buried channels of Williams and Lightning creeks, where it has now practically almost ceased. As the methods employed are, however, of interest in illustration of the mode of occurrence of the richer gold deposits, and may yet be applied to other valleys even in this district, the following description is included. It will serve as a general description of this class of mining, and is substantially the same with that given in the previous publication on the mines of British Columbia, and refers particularly to the work in progress at the time of my visit to Cariboo in 1876.

Shaft-sinking.

To reach the buried channel, on which it is generally impossible to sink directly through the superposed loose and watery materials, a shaft is usually sunk at the lower, or down-stream end of the claim, on the sloping side of the valley, where, after having gone through a moderate depth of clay or gravel, the slaty rock of the district is reached. The shaft is then continued through this, till a depth supposed to be sufficient is attained, when a drift is started at right angles to the course of the valley, and if the right depth has been chosen,—either by rough estimation, or calculation based on that required in other neighbouring workings—the old channel is struck in such a way as to enable the subterranean water collecting in it from the whole upper part of the claim, to be pumped to the surface by the shaft. On driving out of the slate rock, however, into the gravel, so much water is frequently met with that the pumps are mastered, rendering necessary a cessation of work till the latter part of the season, or the application of more powerful machinery. When the drift is not found to be at a sufficient depth to cut the bottom of the old channel, it is generally necessary to close it, and after continuing the shaft to a greater depth, to drive out again. The old channel once reached, and cleared of water, is followed up its slope by the workings, to the upper part of the claim, and where paying side-ground occurs this is also opened.

Drifting.

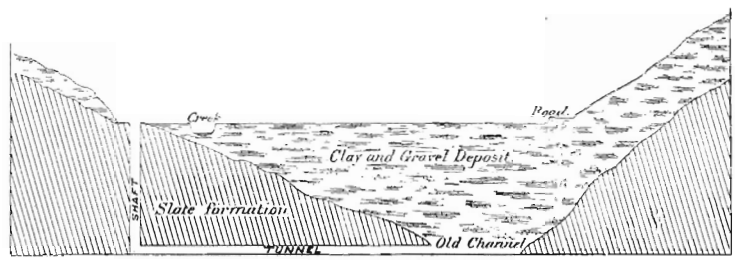


Fig. 1. Section across Lightning Creek valley at the lower end of Victoria Claim, shewing position of old channel, etc. From report by J. Evans, in Report of Minister of Mines of British Columbia, 1875. Approximate scale 120 feet to one inch.

Character of the buried deep channel.

The richest pay is generally obtained in the actual channel of the old stream, but where this is much contracted the force of the water is often found to have swept the gold away to those places where its width is greater. The harder rocks still preserve their polished and water-worn forms, but most of the slates are rotten and crumbling, to a considerable depth, and in cleaning up in the bottom, a thickness of one to two feet is frequently taken out with the pick and shovel, and sent up to the surface with the overlying gravel, for treatment. In the side-work, as in the central channel, the greater part of the gold is found lying directly on the 'bed-rock,' though, in some cases, particularly on Williams Creek, paying layers occur in the gravel several feet above it. The side-ground is worked up from the channel in successive breasts parallel to it.

Deposits of old channels.

The lowest layers of gravel generally contain many large boulders of quartz and slaty fragments not much water-worn, which must have come down from the hill-sides; the appearance being that of deposit by torrential waters to a depth of four to six feet in the channel, above which the gravel is generally better rounded, and more evenly spread, though still mixed with clayey matter.

Difficulties from water, etc.

In consequence of the unconsolidated nature of the gravel, the pressure on the supports of the workings is often excessive. The sets of timber are, in some places, only a few inches apart, and the whole of the workings have, in some cases, to be lined with complete lagging. The timber used is usually massive, being from one to two feet in average thickness, and consisting of the spruce of the country, simply barked and sawn into lengths. Its cost delivered at the mine at the date mentioned, was eight cents per running foot, all suitable sizes being taken at the same rate. The lagging, which is merely split out, four feet long, five inches wide, and two thick, cost seven dollars a hundred pieces. With every precaution, the timbers are frequently crushed by the pressure, or the uprights even forced downward into the slate.

Where large boulders are removed from the sides, or 'slum' is found, spruce brush requires to be extensively used behind the lagging, and in many places the water streams from the roof like a heavy shower of rain.

Flooding of workings.

The whole of such deep workings were, as a rule, annually filled with water at the time of the spring floods, and it was sometimes not till late in the summer or autumn that the pumps again acquired the mastery.

Van Winkle mine.

The following are particulars referring to the Van Winkle mine on Lightning Creek, which was the most successful in operation at the time of my visit in 1876.

The claim covered about 2050 feet in length of the valley, the deepest part of the old channel of which had been cleared out to a length of between 1600 to 1700 feet in October of 1876. Much side-ground, however, yet remained, and the workings sometimes attained a width of from 200 to 300 feet in following this up as far as it could be made to pay. The claim yielded the first dividend in December, 1873, $40,000 having been expended before gold was reached in the channel. It afterward paid handsomely, having produced in one week gold worth $15,700, and on other occasions at the weekly 'clean-up,' sums of $14,000, $12,000, etc. At the date above mentioned the total product of gold had amounted to the large sum of $500,965.

Water pumped.

In the Van Winkle mine, the average depth of the workings was about seventy feet only, the lowest shaft being placed 300 feet from the stream, on the opposite side of which the rock rises to the surface, forming steep cliffs. The water was raised to within forty feet of the surface, when it was discharged into an adit 3000 feet long, which was also used by other claims. There were two pumps, ten inches in diameter, the power being supplied by an eighteen-foot breast-wheel. This did not, however, represent the total volume of water pumped, as the ground of this claim was partly drained by others lower in the series, in which work could not be carried on till late in the season. In October of 1876 the following companies on Lightning Creek were driving their pumps day and night, the Van Winkle being the only mine clear of water:—

Costello Claim.—Pump, twelve inches diameter, nine-foot stroke, making ten strokes a minute.

Vulcan Claim.—Pump, twelve inches diameter, six-foot stroke, making eighteen strokes a minute.

Vancouver Claim.—Pump, twelve inches diameter, nine-foot stroke, making ten strokes a minute (double acting).

Van Winkle Claim.—Pumps, ten inches diameter, fourteen-foot stroke, making ten strokes a minute (two pumps).

The quantity of water being raised at this time would, therefore, amount to about 13,870 gallons a minute, or 19,874,000 per diem.

In many cases the machinery and appointments used in mining on the deep channel were very creditable, and almost the whole of this work was paid for by the miners of the district itself. Money gained in one enterprise was usually invested in another, and the share-holders in a mine were frequently to be found themselves at work in it.

Length of working on deep channel.

On Lightning Creek, the old deep channel has been followed and worked out to a length of about 16,000 feet in all, and in addition a number of rich bench claims and tributary creeks have yielded good returns. In endeavoring to 'bottom' the old channel further down the valley, very great difficulty is encountered, in consequence of the quantity of water and the increased depth of the sinking required. The Eleven of England is the lowest claim in which the old channel has been reached, and though evidence was here found, in the finer character of the gold, of increasing distance from the main sources of supply, it is probable that still lower portions of the valley may be proved to pay, with improved facilities.

Yield of claims on Lightning Creek.

It is impossible to present complete returns of the amount of gold obtained from the old bed of Lightning Creek, but the following approximate statement to November 1st, 1875, published in the report of the Minister of Mines of British Columbia for 1875, is still of interest in showing how large this amount, in the aggregate, must have been. The claims are here arranged in their order following down the creek.—

Campbell and Whitehall	$200,000
Dutch and Siegel (now Perseverance)	130,000
Dunbar	30,000
Lightning	153,962
Discovery and Butcher	120,000
South Wales	141,531
Spruce	99,908
Point	136,625
Van Winkle	363,983
Victoria	451,642
Vancouver	274,190
Vulcan	56,955
Costello	20,476

It would probably not be an exaggeration to state that the deep channel, for the portion of its length above referred to, with the adjacent side ground worked at the same time, has yielded throughout gold to the value of over $200 to the running foot.

Williams Creek

On Williams Creek, on which the towns of Barkerville and Richfield are situated, the chief workings have been in a space of about two miles and three-quarter in length. In this the deep channel has been worked

through, and also as much of the side-ground as would pay at the time at which the mining took place. Many of the lateral creeks and gullies here have paid remarkably well; and the hill-sides, in some places to a height of a hundred feet or more, have proved to be sufficiently rich for the hydraulic method of working, which is now profitably carried on. Though Williams' Creek has produced in the aggregate the greatest amount of gold, Lightning Creek showed for a time a larger annual yield.

Ground above and below 'The Cañon.'

'The Cañon' between Barkerville and Richfield divides Williams Creek into two parts. For about half-a-mile above it, the ground was shallow, and has been worked open to the bed rock. Further up, deep drifting was practised in former years and hydraulic work is now carried on. Below 'The Cañon,' all the work has been deep, in the old channel. alhough 'pay streaks' were sometimes found after getting down about twenty feet, these were usually disregarded in early days. In the Cameron claim, however, half-a-mile below Barkerville, the dirt paid nearly to the surface, and was worked in stages from below after the old channel had been cleared out. The workings were about sixty feet deep at Barkerville, only thirty-five feet at the former site of Cameronton, and at the Ballarat claim,—three-fourths of a mile below Barkerville—eighty feet. This is one of the lowest claims in which the old channel has been bottomed, and most of the gold obtained was light and scaly. The valley is here wide, the present stream turning abruptly to the west, while a wide, low hollow, known as Pleasant Valley, runs off in the opposite direction, to Antler Creek. It is supposed by many, that the main channel of the ancient water-course turns off in this direction, but owing to the great quantity of water and loose character of the ground, neither this nor the present valley of Williams Creek below the Ballarat, has yet been proved, though much money has been expended in the attempt. The Lane and Kurtz Company went to great expense in importing machinery and erected very complete works some years ago, but did not succeed in proving their ground, and have since abandoned the attempt. The place at which this work was carried on is known as 'The Meadows,' the valley here opening out and becoming wide and flat-bottomed. The Company held a concession covering about four miles in length of the valley, but succeeded in reaching a depth of 125 feet only, and in drifting out found that they were still too high for the deep channel, while the volume of water was greater than their pumps could master.

Lower part of valley.

'The Meadows.'

Yield of various claims.

As shewing the great local accumulation of gold in the deep channel of Williams Creek, and indicating its local origin, the following approximate statement of the value of gold obtained in various claims, covering certain lengths of the channel, is important. All these claims

were below 'The Cañon,' but they do not form a consecutive series, no such details being available for many other claims.—

Adams	100 feet.	$ 50,000
Steele	80 "	120,000
Diller	50 "	240,000
Cunningham	500 "	270,000
Burns	80 "	140,000
Canadian	120 "	180,000
Neversweat	120 "	100,000
Moffat	50 "	90,000
Tinker	140 "	120,000
Watty	100 "	130,000
	1340 "	$1,440,000

Prospects for further work on Williams and Lightning Creeks.

In Cariboo district, even to the present time, the prices of labour and supplies have never been lowered to a point at which it would be profitable to work any but the richer deposits, which in the nature of things bear a small proportion to those capable of yielding a moderate or small amount of gold; and in working over the deep ground in early days much was left that would even now pay handsomely, but cannot be found or reached on account of the treacherous nature of the moved ground, filled with old timbering and water. On both Williams and Lightning creeks, but particularly in the former, there must be a great quantity of gold in ground of medium richness even yet. To render this gold available, however, and to prove successfully the lower and more difficult parts of the valleys, greater and more exact engineering knowledge, better and larger machinery, and, above all, cheaper labour and supplies, dependent on greater facilities of transport, such as would result from railway connection, are required.

Bed-rock Drain and Flume.

The most important works of a general kind which have so far been carried out in Cariboo district are the Bed-rock Drain and Bed-rock Flume, on Williams Creek. The first of these is a tunnel which runs through all the old deep workings, beginning at the lower end of the part of the creek called 'The Cañon' (about 1000 feet above Barkerville) and running out in 'The Meadows.' The total length of this tunnel is about one and one-eighth mile, and the cost of its construction is estimated at about $100,000. The Flume, constructed in 1865, begins about 1000 feet above the head of the Drain, at the upper end of 'The Cañon.' It is a cutting averaging about twenty feet in depth and a mile in length, and is estimated to have cost about $250,000. Into it the small flumes of the various companies working along the creek discharge, and it has also served for the working of the ground belonging to the Flume Company. By means of the free drainage

afforded by these works, a great part of the later mining has been rendered possible.

Possible flume to Antler Creek

As an illustration of what might be done in this way, it may be mentioned, that it has been suggested, that by cutting a flume to Antler Creek — part of which would require to be a tunnel — free drainage of the whole upper part of Williams Creek would be obtained, and if the grade should prove to be sufficient on survey, it would enable the valley from its sources to the flume level, with all its old workings, and the great depth of tailings holding more or less gold which has accumulated, to be completely stripped by extensive hydraulic works.

Unproved deep ground on other creeks.

In the above general notes on Cariboo district, Williams and Lightning creeks have been particularly referred to as exemplifying the conditions there found, and the methods employed in working the old deep channels. These two creeks have, besides, yielded by far the greater quantity of the gold, and on them the pre-glacial channels have been found to be continuous, and though deep, specially well adapted for working. Underground drifting on old channels has, however, been practised, as well as several other creeks, of which Keithly, Harvey, Grouse and Mosquito creeks may be specially mentioned. There are besides a number of creeks which have yielded much gold by surface work or in open sinkings of moderate depth, portions of which still remain, which it is confidently believed by miners would prove rich in deep ground if properly explored. Antler, Cunningham, and Jack-of-Clubs creeks with Willow River are supposed to be specially promising from this point of view, and though attempts have been made from time to time to test the deep ground on several of these, it has not yet been successfully accomplished. On Antler Creek, in particular, the Nason Company has been at work with this object for a number of years, and has not yet abandoned the efforts.

Gold yield of Cariboo district

Approximate statement of value of gold produced by Cariboo District, from 1874 *to* 1888. *

1874 (partial)	$ 700,000
1875	1,075,237 †
1876	646,000
1877	411,402
1878	380,535
1879	500,000
1880	564,000
1881	610,737
1882	471,525

* From the Reports of the Minister of Mines of British Columbia.

† Possibly too high. Lighting Creek was, however, yielding well in this year, and was estimated to have produced $500,000 of this amount.

1883	457,787
1884	423,855
1885	347,700
1886	288,300
1887	247,673
1888	250,377

Remarks on yield.

The amounts above assigned to the various years are merely approximate, particularly for the earlier years of the series, the returns for which are extremely imperfect. The table as a whole, however, illustrates the large amount continuously afforded by the Cariboo district from a period beginning more than ten years subsequent to its discovery and after the most productive years had passed. It also evidences the gradual falling off in yield, which has been nearly continuous since the richer portions of the deep channel of Lightning Creek has been worked over.

Similkameen, Rock Creek and Okanagan.

Having given in the preceding pages a somewhat full outline of the general mode of occurrence and working of the gold-placers of Cariboo, which are the most important in the Province, the remaining placer-mining regions must be very briefly noted, reference being made for such special particulars as appear to be of interest to the list of localities on subsequent pages. The general features of the various districts, though here given in connexion with placer-mining, may also be referred to in connexion with vein-mining in the same localities.

Physical characteristics.

The Similkameen, Rock Creek and Okanagan region includes some of the first discoveries of gold in British Columbia, and has never since been entirely abandoned, though the amount of work carried on has fluctuated from year to year. This region stretches across the interior of the Province, and includes on one side streams rising in the inner flanks of the Coast Ranges; on the other, valleys which penetrate the western edge of the elevation of the Gold Ranges. The physical characteristics met with in this wide stretch of country are very varied, including mountains and plateau country with extensive wooded tracts penetrated with difficulty, but also some of the lowest, warmest and most arid valleys of the Province, like that of the Similkameen itself. The most notable portions of the region in respect to the occurrence of 'coarse' gold, of evidently local origin, are Granite Creek and Tulameen, Rock Creek and vicinity, Cherry Creek and Mission Creek. Elsewhere the gold is generally 'fine,' and is chiefly obtained from river-bars and flats, or from low benches. The most interesting features in the region are, the late resumption of gold mining

Localities of coarse gold.

on a somewhat extensive scale on the Tulameen, the recent discovery (in 1885) of rich deposits of 'coarse' gold on Granite Creek, an inconspicuous stream, passed by hundreds of prospectors in early years; the transference of attention from the more or less completely exhausted placers of Rock Creek and Cherry Creek to the development of veins containing the precious metals, in the same vicinity, and the occurrence in very considerable quantities throughout the Similkameen district of platinum, alloyed with other related metals. On these points, further details are given elsewhere. It may be added here, that no part of this region is now so remote from means of communication as to cause serious difficulty in the development of any really rich metalliferous deposits, and the adoption, where circumstances warrant, of improved methods of placer-mining on a large scale. Features of interest. Platinum.

No reasonably complete returns of the annual gold yield of the region here spoken of exist, in consequence of the desultory character of most of the mining, and the various channels by which the gold obtained found its way out of the country. Since the resumption of activity on the Upper Similkameen, consequent on the discovery of Granite Creek, the returns for that part of the region are given as below, in the reports of the Minister of Mines of British Columbia. Of the entire yield stated, Granite Creek itself has contributed $383,000.— Gold yield.

1885	117,500
1886	203,000
1887	128,000
1888	105,000
Total	553,500

Kootanie and Big Bend.

Disregarding numerous less important and scattered localities of gold-mining, the remaining districts which have acquired celebrity from this point of view, align themselves, with that of Cariboo, on that member of the Cordillera system, which has been described under the name of the Gold Range. The Kootanie region, including under that general term the somewhat distinctly separated Big Bend country, extends from the International boundary north-westerly to the Great Bend of the Columbia, with a length of 246 miles. It is, for purposes of description, also regarded as including the adjacent western slopes of the Rocky Mountains proper. Wild Horse, Perry, French, McCullough and Carnes creeks may be mentioned as the most productive, though there are also many less noted localities, and a great number of streams which have as yet been little, if at all prospected, though Principal localities of mining.

favourable in appearance. The mines of Wild Horse Creek have proved the richest in this region, though confined to about two miles in length along the valley of that stream. They were developed early in the history of gold-mining, and have ever since produced a considerable annual yield. Nearly all the other streams which enter the Columbia-Kootanie valley are known to hold more or less gold, and river-bars have been successfully worked along the Columbia and in places on the Kootanie. The discovery within the last few years of paying ground on Porcupine, Cañon and Quartz creeks, shows that the possibilities of this region for placer work are as yet by no means exhausted, and the resumption of work on Carnes, French and McCullough creeks, since the opening up of the country by the railway, bears similar evidence.

Physical characteristics.

With the exception of some considerable tracts of fertile and partly open country along the lower valleys, the greater part of this region is extremely mountainous. It is generally well wooded, often bearing fine timber, but it is penetrated with difficulty, and much yet remains to be done in the way of prospecting before it can be considered to have been even fairly run over in search of placer mines. There is good evidence, in several places, of the existence of rich, deep ground in the valleys of creeks partly worked in former years, and some attention is also being paid to the initiation of hydraulic work on a considerable scale. The climate in the lower valleys enables a prolonged working season to be obtained on the placers. The rough character of the country, with the circumstance that neither the Columbia nor the Kootanie is continuously navigable, renders many parts of the region very difficult of access, and up to the time of the opening of the Canadian Pacific Railway, communication with it was almost entirely maintained from the south, a comparatively small portion of the gold yield finding its way to the banks in Victoria, and therefore not appearing in the returns, though it may be supposed to be covered by the amount allowed for as not recorded. The recent developments of vein-mining in this region are elsewhere alluded to.

Gold yield of Kootanie district.

The gold-yield from 1874 to 1888 from the Kootanie district (nominally including also the Big Bend country, though except in the later years covered by the return, no mining of consequence was actually in progress there) is given by the Minister of Mines of British Columbia, as below.—

1874	$50,000
1875	41,890
1876	25,000
1877	37,000
1878	25,400

1879	19,000
1880	19,500
1881	25,000
1882	29,500
1883	29,100
1884	60,826
1885	76,650
1886	58,500
1887	37,900
1888	47,612

Omenica District.

Next in order, on the line of the auriferous axis of the Province, and separated from the last-mentioned region by a considerable interval in which no important gold-mining has yet occurred, is the Cariboo district, previously described.

Physical characteristics.

Still further to the north-westward along the same belt, beyond an interval in which the Gold Range can scarcely be traced, is the Omenica district, first entered about 1864, but scarcely developed till 1867. This district is situated near the 56th parallel of latitude and is in the drainage-basin of Peace River. The area within which the greater part of the mining has taken place is scarcely more than fifty miles in greatest diameter, and includes the upper portions of Germansen, Omenica and Mansen rivers and their tributaries. This area is described as being hilly rather than mountainous, and is nearly everywhere covered by the dense northern forest. A very high opinion was at first formed by miners of the Omenica district, but when the Cassiar discoveries occurred, it was nearly abandoned. In 1879, it was re-occupied by about fifty-seven Whites and twenty Chinese, and Vital, Germansen, Mansen, Black Jack (a tributary of the last) Slate and Lost creeks were being worked; but the richer known localities having been since worked over, the mining has gradually dwindled to very small proportions. In 1887, only twelve Whites and about eighteen Indians are known to have been at work, and the gold produced is estimated at $13,000. Much 'coarse' gold was obtained, but the diggings were generally complained of as being 'spotted' or irregular.

Mining.

Little 'prospected' region.

This district is practically the most remote and inaccessible in the Province, the cost of supplies has always been excessive, and the difficulties in the way of enterprise in the form of exploration thus very great. A wide area of promising country in this region, therefore, remains untried. The head-waters of Finlay River have always been considered particularly promising, from the fact that good 'prospects' of fine gold are found in all the river-bars, some of which have paid well for work

on them. The sources of the Nation River have also been favourably spoken of, and the Misinchinca and other tributaries of the Parsnip, present all the appearance of gold-bearing streams, but so far as I know have never been tested. The 'fine' gold which is found and has been mined along the whole upper portion of the Peace River, has doubtless been carried through the mountains by that stream, and is derived from the wide belt of dark, shaly and schistose rocks which runs along the western flanks of the Rocky Mountains in this portion of their length.

Arquerite or silver amalgam

Considerable quantities of arquerite, a silver amalgam containing about eleven per cent. of mercury, have been found with the gold in scales and nuggets, in Omenica, particularly upon Vital and Silver Creeks. This metal is commonly referred to by the miners as 'silver,' with which its appearance is identical (see p. 73 R). Very promising deposits of highly argentiferous galena have been found in the vicinity of the placer mines in Omenica, but no attempt has so far been made to work them. (See p. 73 R).

Routes to Omenica.

The miners reached Omenica by two principal routes, viz., with pack-animals, by trail from Quesnel *via* Stuart Lake, and on foot across the Babine and Fire-pan Mountains from the Forks of the Skeena, the Forks being attained in the first place by ascending the Skeena from the coast in canoes.

Gold yield of Omenica.

The gold-yield for the first and more prolific years of the Omenica district cannot be ascertained with any completeness, and even since the commencement of the annual government reports, a gap of three years occurs, no returns being given for 1876, 1877 and 1878. During these years, however, the field was virtually almost deserted. The following table is based on the government reports.—

1874	$38,000
1875	32,040
1876	no return.
1877	"
1878	"
1879	36,000
1880	45,800
1881	39,300
1882	25,330
1883	21,000
1884	12,000
1885	16,500
1886	17,600
1887	13,000
1888	no return.

Cassiar.

The Cassiar district, includes the most northern region of gold-mining in British Columbia, and some of the creeks which have been worked lie to the north of the 60th parallel, or northern boundary of the Province. Dease Lake, lat. 58° 30′, long. 130° may be considered as the central point of the district. This lake is the source of the river of the same name, which is a tributary of the Liard, itself a branch of the Mackenzie. Gold had already been found and worked on the river-bars of the Stikine for eleven years, when Thibert and McCullough, coming from the east, reached and discovered the richer deposits of the Liard drainage-basin in 1872. The miners, who soon flocked into the district, came by way of the Stikine River, though a route for cattle and pack-animals was also opened overland from Fraser Lake. Dease, Thibert and McDame creeks and their tributaries have proved the richest, and a large quantity of gold has been obtained from them; though the yield has, of late years, become comparatively inconsiderable. The region presenting identical or analogous characters with that portion of it which has proved to contain these rich deposits, is very extensive, and much the same remarks which have been made in regard to the exploration of the Omenica district apply here also, though the cost of living in Cassiar has usually been somewhat more moderate. The country is generally wooded and mountainous, and difficult to traverse, but a waggon-road or even a railway, might without difficulty be constructed from the head of navigation on the Stikine to Dease Lake, and this will no doubt eventually be accomplished, as discoveries of veins containing the precious metals are confidently to be anticipated. Argentiferous galena has already been found, and the rough, unworn character of the gold on some of the creeks leads to the belief that its source might be ascertained without great difficulty. 'Coarse' gold is found locally on that part of the Stikine above Telegraph Creek, and the circumstances appear to indicate the existence there of an old channel, above the present river-level, but covered by massive flows of basalt of Tertiary age. (see p. 47 R.)

Chief localities of mining.

Region to be prospected.

Difficulties have been encountered in this district from permanently frozen soil met with in mining, but when once the covering of forest and moss had been cleared off by fire these disappeared.*

Frozen soil.

The gold yield of the Cassiar District, from the commencement of mining to the present date, so far as known, is shewn in the following table, which, however, gives no returns for the earlier years of mining, when work was confined to the Stikine River.—

Gold yield of Cassiar.

* For further particulars on the Cassiar Region see Annual Report Geol. Survey, 1887. Part B.

1873	Not known.
1874	$1,000,000
1875	830,000
1876	556,474
1877	499,830
1878	519,720
1879	405,200
1880	297,850
1881	198,900
1882	182,800
1883	119,000
1884	101,600
1885	50,600
1886	63,610
1887	60,485
1888	43,325
Total	4,929,394

Yukon District.

This extensive region, situated to the north of the 60th parallel, and west of the main range of the Rocky Mountains, lies beyond the northern boundary of British Columbia, but in the continuation of the same metalliferous Cordillera belt, and is therefore naturally included in connexion with the Province. Gold-mining began here only in 1880, and so far has been chiefly confined to river-bar work, nearly all the long streams tributary to the Yukon having proved to yield more or less 'fine' gold. The aggregate length of rivers upon which gold has already been found is almost unprecedented, and the field for prospecting in search of richer deposits of 'coarse' gold is very extensive. So far the only discovery and mining of 'coarse' gold has been upon Forty-mile Creek, in lat. 64° 30′. The country is wooded and in general not extremely mountainous, and the rivers afford a means of travel in summer, though usually swift. Access to the country is, however, difficult, being generally obtained by way of the Chilkoot Pass which crosses the continuation of the Coast Ranges at the head of Lynn Canal.*

Great length of auriferous rivers.

Skeena River.

Gold yield of Skeena.

On the Skeena River, which reaches the Pacific near the northern end of the coast-line of British Columbia, placer-mining has been carried on to a limited extent during the past few years. Lorne Creek is the most important auriferous locality, but gold has been found in

* For further particulars on this region see Annual Report Geol. Survey, 1887, Part B.

several other creeks and gulches in the same vicinity. These are easily reached by canoe from the coast. The yield of gold, chiefly from Lorne Creek, is reported as follows.—

1884	$17,000
1885	18,000
1886	13,400
1887	5,280
1888	no return.

Vancouver Island.

In Vancouver Island, the only placer mining district of importance which has been worked, is that of Leech River, some particulars relating to which will be found on page 141 R.

General Considerations Respecting Placer Gold-Mining.

Future of placer-mining.

Though the yield of the gold-placers of British Columbia is now very much less than it was at one time, and shows at present a gradual decrease, placer-mining still contributes substantially toward the prosperity of the Province, and employs a considerable number of men. It is, moreover, to be anticipated that this form of mining may continue to be a feature in the industries of the Province for many years to come, and it is quite possible that circumstances may occur which shall bring about a notable revival of mining of this kind. Elsewhere it is commonly observed that placer-mining has been the first step toward vein-mining, not alone indirectly from the fact that the placer work has drawn a population to the metalliferous regions, but also directly by the actual tracing up of the gold first found in the alluviums to its original matrix. We cannot therefore afford to set this class of mining aside as a dead issue.

The future of placer-mining deserves consideration, particularly from the following points of view :—

Respective areas of rich and poor ground.

1. In each proved auriferous district, the poorer or less concentrated gold-bearing ground must necessarily greatly surpass in area that of the very rich deposits which alone pay for work with primitive appliances and with the cost of supplies and labour at high figures. Thus the cheapening of these essentials, produced by improved means of communication and by the settlement of the country, coupled with the attendant facilities for bringing heavier machinery and appliances into use, will enable the profitable working of greatly extended areas. These considerations apply particularly at the present time to the region of country in the vicinity of the railway or connected with it by

easily travelled routes. By the construction of the railway a large part of the Kootanie district, together with that bordering upon the lower part of the Fraser, has been opened up for work of this kind, and deserve particular attention. The hydraulic method of mining will doubtless rank first among the means to be brought into use for the utilization of the poorer deposits. From this point of view, the railway has also, to some extent, changed the conditions in the Similkameen and Rock Creek country, and in the Cariboo district. It has effected no change in regard to the Cassiar district, but as already noted, this district may, without great cost, be rendered easily approachable from the coast. The difficulties remain greatest with respect to the Omenica district, and a number of outlying places of less importance.

Further prosecution of placer-mining in known localities.

2. Another point deserving consideration, is the further exploration of the already known rich deposits of gold confined principally to the old buried channels of the streams. In reviewing the experience already obtained in working these, we notice, in a majority of cases, that it has so far been found possible to work lengths of from one to three miles of these old channels only, and while, in some instances, it appears that the rich ground is not more extensive, in many there is good reason to believe that much more remains, capable of yielding good returns, but which it has been found impossible to get at with the appliances and means at command. There are also quite a number of valleys in which, though the bed of the present stream has proved rich, the deep ground or old channel has not even yet been reached, or if reached, has not been satisfactorily tested. In all these cases it requires only more effective machinery and greater engineering skill to be brought to bear, to attain and work the deposits referred to, and it is likely that many of them will pay well when such means can be applied at a reasonable cost. It is not improbable, for instance, that thus treated, such localities as Williams Lightning, Cunningham and Antler creeks in Cariboo might be found to yield great additional amounts of gold, and whenever railway communication is provided for the Cariboo district, they will at least be thoroughly tested. Other methods involving extensive works with the same object, such as the damming or diversion of streams, and the construction of long, bed-rock flumes or drainage adits, fall under the same head, and there can be no doubt that extensive works of this character will eventually be undertaken in the Province with satisfactory results.

New discoveries.

3. The discovery of important new gold-bearing creeks is still to be anticipated from time to time. The small portions of the lengths of individual streams which have been found to contain great quantities of gold, is alone sufficient to show how easily such localities may be

missed or passed over in a rough mountainous country of great extent. Granite Creek and Coyooh Creek afford definite cases of this kind, the first discovered only in 1885, the second in 1886, and both in parts of the country which have been more or less thoroughly over-run by armies of prospectors for the past twenty-five years. The tracts which have been slightly or scarcely at all examined, even those situated on the line of the auriferous range, are very extensive, and in the Yukon district, to the north of British Columbia, the prospects for discovery of this kind appear to be most favourable, and are still almost limitless.

Probable existence of older placers.

4. Not the least important consideration, however, from the point of view of placer-mining, is that of the probable existence of placer deposits differing in age and character from those which have so far been worked in the Province. The rich deep leads of Cariboo evidently date from a period antecedent to that in which the country was for a time covered by a great ice-mass, or are, in other words, pre-glacial, and lie beneath the boulder-clay and other deposits due to the 'ice age.' The wearing down of the country-rock and natural concentration of gold had been in progress from the close of the Miocene or Middle Tertiary period (or perhaps in some localities even from an earlier date) to the glacial period. During the period of the Middle Tertiary, a great part of the Province included between the Coast Ranges and Gold Range became occupied by fresh-water lakes. These covered and by degrees filled up with their fine sediments, whole systems of drainage which had been produced during early Tertiary time; and into the lakes themselves, during the period of their existence, streams from the surrounding mountain regions discharged, forming gravel-beds, which are particularly abundant at the base of the finer deposits. Toward the close of the Middle Tertiary, extensive volcanic action occurred, producing the basalts and other igneous rocks which still overlie the greater part of the area of the old Tertiary lakes. Denudation which has gone on since this time, has locally removed considerable portions of these Middle Tertiary deposits, and has cut new valleys in them, and there

Character of Tertiary deposits and Tertiary placers.

Modern placers

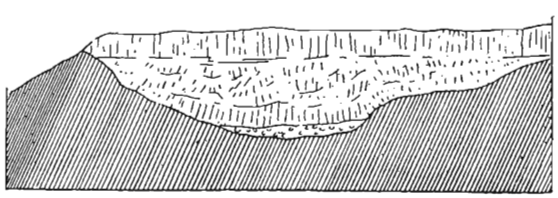


Fig. 2. Section on the Stikine River, above Telegraph Creek, shewing basalts filling a pre-Miocene valley and overlying the old river-gravels. From Annual Report Geol. Surv. Can., 1887, p. 71 B.

is reason to believe that some of the modern placer deposits have been enriched more by the robbing of these old, early and Middle Tertiary gravels than directly from the wearing down of the original rocks.

Places where ancient placers may be found.

Whenever, therefore, these old Tertiary gravel-beds or conglomerates exist in the vicinity of the known auriferous districts, they well deserve careful examination, though, so far as I am aware, none of them have actually been worked as yet in the Province. In such localities for example as Mission Creek, the South Similkameen and Whip-saw Creek, recent auriferous gravels rest upon the worn surface of Middle Tertiary rocks, consisting of soft argillites, shales and sandstones. These rocks are generally known to the miners as 'false bed-rock,' and it is highly probable that if they were sunk through to the bottoms of the still older valleys in which they lie, rich gold-bearing gravels or conglomerates might be found.

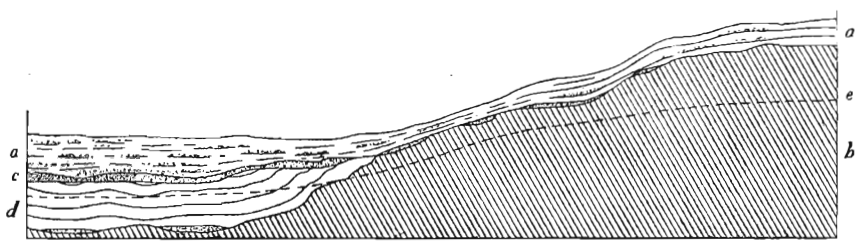


Fig. 3. Diagram representing mode of occurrence of gold on Mission Creek. *a*. Recent gravels. *b*. Crystalline rocks. *c*. Auriferous gravel. *d*. Tertiary beds, shewing the possible occurrence of underlying Tertiary placer-deposits. *e*. Line representing present bed of stream. From Report of Progress, Geol. Surv. Can., 1877-78, p. 157 B.

Mission Creek.

The accompanying section, reprinted from my report of 1877-78, illustrates the known mode of occurrence of gold on Mission Creek and the possible existence of old Tertiary gravels in that vicinity.

Probability of Cretaceous placers.

It is further probable that gravels dating from periods still earlier than the Tertiary, and now consolidated into conglomerates of varying degrees of induration, may be found to contain gold in remunerative quantity. Allusion has already been made in this connexion to the Cretaceous conglomerates of the Lower Fraser (p. 29 R), and similar conglomerates are also known to occur in great mass near Tatlayoco Lake and the head-waters of Bridge River, on the Quesnel River, and elsewhere. It may in fact be affirmed, that all gravel-beds or conglomerates of whatever age, occurring in or near the auriferous regions, are worth examination for gold, and particularly so when they are found directly in contact with the surface of the still older rocks which constituted the 'bed-rock' at the time of their formation.

The gravels and conglomerate deposits of the Middle Tertiary, often bear a distinct relation to the modern valleys in the more mountainous districts, in which the main outlines of erosion have been nearly constant from a very early period, but in the wider and lower parts of the Interior Plateau, great areas are covered by nearly horizontal flows of basalt, beneath which, should old auriferous stream-beds exist, they can only be traced by underground work or by boring, in the manner adopted at Ballarat and elsewhere in Australia and in some places in California. Since the period of deposition of the still older Cretaceous conglomerates, the surface of the country has suffered so many changes, including among others the elevation of the Coast Ranges, that these conglomerates now bear little or no relation to the present drainage systems.

Relation of placers of different periods to physical features.

The considerations above stated are not merely of a theoretical character, but are warranted by experience gained in other regions. The old buried placers of California (which Prof. Whitney believes to have been in process of formation by erosion continued throughout nearly the entire Tertiary peiod), and those of Australia, are so well known to most gold-miners as to require no more than mention. It is not so generally known, however, that conglomerates of Carboniferous and of Carbonifero-Permian age have been worked for gold in New-South-Wales, and in Queensland (as at Peak Downs) and that gold in greater or less quantity has been found in conglomerates of the Carboniferous period in Nova Scotia (at Gay's River), and in France. Of still greater interest, in the same connexion, is the existence of gold in the Potsdam conglomerates of the Black Hills in Dakota, where these rest upon the surface of certain still older schistose rocks which contain auriferous quartz-veins. Regular mining operations have been conducted in these conglomerates, and they have been found to be, locally, extremely rich. Mr. Jenny states that there are four distinct ages of

Instances of ancient placer deposits.

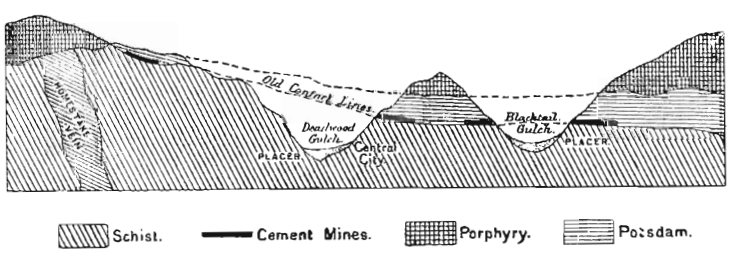


Fig. 4. Section in the Black Hills, Dakota, shewing the mode of occurrence there of ancient gold-placers in conglomerates at the base of the Potsdam sandstones, and the manner in which these have served as a source of supply of gold for newer placer-deposits in valleys subsequently formed by erosion. From paper by W. B. Devereux in Trans. Am. Assn. Mining Engineers, Vol. X, p. 468.

gravel formations in the Black Hills: —(1.) Potsdam, (2.) close of Tertiary, (3.) close of Glacial period, (4.) recent, and that all of these have proved to be auriferous, except the third. The accompanying section will illustrate the mode of occurrence of the 'fossil placers' of the Potsdam in the Black Hills, and the formation of recent placers secondarily from these, better than any description.

The auriferous Potsdam conglomerates are very compact, and require to be milled and treated like auriferous quartz, and the same may be said with respect to some of the old conglomerates or 'cements' of Victoria and of New Zealand. Some of those in Victoria are, however, stated to have yielded an average of twelve ounces of gold to the ton.*

Connexion of Placer-Mining and Vein-Mining.

Intimate relation of placers and gold-ores.

The transition from placer-mining to 'quartz-mining' is an easy one. The richer and more easily reached placers are, as a rule, soon worked over, and it then becomes natural to enquire as to the sources of these old concentrations. The consequent change of the centre of interest has already occurred in most parts of California and in Australia, but British Columbia is still in the transition stage in respect to gold mining. Save in a few exceptional cases, the occurrence of 'coarse' or 'heavy' gold in the old channels, may safely be accepted as proving that the original source of the gold is not far off. The distance to which 'coarse' gold travels is, as a rule, very inconsiderable, even in the beds of rapid streams. Additional evidence to the same effect is generally afforded by the varying assay value of the gold found on different creeks or even on different parts of the same creek, and this is often emphasized by the rough unworn character of the gold and the circumstance that it not unfrequently still holds imbedded fragments of quartz. It is from this point of view in particular, that it is most important to note and preserve a record of the observations made by the placer-miners in the course of their work, even where the deposits do not any longer continue to be remunerative.

Conditions in California.

Speaking of broad areas in California and Australia, where work of both kinds is in progress, it may be affirmed that the rich placer districts coincide with the rich quartz districts throughout. Innumerable special cases might be cited, if it were necessary, to shew the exceptionally rich local deposits of placer-gold depend on the occurrence of notably rich quartz-veins in immediate and clear relation to them, and in the fact that extremely rich localized placers have been found

* See, in this connexion, Ore Deposits, J. A. Phillips, pp. 232, 459, 508, 602; Mineral Wealth of Queensland, 1888, p. 25; American Inst. of Mining Engineers, vol. x, p. 466; U. S. Tenth Census, vol. xiii, p. 90.

in many parts of British Columbia, and particularly in the Cariboo district, we find justification for the belief in the future of 'quartz-mining.' It is true, that in some instances the natural concentration of the gold derived from the wearing away of a great mass of comparatively poor rock, may give rise to rich placer deposits, or that the veins from which the gold has been derived may be too irregular in richness, or too much broken, to be profitably worked themselves; but those exceptions cannot be regarded as negativing the general rule. The fact remains that a large proportion of the mines of precious metals in California and in Australia have been discovered by tracing the placer deposits of gold to their sources. Placer deposits derived from the Comstock lode were worked for ten years before the lode itself was discovered, and when found and opened, it proved to be essentially a great silver mine in which gold occurred in relatively small quantity. In the same way, the working of placer deposits preceded the discovery of the now celebrated Treadwell mine in Alaska, and the 'prospector' is justified in following up this clue wherever he can find it.

Placer deposits indicative of auriferous quartz.

General Remarks on Vein-Mining.—(*Precious Metals.*)

Gold.

The conditions of occurrence of workable auriferous lodes in British Columbia, yet remain to be studied in detail and discovered as the development of mining of this kind progresses. It may, however, be stated from what is already known, that while not confined to rocks of this class, the more important gold occurrences are usually found in connexion with areas of argillite-shales and schists, commonly of dark colours, and often more or less distinctly carbonaceous. Further, that only in certain parts of the extent of these argillite rocks have really rich placer deposits been found, a fact depending apparently on the occurrence locally of quartz-veins traversing them, and also, possibly, on the existence of igneous intrusions or other peculiar circumstances, which remain to be ascertained. So far as these generalizations go, they correspond with those already arrived at in California, saving that in British Columbia the argillaceous and schistose belts referred to, appear to belong to several geological horizons widely separated in date of formation, as already noted. The accessory local causes which have resulted in the deposit of gold in veins, etc., appear to be found most frequently in and near the Gold Ranges.

Occurrence of gold in British Columbia.

Comparison with California.

While it is not possible here, even if it were necessary, to enter into any general discussion of the features and principles of the mining and treatment of ores of the precious metals, it may be useful to those now

interested in the discovery and development of such deposits in the Province, to note very briefly a few important points bearing on this subject and dependent on recent investigations.

Tendency of recent mining.

As showing the general tendency of recent mining, and for the purpose of directing attention to the larger deposits of low-grade ores, I can not do better than quote the following judicious remarks of Mr. Clarence King, who writes:—"It may be said that the richer and purer ores which were sought for in the early days of mining, have been gradually giving way to those of more complicated nature and generally of lower value in the precious metals. Consequently in the reduction processes we find smelting acquiring a relatively more important place than it formerly held, and in milling an increasing use of dry crushing processes connected with subsequent roasting of the ore, and a marked growth of the lixiviation process."*

Low grade gold-ores.

A particular instance of the treatment of low grade gold-ore occurring in great mass, of special interest to British Columbia on account of its proximity, is afforded by the Treadwell mine in Alaska; the profitable working of which, upon a large scale, is rendered possible only by the great advance in modern appliances and methods of treatment. Further important evidence to the same effect is afforded by the results of recent mining in Australia and in the United States. From the

Australia.

Government Mineral Statistics of Victoria for 1887,† we learn that the average yield per ton in that year was 9 dwt. 9·95 grains only of gold, (0·471 oz.) the quantity of quartz treated being 780,733 tons, while the Ballarat district, one of the most important, yielded an average of only 7 dwt. 23·57 grains (0·399 oz.). Since the first publication of mineral statistics in Victoria, particulars have been obtained respecting 23,386,935 tons of quartz, the yield of gold from which averaged 10 dwt. 11·09 grains (0·523 oz.). The cost per ton for crushing alone, varied, in 1887, from 15s. to 4s. 6d.

California.

In certain localities in California, where the ore can be quarried rather than mined, under specially favourable circumstances, gold-bearing quartz yielding as little as $1 to the ton is reported to have been profitably worked.

For the purpose of further illustrating the class of gold-ores which may be worked with profit, the following tabular statement representing certain well known and largely productive mines in California and in the

Dakota.

Black Hills of Dakota, has been compiled. The first four mines yield free-milling ores, the last a sulphuret ore with only a certain proportion of free gold.‡ The figures for the two first mines and the fourth refer to the year 1885. Those for the third to 1884-85, and those for the fifth represent the average work for four years, 1881-84.

* U. S. Tenth Census, vol. xiii., p. xii.
† Mineral Statistics of Victoria for the year 1887. These figures refer to the ton of 2,240 lbs.
‡ See Hamilton Smith in Mining Journal, London, 1886, vol. lvi, part 2, p. 857, and T. G. Carning, in Engineering and Mining Journal, N.Y., 1886, vol. xlii, p. 419.

Mine.	Quantity of ore treated.	Mining.	Milling.	Management, etc	Total cost.	Total yield.	Profit.
	Tons.	$	$	$	$	$	$
Sierra Buttes, Cal.....	54,479	4.06	0 56	1.21	5 83	6.98	1.15
Plumas Eureka, Cal.....	56,052	4.36	0.61	0.60	5.57	7.69	2.03
Homestake, Dak.....	213,190	Total cost per ton, mining, milling, etc..			3.25	5.72	2.48
Father de Smet, Dak.....	106,855	" " " ..			2.12	3.57	1.45
Idaho Mine, Grass Val., Cal..... ...		Average cost of mining, milling, etc.....			8.97	18.59	9.62

Gold-ores of various kinds other than 'quartz.'

It is of great interest further to observe, as the result of discoveries and investigations made within the last few years, that in endeavouring to trace out the sources of placer-gold and discover workable gold-ores, attention should not be too exclusively given to quartz-veins alone. While the greater part of the known gold-ores belong to the class of quartz-veins, it is now found that gold occurs also in payable quantity in many other associations.

Peculiar occurrences of gold. Queensland.

It has long been recognized that certain belts of rocks containing numerous small and irregular quartz stringers only, will pay for mining and crushing as a whole, and where, as in Cariboo, there is reason to believe that the larger known veins can scarcely be looked upon as the true sources of the 'coarse' gold of the placers, such quartzose belts of country-rock may well be sought for and tested. In Queensland, Victoria and New-South-Wales, Mr. Daintree and others have been able to prove, not only that there is an association between the paying quartz-veins and the vicinity of the occurrence of certain intrusive igneous rocks, but also that in these intrusive rocks and notably in certain pyritous diorites, gold occurs in some instances in such quantity as to have produced paying placers by their decomposition. Similarly, in Colorado, between South Park and Blue River, Prof. J. J. Stephenson describes certain dykes of compact trachyte and Silurian and Carboniferous quartzites as the sources of the placer gold which has been extensively worked there, though not themselves containing gold in payable quantity.

Colorado.

North Carolina.

In further evidence of the wide distribution of gold, it may be added, that in North Carolina, Prof. W. C. Kerr notes the following rocks as being there auriferous. In Morse County, a mine which yields its gold mainly from felspathic schist. In the famous King's Mountain mine the gold is obtained not only from certain seams of quartz, but also from a sixty-foot bed of schistose limestone, which is quarried out bodily and sent to the stamps. Gold is also found in paying quantities in quartzite-schist and quartz-slate, and in "grey much jointed quartzites and felsites of the Huronian hills on the eastern side of the

great slate belt" of North Carolina. From these facts Prof. Kerr is led to conclude that, "gold is so widely diffused that we may expect to find it in any kind of rock."

Mount Morgan deposits.

The Mount Morgan gold deposit of Queensland, which is the most important recently discovered, illustrates still another peculiar occurrence of exceptionally rich gold-ore. The gold is here found minutely disseminated in a mass of brown and red hæmatite and siliceous sinter, which has apparently been produced by a former thermal and geyser-like spring. The gold-content of this material is no less than about seven ounces to the ton and at present 1500 tons a week are treated. Fragments of richly auriferous rock resembling that of Mount Morgan have been found at Clinton, in British Columbia, but have not yet been traced to their source.

Treadwell Mine, Alaska.

I am not aware that any systematic description has yet been published of the Treadwell mine of Douglas Island, Alaska, but from an examination of it which I was able to make in 1887, I may say that the rock there worked appears to be nothing more than an upper part or edge of a great granitic dyke or intrusion, which has broken through the black, slaty argillites of the region, and has been subjected to extensive hydrothermal action, produced either by emanations from the granite mass itself, consequent on its relief from pressure on approaching the surface, or subsequently to the intrusion of the granitoid rock by independent agency. This action, however brought about, has entirely decomposed whatever mica or hornblende the rock may have originally contained. It has also, to a great extent, decomposed the felspars and has charged the whole mass with quartz of secondary origin, which sometimes takes the form of minute stringers, but more generally spreads itself uniformly in the decomposed rock-material, and is associated with small crystals of auriferous iron pyrites and minute quantities of free gold. The same hydrothermal action which has caused the decomposition of the edge of the granitic intrusion, has evidently produced the quartz-veins found to penetrate the adjacent slaty rocks; which veins, in the neighboring "Silver Bow Basin," are found to hold gold in distinctly visible particles and small nuggets. The rock-formations met with on the part of the Alaskan coast where this mine is situated, being identical with those of the coast region of British Columbia, to the southward, it becomes important that all similar contacts of rusty or pyritous granitoid rocks with the argillites, should be examined and assayed, as it is not improbable that further deposits of the character of the Treadwell mine yet remain to be discovered there.*

* On peculiar modes of occurrence of gold referred to in the preceding pages, consult Ore Deposits, J. A. Phillips; Quart. Joun. Geol. Soc., vols. xxviii, p. 271, xxxiv, p. 431; U.S. Geographical Survey west of the 100th meridian, vol. iii, p. 423; Trans Am. Inst. of Mining Engineers, vol. x, pp. 340, 475; Mount Morgan Gold Fields, 1884; Mount Morgan Gold Deposits, Second Report, 1889, R. L. Jack, Queensland, Government; Mineral wealth of Queensland, 1888.

Silver.

Respecting silver-ores in the province of British Columbia, it may be stated, as the result particularly of the developments of the past two years, that these appear likely to achieve importance even before those which are distinctively auriferous. There is every reason to believe that before many years elapse the Province will take its place as one of the great silver producing regions of the world, and it is possible that silver may attain and continue to hold a greater importance than gold.

Definition of chief silver-bearing belt.

Characteristically silver-bearing ores have already been found in numerous widely scattered localities. The greater number of these, however, arrange themselves along the metalliferous belt which has already been referred to as that upon which the most important placer-deposits of gold occur. Argentiferous galenas appear to be the most abundant ores, and the knowledge of these already attained is sufficient to enable us to trace this silver-bearing belt, from point to point, from the International boundary north-westward to the 60th parallel of latitude (forming the northern boundary of the Province) and beyond it to Forty-mile Creek, where the Yukon leaves the North-west Territory to enter Alaska. The belt thus defined has the almost unexampled linear extent of about 1200 miles, and it may be said that wherever it has been explored and prospected (which has occurred generally in connexion with work on gold-placers), highly argentiferous galena ores have been found.

Discoveries in southern British Columbia.

The most considerable discoveries so far made, however, are those in the southern part of the belt, and for the most part at no great distance from the Canadian Pacific Railway. These deposits, it is fair to assume, have been brought to light on account of the accessibility of the region in which they occur; for nothing is known to show that other parts of the same belt of country, when similarly brought within reach and examined, may not prove to be at least equally rich in such ores. Even in the district in which discoveries and development are now being actively pushed at several centres, there is reason to believe that what has become known, bears but a small proportion to that which remains to be found; for by far the greater part of this rough mountainous country is still unexplored, or has been traversed only along certain routes, between which are wide, untrodden and often densely forested and rugged tracts. Thus, from every point of view, the discoveries made within a very short time in this southern portion of the metalliferous belt, must be considered as of the most encouraging character.

Modes of treating silver-ores and expense.

The principal modes of treating the various classes of silver-ores, depending on their composition, may be summarized as below :—*

Free silver, decomposed argentiferous ores or chloride minerals : Treated by free silver milling.
Silver ore, accompanied by sulphides of copper or other base metals : Low grade, fine concentration ; high grades, roasting milling.
Argentiferous copper- or lead-ores : Coarse concentration and smelting.

A large proportion of the ores found up to the present time in British Columbia, including nearly all those of the Kootanie region, belong to the last-noted class. The expense of treating such ores must vary very materially according to the cost of labour, fuel, etc., but may run from $15 to $25 a ton, and this the price of the metals in the ore must be sufficient to cover after all the cost of mining, concentration and transport to the smelter have been charged against them.

Vein-Mining Districts (*Precious Metals*).

Classification of ore-deposits.

Under this heading, it is proposed to give a few particulars relating to the various districts which have already attracted some notice on account of the occurrence of veins containing gold and silver. Some of the deposits mentioned might with equal propriety be classed as lead-ores or copper-ores, but when these contain the precious metals in workable quantity, it becomes more convenient to include them here. As it is difficult to follow any regular geographical order, the Cariboo district, as being that in which the earliest attempts at 'quartz-mining' have been made, is placed first.

Cariboo.

History of 'quartz-mining.'

The general features of the Cariboo mining region, have already been referred to in connexion with its placer mines. Almost from the first working of the placers, the existence of numerous quartz-veins was noticed, but no particular attention was given to these till the yield of alluvial gold began to be notably diminished. It was then felt, that notwithstanding the remoteness of this district, the existence of settlement and of a considerable mining population in it, justified the attempt to develop 'quartz-mining.' This feeling brought about the premature quartz excitement of 1877 and 1878, which was based on exaggerated ideas of the richness of certain known lodes, and on erroneous views as to the facility with which gold might be extracted from the pyritous ores which these afforded. From the collapse of this

* From the Mining Journal, vol. lix., p. 278.

excitement, vein-mining received a severe check, but in spite of this discouragement, the miners of Cariboo have not relaxed their efforts toward the development of vein-mining, their attention being, as is only natural, almost entirely directed to gold-bearing quartz.

Eventual success assured

From what is known of the district, I can entertain no doubt that it is destined to become an important vein-mining one. It has been made clear that in that part of the district in the immediate vicinity of the rich placers, there exists a great number of well-defined quartz-veins, and while such small tests as have so far been made, shew that a majority of these yield low returns in gold, some are already known to afford encouraging results, such as to warrant extensive working if the region were better provided with means of access.

Great number of veins.

The explorations of the miners have been assisted by the work (in 1885 and 1886) of Mr. Amos Bowman, of the Geological Survey. In a preliminary report already published* Mr. Bowman enumerates nearly a hundred ledges and 'quartz prospects' visited by him, adding that these do not comprise probably half the number noted or a hundreth part of the really good ledges which a prospector might find in the Cariboo country. These places are described in greater detail in his forthcoming report on the district. Notwithstanding the absence of railway communication, the prospects of the establishment of an important 'quartz-mining' industry in Cariboo were never so bright as at the present moment.

Group of promising veins

It is, of course, impossible to mention here all the very numerous localities in which ledges have been located or noted, or even to specify those upon which more or less prospecting and exploratory work has been done. These details will find a place in Mr. Bowman's forthcoming report. It may be stated, however, that Mr. Bowman considers the following groups or series of ledges as among the more promising ones known up to the present time, and apparently worthy of special attention:—

Ledges between Island Mountain and Mosquito Creek, extending two miles. (Including "Walker," "Sadou," and "St. John's" or "Island Mountain.")

Ledges near Williams Creek, from Lowhee divide to Proserpine Mountain, extending one mile and a half. (Including "Proserpine," "Stedman," "Big Bonanza," "Enterprise," "Victoria," and "Sam Crane.")

Ledges at Burns' Mountain, Lightning Creek, entending half a mile. (Including "Perkins," "Burns' Mountain," and some of the Lightning Creek ledges.)

Ledges crossing Grouse Creek. (Including "Dufferin" and "Fountain-head.")

* Report of Minister of Mines of British Columbia, 1886.

Ledges on Snow-shoe Plateau from Break-neck divide to French Snow-shoe Creek, extending about two miles and a half. (Including "Haywood" and "Arastra".)

Ledges crossing Hixon and Cañon Creeks. (Including "Washburne," "Stewart" and "Morrison.")

Table of assays

Reference should also be made to the assays from various veins given elsewhere. (See p. 76 R.)

Transition from placer- to vein-mining.

While it is conceivable that extremely rich placer deposits, like some of those of the Cariboo District, might be produced by the wearing down and natural concentration of great masses of rock, through which gold may have been very thinly scattered, or in which the gold occurs merely in small and irregular quartz stringers, there is no probability that such conditions are universal in the Cariboo district. The very 'coarse' character of much of the placer gold and the definite localization of the richer parts of the deposits here, shew that these must often be near their points of origin, and the problem now before the miner is that of ascertaining the sources of the gold, and discovering the rules locally applicable to the original deposits.

Points to be considered.

In connexion with this problem in Cariboo, I would invite attention specially to the points alluded to in the general remarks on vein-mining (p. 53 R) for the purpose of inducing an enlargement of the scope of the enquiry. It may also be mentioned that the very fact of the 'coarse' character of much of the Cariboo gold, goes to shew that while gold may exist as well in paying quantities in a finely disseminated state, much of it must evidently occur very irregularly in the productive ledges, from which it may, therefore, be necessary to obtain the average of a large quantity of rock before a conclusive test can be said to have been made. The existence of 'pay chutes' is a fact familiar to all miners, and has been found notably to characterize gold lodes in both California and Australia. Such chutes may form but a small portion of the natural outcrop of the veins, an additional circumstance calling for trials of lodes on a somewhat extensive scale before they can be affirmed to have been fully proved.

Relation of sulphurets to gold.

In the Californian gold belt, according to Mr. G. F. Becker, so general is the association of gold with sulphurets, that where gold is not visible, miners, judge of the value of an ore by the quantity of sulphurets it contains. Mr. Becker adds:—"Quartz with plenty of sulphurets and no visible gold often occurs in large bodies, and is apt to pay better in the long run than quartz with very coarse gold, or 'specimen quartz,' as it is called by the miners."* While this rule seems to hold also to a considerable extent in Cariboo, particularly in the association of gold in veins with iron-pyrites, it would appear, so

* U. S. 10th Census, vol. xiii, p. 10.

far as experience has gone, that it is either not so constantly the case, or that the proportion of gold in the pyrites is less considerable than in the gold belt of California. This and other similar points are, however, only to be settled by exploratary work and by working tests, and as several very strong pyritous lodes are already among those best known, it will probably not be long before their character is fully ascertained.

Test-mill.

With the object of encouraging such trials, the government of British Columbia has erected a test-mill, near Barkerville, which is at the present time nearly ready for work. There are also already in the same vicinity four small stamp-mills.

Kootanie.

This region includes the Selkirk and Purcell ranges and adjacent western slopes of the Rocky Mountains proper. It may be conveniently divided, for purposes of description, into West and East Kootanie, the line of separation following approximately the watershed between the two arms of the Columbia River.

Recent development of rich ores.

Since the Selkirk Mountains have been traversed by the Canadian Pacific Railway, and have thus been rendered accessible, and a means afforded for the shipment of ores, very active prospecting has been carried on in a number of localities, and has resulted in the discovery of numerous deposits of rich ores, principally silver-bearing. This region is, at the present moment, that in which the interest of mining men is chiefly centred, and the developments so far made,—though but in their initiatory stages,—are of the most promising kind. The summer of 1889 will no doubt witness great activity in this entire region, and it is confidently expected that before the autumn the first really considerable shipments of silver-ores will have been made, and the reputation of the region as an argentiferous one well established. Though not in a position to speak from personal investigation of the localities which have quite recently sprung into notice here, I am indebted to Messrs. G. M. Sproat and A. W. Vowell, Gold Commissioners, and to Mr. G. B. Wright, for a number of particulars, upon which and on such other information as is available, the following brief notices are based :—

West Kootanie.—

Chief metalliferous belt.

The principal metalliferous belt which has so far attracted attention in this region, is believed to extend along the western slope of the mountains, with a width of about twenty miles and a general course slightly to the west of north, from a point six or eight miles south of the outlet of Kootanie Lake, nearly to the Big Bend of the

Columbia, where the Selkirks, as a distinct range, seem to terminate somewhat abruptly. The localities on this metalliferous belt which require special notice, are, in order from south to north, *Toad Mountain Mining Camp*,* with silver and gold ores; *Hot Springs* and *Hendryx Camps*, with silver-ores and lead; *Illecillewaet*, with silver and lead ores; and the *Big Bend region*, apparently characterized principally by gold-bearing quartz.

Mining Camps.

Toad Mountain

Toad Mountain Camp.—The centre of the group of metalliferous deposits included under this name, is situated about four miles and a half south-west of the outlet of Kootanie Lake, some forty miles north of the International boundary, at an elevation of about 3900 feet above the lake, or approximately 5700 feet above sea-level. The deposits were discovered in the autumn of 1886. They occur principally in a belt of calcareous rock (called by the miners a lime-shale), which is said to be bounded on both sides by granite. This belt has a width of a little less than a mile, and has already been imperfectly prospected for a length of five or six miles. The course of the metalliferous belt is nearly east-and-west, running along the northern slope of the high, southern mountain-wall of the valley of the Kootanie River. The silver-bearing lodes are, however, not strictly limited to the above described belt, but have been found also in various places several miles removed from it. The claims registered in and near the Toad Mountain Camp numbered on the first of August last 228. The deepest shaft at that time did not exceed seventy-five feet, and most of the shafts or tunnels were much less than this in depth or length. The most prominent claims at the present time appear to be those in the Hall Brothers group, the "Silver King," "Kootanie Bonanza" and "American Flag." The first-named is that upon which the largest amount of work has been done. The outcrop of the vein here showed an apparent width of about twenty feet, but is reduced to a width of from six inches to four feet, at the depth to which it is now opened. There are no well-defined walls, the ore being apparently incorporated closely with the country-rock. The ore is said to consist of copper-stained iron-ore, peacock copper, copper-pyrites and tetrahedrite, with streaks of what the miners term 'brittle silver,' and is often very rich. Assays of choice specimens are said frequently to run from 100 to 1700 ounces of silver to the ton. I have seen the returns of a trial shipment of twenty-two tons of ore, sent for treatment to Montana, which yielded $6463, chiefly in silver. The ore was hand-picked, but not otherwise concentrated. It was divided into two lots, which assayed respectively:—

Silver ores.

"Silver King."

Trial shipments made.

* The expression "mining camp" is here used in its western sense, as a convenient and generally recognized term for a mining district of limited area, more or less definitely separated from others.

	I.	II.
Silver	297·70 oz.	285 oz.
Gold	$2·16	$1·44
Copper	28·9 %.	27·2 %.

Other small shipments have since been made of similarly rich ore, but no systematic plan has yet been adopted for working the mine on a large scale.

Other claims shew a greater amount of galena, which is apparently present in the "Silver King" ore in very small quantity only. The "Dandy Mine" and the "Tough-nut Mine" are mentioned as shewing veins from four feet to ten feet wide, the ore from the latter being stated to assay about $100 to the ton in silver. About sixty claims in all have been partially prospected or opened up to a limited extent, most of these being within an area about three miles in length. Character of ores and veins.

West of the silver-bearing veins, and upon Cottonwood Creek, near the Kootanie River, claims have been located which show rich free-milling gold-ores. These have lately been bonded for $40,000, which amount is believed to be covered by the ore in sight, while another gold-bearing deposit has been purchased, the intention in both cases being to put in stamping machinery in the spring. Gold ores.

Most of the claims in this camp appear to be held by the discoverers at very high prices, which circumstance has up to the present time somewhat tended to prevent its rapid development.

Hot Springs Camp.—The Hot Springs Camp is situated on the west side of Kootanie Lake, about thirty-five miles from the last. It may be said to embrace an area of about five miles by three, lying between Coffee and Woodberry creeks. The country-rock is described as being a mica-schist, with associated magnesian limestone, and it is said that some of the veins can be traced without apparent break or interruption for distances of one or two miles, with widths varying from two to eight feet. The argentiferous galena appears to be somewhat irregularly distributed in these veins, with a thickness varying from a few inches to three feet. Near the lake the ores are stated to assay from twenty to forty ounces of silver to the ton, but at a greater distance and elevation, the ores appear to be more decomposed, assuming a rusty appearance, and being known to the miners as 'carbonate ores.' The ores of this class are generally found to be richer in silver. About sixty claims have been partially developed in this camp. During the past season a considerable amount of capital has been invested here and good prospects have sold well. The highest price so far paid for a claim is $20,000, on a bond, a few days only after its discovery. Other claims and interests in claims have changed hands at prices ranging from $5000 to $1500. A considerable quantity of ore Hot Springs Camp. Argentiferous galena.

is now being brought down to the edge of the lake in small lots for shipment.

Quantity and quality of the ore.

In a letter received from a gentleman well able to judge of the facts, it is said that in quantity the ore of the Hot Springs Camp will equal the Cour d'Alaine mines, while in quality the ores are much better, some of them carrying three or four times the amount of silver to the ton. According to the same authority, it is stated that it appears that there are several distinct veins running northerly and southerly for a distance of about five miles, all shewing a continuous body of fair grade ore, say thirty ounces to one hundred ounces of silver, and sixty per cent. or more of lead, and that for each hundred feet in vertical depth the various veins already discovered will eventually turn out 500,000 tons of shipping ore in the aggregate.

Various claims.

Of the numerous claims taken up in this camp, some of those which have attracted most attention, and for which notes are available, are enumerated below. As before explained, while unable to speak from personal knowledge of the accuracy of the statements made, I have every reason to believe that they are in the main correct:—

"Little Donald Mine."—Situated 1250 feet above the lake. Vein, eight feet wide, shows two feet and a-half of galena, which assays 60 to 130 ounces of silver to the ton, and 60 per cent. of lead. "Krao Mine."—Galena obtained here said to run over 100 ounces of silver to the ton, and a few tons of rich 'carbonate' ore yielded 280 ounces to the ton at Butte City. "Sunshine Mine."—Apparently a strong vein, six feet wide, but little developed. Runs N. 60° W., cutting across the others. Assays said to average sixty ounces silver to the ton. "Gallagher."—Situated higher up the mountain than those above-mentioned. Ore largely the so-called carbonate ore, *i.e.*, galena, etc. decomposed by sub-aerial agencies, soft and easily worked. Assays said to run from 60 to 190 ounces silver to the ton. Contains about 10 per cent. of lead, with a large quantity of iron oxide. "No. 1 Mine."—On a line with the last. Ore of the same character. Assays from 60 to 500 ounces of silver to the ton.

Hendryx Camp.

Hendryx Camp.—Situated on the east side of Kootanie Lake, opposite Hot Springs Camp, the lake being here about a mile and a-half wide. The galena ores of this place are said to have been discovered by the botanist Douglas in 1825, and have frequently been referred to, but have only of late come into prominence, though locations have been taken up and successively abandoned several times. The ore is understood to be of comparatively low grade, but to occur in great mass and to be of easy access, being situated close to the shore of the lake. The "Blue Bell Mine" is owned by the New Haven Mining & Smelting Co., which has already spent $100,000 in preliminary work. The galena

Character of its ore.

here occurs in a series of parallel veins, separated by bands of limestone, and associated with oxidized vein-matter. The vein is reported traceable on the outcrop for over 400 feet, and has been cut across at some depth by a tunnel 195 feet long, and shows in one place an unbroken body of galena ore 86 feet in width. The galena is said to assay from 15 to 40 ounces of silver to the ton. Several hundred tons have been shipped and several thousand are plainly in sight. The "Kootanie Chief" and "Comfort" mines, in the same vicinity, are owned by the Ainsworth Syndicate. Little development has yet been made on either of these, but their appearance is reported to be equally favourable with the last.

Great size of veins.

In addition to the above recognized 'camps,' it may be stated that in this region numerous isolated 'prospects' of silver-bearing galena have been found in the same general district. One of these is situated about eight miles west of the Columbia River, near the Boundary; and another to the east of the Columbia, on the summit of the divide between Slocan Lake and Kootanie Lake. 'Prospectors' report a very large surface showing of galena at this place. Following the Lardo River, which enters the north end of Kootanie Lake from the north-westward, nearly on the line of the main metalliferous belt referred to on a former page, we find several lodes of silver-bearing ores reported, but respecting the extent or richness of these nothing absolutely certain is known. On the north-eastern arm of the Upper Arrow Lake, known as Galena Bay, locations have been recorded on a vein which is said to assay 50 ounces in silver to the ton, and on the head waters of Fish River, running into this bay, another vein is reported, yielding about 100 ounces in silver to the ton. Continuing a short distance still further northward, we reach the Illecillewaet River and line of the Canadian Pacific Railway.

Continuation northward of metalliferous belt.

Illecillewaet Mines.—This group of mines is chiefly contained in the angle between the north and south branches of the Illecillewaet River, in a very mountainous country. Over 200 claims have been located here, and on sixty or seventy of these the work necessary to hold them under the provincial mining law, has been done. Some of the claims are not far above the valley, but many are high up in the dividing ridge between the two rivers, and the ore so far brought down from there has been carried on mule-back.

Illecillewaet.

Dr. Selwyn describes the mode of occurrence of the ores here as follows.*—

Mode of occurrence of ores.

"The argentiferous galena of Illecillewaet occurs chiefly in quartz-veins, cutting a series of black carbonaceous or graphitic slaty shales,

* Summary Report Geol. Surv. Can., 1887, p. 4.

and thin bedded limestones, often much folded, but shewing an average dip of from 35° to 40° to E.N.E., and apparently flattening towards the summits of the mountains. Most of the veins are parallel with the stratification, though not unfrequently passing from one bed plane to that of another. No fossils have yet been found in these slates, but they closely resemble the black graptolitic shales, described by Mr. McConnell, p. 22 D, Annual Report Geological Survey, 1886, and may be of Cambro-Silurian (Ordovician) age."

Work done on claims.

This group of mines has been, on the whole, more fully developed than any in the Kootanie region. During the past two years, galena and 'carbonate' ores have been shipped in larger or smaller quantities to Omaha or San Francisco, for smelting purposes. Work has been steadily carried on by several companies with a view to development. A two-thirds interest in one claim has been sold as a 'prospect' for $16,000, and many 'prospects' have changed hands at $3000 down to small or nominal sums. The Selkirk Mining & Smelting Company has sent out about 500 tons of ore, derived principally from the "Lanark Mine," which is situated in sight of the railway, but at an elevation of about 3000 feet above it. This ore is stated to have produced about 100 ounces of silver to the ton. The erection of an aerial wire tramway is contemplated. About 500 feet of tunnels have been driven to intersect the lode, the lowest being at 400 feet below the

Various claims.

level of the out-crops, and about 300 feet of drifting in the lode has been done. The same company holds the "Sutton," "Sprague," "Whale" and "Shark" claims to the north-west, and the "Isabella" and other claims in a south-easterly direction from the "Lanark." The Corbin & Kennedy Company also own several claims, of which their "No. 2" is stated at the present time to be the most promising. This vein is said to be from four to eight feet in width, and has been penetrated by tunnels for a hundred feet. It is a concentrating ore, and can be reduced to one-tenth by ordinary methods of concentration, the concentrates being reported to run from 300 to 400 ounces of silver to the ton. Promising veins of galena and grey copper ore are covered by other claims, from which assays running from 100 to 2800 ounces (in one instance) have been obtained, but no systematic

Gold only in traces.

work has yet been performed on any of the properties, with the exception of those above mentioned. Gold occurs only in traces in these ores. There is a crushing and sampling mill, capable of treating one hundred tons of ore a day, at Illecillewaet Station, on the railway, and a small village has sprung up there. This 'camp' seems to show every appearance of becoming a permanent ore-producing one of considerable importance.

Big Bend.—Very little is yet known respecting the prospects of vein-mining in this part of the Kootanie region, but what information has been obtained is of a favourable character. There appear to be indications that the argentiferous belt runs northward from Illecillewaet through it. The placer-gold mines of the district have been referred to on a former page (p. 39 R), and a number of quartz-veins are reported, from which some exceedingly rich specimens of gold have been brought. Prospecting has, however, so far, chiefly been turned toward placer mines, of which Gold Creek and its tributaries are the most noted localities. These are reached by river, or by trail of about sixty miles in length from Revelstoke. It is probable that prospecting for veins will be actively carried on here in the near future. On Carnes and McCulloch creeks veins of argentiferous galena are reported. Big Bend.

In his official report for 1888, Mr. Sproat writes, of the West Kootanie District.—"We already, when nothing beyond 'prospecting' work on mineral claims has been undertaken, have marketed about 600 tons of silver-ore—most of it in galenite, of which total about 60 tons have returned over 300 ounces; 100 tons, 110 to 150 ounces; and 440 tons, 60 to 70 ounces, silver, per ton. The close of the season, and want of means of transport, alone prevented more of the higher grades from being marketed. The time is not far distant when I shall have to report to you a product of 500 tons a day of silver ores from this district, with a fair proportion of ores of high grade."* Future of the mines.

East Kootanie.—

What may be described as the East Kootanie division, includes the eastern slopes of the Selkirk and Purcell Mountains, the upper parts of the Columbia and Kootanie valley, (separating those ranges from the Rocky Mountains) and the western slope of the Rocky Mountain Range. The discoveries so far made of deposits of the precious metals in this district, other than placer-mines, appear to be confined to that portion of it to the south of the railway. Here, during the year 1888, according to Mr. A. W. Vowell, the Gold Commissioner, 102 claims have been taken up, upon twenty-three of which assessment work has been performed; but with the exception of certain claims at Mount Stephen, no mining work of importance has yet been undertaken. The prospects of the district as a whole are, however, at the present moment extremely encouraging, and there is every reason to believe that mining will here before long be prosecuted with vigour. Claims taken up.

The localities which have up to the present time attracted most attention, and round which most of the claims are gathered, are as follows:—Mount Stephen, near Field Station, Canadian Pacific Rail- Principal localities.

* Report of Minister of Mines of British Columbia, 1888, p. 302.

way; Otter-tail, near the station of the same name; Spilimichene and Jubilee Mountain, Columbia River; Spilimichene River, Second Fork; McMurdo district, near head of the Spilimichine River.

Mount Stephen

At Mount Stephen (Tunnel Mountain) the four original claims, known as the "Monarch," "Cornucopia," "Alpha" and "Mogul," are stated to have been sold for $25,000 to the British Columbia Smelting Company, which company has expended a large sum in opening up the deposits, and has already, to the end of 1888, shipped about 600 tons, chiefly from the "Monarch," to their works at Vancouver. The geological formation of this locality is fully described by Mr. R. G. McConnell in a late report of the Geological Survey,* where some account of the mineral deposits is also given. The ore is galena, which frequently appears in considerable mass, nearly pure. It seems to impregnate a zone of interbedded calcareous rocks, and had been traced for a considerable distance even before the work previously spoken of had been carried out. It is most favorably situated for shipment, but carries a very moderate amount only of silver, which, according to assays made in the laboratory of the Survey, varies from four to eleven ounces to the ton.

Otter-tail.

At Otter-tail, one of the claims is situated directly under the railway-track, and several others at no great distance from it. In the report last referred to, the ore is described as an argentiferous galena, associated with some copper and zinc, and holding traces of gold. It occurs in quartz and calcite veins, which run parallel or nearly so to the strata of the calcareous schists and limestones of the district. The veins seldom exceed eighteen inches in thickness, but the ore is reported in some instances to contain a high percentage of silver. Several assays made in the laboratory of the Survey run from 5·8 to 113·7 ounces of silver to the ton.

Cinnabar.

Further down the Wapta (Kicking Horse) River, not far from Golden, and also in the immediate vicinity of the railway, a vein of white calcite holding flecks of bright red cinnabar, has been 'prospected' to some extent.

Copper ores.

The deposits of copper-ore met with in Copper and Castle mountains and in their vicinity, may also be alluded to here, though, as they occur to the west of the water-shed, they lie beyond the eastern boundary of British Columbia. Massive specimens of purple ore have been obtained at the first-mentioned locality, and some work has been attempted in connexion with the deposits, though so far without important results. The precious metals are found in these ores in very small quantity, and, generally speaking, the result of numerous assays made up to the present time, is to shew that neither the lead- nor copper-ores of the Rocky

* Annual Report Geol. Surv. Can., 1886, Part D.

Mountains proper in this region, compare favourably in this respect with those of the Selkirk and Purcell mountains.

Jubilee Mountain. Jubilee Mountain, situated on the west side of the Upper Columbia River, about thirty miles south of Golden Station, and in easy communication with that place by the river, has been the scene of considerable 'prospecting' operations during the past two years. The ore-deposits here are said to occur in a limestone formation and to be very massive, though of somewhat low grade in silver and containing scarcely any gold. The specimens received, show much copper in the form of copper-glance and other sulphurets and some galena. They are generally much decomposed, and present a rusty or greenish appearance. Assays of the richer specimens made in the laboratory of the Survey run from 5·1 to 39·37 ounces of silver. Thirty-five claims were recorded here or in this vicinity in 1888.

Vicinity of Spilimichene River. In the vicinity of the Spilimichene River, which flows into the Columbia thirty-seven miles south of Golden Station, active 'prospecting' has been in progress, the discoveries being in three groups, known as Spilimichine Mountain, Second Fork of Spilimichine River and McMurdo District, including the Middle Fork of the river. Not having had an opportunity of visiting these places, I am not in a position to give details relating to them. In 1888 nine claims were taken up in the first, nine in the second, and twenty-one in the third. The "Spilimichine" and "Rothschild" claims, taken up in 1884, are said to be upon a ledge of great size, containing galena and reported to average $12 to the ton in silver, without concentration. Four claims, known as the "Southern Cross," "Monitor," "Great Republic" and "Old Dominion," in the McMurdo district, are stated to have been bonded for $36,000, and others have been sold. Assays are said to run from $15 to $200, almost entirely in silver. Specimens of ores received consist of quartz, holding galena, with some tetrahedrite, copper-pyrites, etc. Two assays made in the laboratory of the Survey shew 13·88 and 37·53 ounces, respectively, in silver, but it is doubtful whether these fairly represent the general character of the ores.

Various claims.

Wild Horse and Toby Creeks. Five claims have been recorded lately on Wild Horse Creek and a like number on Toby Creek, covering deposits of argentiferous galena. Ore from the first-mentioned place is reported to contain $20 to $80 in silver, from the second 65 ounces of silver to the ton. The lode on Toby Creek is said to be very large and well defined, and has been partly opened up on the "Jumbo claim."

Interior Plateau Region.

In a number of places in the southern part of the Province, included between the Gold and Coast ranges, or on the western and eastern flanks respectively of these mountain systems, discoveries of ores holding silver and gold have been made. Of these the following require special mention as being those in which groups of claims have been located and some 'prospecting' and exploratory work undertaken. Of these Stump Lake and Rock Creek are, however, the only ones which, as yet, are entitled to be called 'mining camps':—Cherry Creek, Rock Creek, Stump Lake, Jamieson Creek, Upper Tulameen, Cayoosh Creek, and Big Slide.

Principal localities.

Cherry Creek.

The occurrence of exceptionally rich silver-ore at Cherry Creek, thirty-three miles east of the head of Okanagan Lake, has been known for a number of years, and several attempts have been made toward the development of the deposit, but difficulty has been experienced in following the vein. The "Hidden Treasure Mining Company" are at present engaged in prosecuting exploratory work on a scale more extensive than previously attempted, and apparently with fair prospects of success. The ore consists of argentiferous tetrahedrite or freibergite, with galena and blende, the gangue being quartz, and the country-rock blackish shales or slates. Average specimens broken from a large mass of the richer ore, yielded on assay 658·43 ounces of silver to the ton. In addition to the vein here particularly referred to, several other silver-bearing veins have been found in the same neighbourhood, and pellets of galena found in the sluice-boxes on the creek above the out-crop of the principal vein, yielded at the rate of 220·93 ounces of silver to the ton. These doubtless indicate additional silver-bearing deposits which have not yet been discovered.

"Monashee ledge."

Eight miles south-eastward from the placer-mines on Cherry Creek, on the south slope of the mountains between Cherry Creek and Kettle River, is the so called McIntyre or "Monashee" ledge. This is said to contain free gold. Some 'prospecting' has been done upon it and a trail has been cut out from Cherry Creek to the ledge.

Rock Creek and vicinity.

The general character of Rock Creek, situated a short distance north of the International boundary, and east of Osoyoos Lake, is elsewhere noted in connexion with its placer gold-deposits (p. 38 R). This locality has been visited by Mr. Bowman of the Geological Survey, but at the time little had been done in the matter of quartz discovery. During the past two years, however, general attention has here been turned in this direction, and very promising discoveries are reported, including both free-milling gold-ores (yielding some very rich specimens) and argentiferous galena-ores. On a claim known as the "Cariboo,"

a tunnel 200 feet in length is reported to have been driven, as well as a couple of shafts of fifty feet in depth. On the "Argen" claim, a prospecting shaft forty-two feet deep has been sunk, and the "Vancouver" has been opened to a depth of fifteen feet. On the "Eureka" is a shaft of about one hundred feet. A little mining town has already sprung up here.

At a place about twenty-five miles west of Rock Creek and twelve miles north of the Boundary-line, discoveries reported to be important have been made within the past few months. The ore is described as containing galena and free-milling gold. Twenty-eight locations have so far been recorded here.

Nicola or Stump Lake mines.

In the year 1887, 200 claims were recorded in the vicinity of Stump Lake, and during the summer of 1888, I had the opportunity of examining a number of these, comprising all those upon which any considerable amount of work has yet been done. Some locations were originally taken up in this neighbourhood about six years ago, but 'prospecting' work appears first to have been undertaken in 1885. The principal developments are comprised within an area of about five miles in length, with a variable breadth, lying nearly north-and-south on the east side of the lake. The claims included in the property of the "Nicola Mining Company" and in the adjoining property of the "Star Mining Company," are those upon which the most extensive operations have been undertaken, confined, in the case of the first-named property, to development by means of several shafts and 'prospecting' on the surface. In the case of the second, a small crushing and concentrating plant has also been established. Development and 'prospecting' has also occurred to a considerable extent by the "Mary Reynolds Company" on the "Hepburn" group of claims, on the opposite side of the valley and further south than those above mentioned, and from these, some of the richest ore, of which very satisfactory trial shipments have been made, has been obtained.

Developments made.

Mr. W. J. Sutton reports that up to the end of the year 1888, about 2000 feet in all of good working shafts and tunnels have been run in the course of development of these Stump Lake or "Nicola" mines.

Character of the veins.

The metalliferous veins which have been found within the limited district above defined, are very numerous. They vary from about ten inches to five or six feet in width, and some of them have been traced for a length of several hundred feet. Though it is probable, from the great number of veins which exist, that no single one will be found to be continuous for a very great distance, a large supply of ore is already assured. Most of the veins run with very considerable uniformity in bearings a few degrees west of true north, or from N. 10° W. to N. 30° W. magnetic. There are, however, a few which diverge widely from

this direction, and two or three which run nearly at right angles to it. The gangue is generally white quartz, and the principal metalliferous minerals present include iron- and copper-pyrites, galena, blende and tetrahedrite. Assays made in the laboratory of the Survey, run from 15 to 406·5 ounces of silver, with 0 to 6 ounces of gold per ton of 2000 lbs., according to the relative amounts of the various mineral constituents. The country-rock consists of altered volcanic materials of Palæozoic or Triassic age and may be generally characterized as a diabase-porphyrite, the most characteristic material in this place being a rock of green and green-grey colour with coarse porphyritic crystals of plagioclase and pyroxene.

Encouraging prospects.

On the whole, the prospects for the immediate development of an important mining district are here most encouraging. The occurrence of these ores in the green, altered, volcanic rocks, which under slightly varying forms occupy so large an area of the southern interior of British Columbia, is a feature of peculiar interest, inasmuch as it leads to the belief that these wide-spread rocks become a metalliferous series where the other conditions are favourable.*

Jamieson Creek

In the vicinity of Jamieson Creek, which flows into the North Thompson from the west, fifteen miles from Kamloops, a number of claims have been recorded within the past two years, though very little work has yet been done on them. The veins occur in a mass of greyish granite, which breaks through certain black micaceous schists or argillites which form an important intercalation in the Palæozoic rocks, generally of volcanic origin, of this part of the Province. The granite is highly silicious in the vicinity of the veins, and these appear to have been produced contemporaneously with the intrusion of the granite. The gangue is quartz and contains pyrites, with a little galena, blende and tetrahedrite. Assays made in the laboratory of the Survey shew from seven-tenths to one ounce of gold and two and a-half to thirty-four ounces of silver to the ton. Little can as yet be proved respecting the continuity of the veins in this district, and the area within which claims have been recorded is comparatively small. The surface display of quartz is, however, considerable, and this, with the rich character of the ores, would appear to warrant some expenditure of a tentative character. The thickest vein seen is from five to six feet in width. It may further be mentioned in this connexion that similar veins were seen by us near the the head-waters of Jamieson Creek.†

* See Summary Report Geol. Surv. Can., 1888, p. 6. Report of Minister of Mines of B.C., 1887, p. 275.

† See Summary Report Geol. Surv. Can., 1888, p. 7.

On the Upper Tulameen, above Granite Creek, several quartz-veins have lately been discovered, but nothing except a limited amount of preparatory work has yet been done toward their development. I may state, however, that the district appears to be worthy of attention by the 'prospector,' as it presents very favorable indications, and the rocks often show evidence of solfataric action, being highly silicified and holding much pyrites in certain belts. A specimen of ore collected by myself at the "Bonanza Queen" location, has since been ascertained on assay to contain 1·3 ounces of gold, and 5·1 ounces of silver, to the ton of 2000 pounds. A remarkable indication of the existence somewhere in the Tulameen basin of extremely rich ores, is found in the discovery in sluice-boxes on the river, about thirteen miles above Granite Creek, of small rolled pellets of pure silver-glance strung through with filamentous gold. Tulameen region.

On Mad River, a tributary of the North Thompson above the Clearwater, a vein has been discovered and prospected, a specimen from which yielded on assay in the laboratory of the Survey gold 4·37 ounces silver 21·35 ounces to the ton. Locations have also been made on the Clearwater, Deception Creek and Mahood Lake, but their character has not been proved. North Thompson.

The quartz-veins recently found on Cayoosh Creek, near Lillooet, about twelve miles up the creek, are the sources from which the gold of the rich placer-deposits which have been worked there during the past few years, has been derived. Assays of quartz from these veins made in the laboratory of the Survey, give a remarkably favourable showing, the gold being free and minutely and uniformly distributed through the rock. These assays run from 0·722 to 0·992 ounces in gold to the ton. The country-rock is a dark, slightly micaceous slate or schist. This is much broken up and disturbed, and the veins are very numerous, but small and apparently irregular. It would appear to be worth ascertaining, at this place, whether some portions of the rock with its included veins would not pay for extraction and crushing as a whole. The work yet done here is merely ' prospecting.' A discovery is reported to have been made in 1888, in this vicinity, between the head of Anderson Lake and McGillivery Creek, of a strong lode of quartz containing galena, and assaying to the value of $46 in silver with $14 in gold to the ton. Cayoosh Creek.

On the " Big Slide Mine," the property of the Foster Mining and Milling Co., a considerable amount of work has been done and expenditure incurred in bringing in and erecting crushing and chlorinating machinery, etc. The deposit, which was discovered in 1872, is situated on the bank of the Fraser River near the mouth of the Kelly Lake Creek. The vein is reported to be from fifteen inches to five feet in " Big Slide mine."

width and traceable for a long distance. The average value of the ore is reported as $22·50 to the ton, of which $20 is gold. The highest assay reported is one of $118. Operations are at present suspended, owing to difficulties met with in saving the gold.*

Coast Ranges.

Silver mines near Hope.

The most important discovery of silver-ore yet made in the Coast Mountain belt is that near Hope, on the Fraser. The veins here run through a mass of conglomerate which caps a mountain known as Silver Peak, of which the lower part is composed of granitoid rocks. The conglomerate is believed to be of Cretaceous age. Difficulties which have occurred in connexion with ownership, have unfortunately so far prevented the working of this very promising deposit. The following notes concerning it are chiefly derived from the Report of the Minister of Mines of British Columbia for 1874, p. 16.

"Eureka" and "Van Bremer"

About 1871, veins of silver-ore were discovered in the Coast Mountain Range at Fort Hope about six miles south of the town. The first vein discovered, named the "Eureka," crops out about 5000 feet above the river-level, is well defined, and from four to seven feet thick, and has been traced 3000 feet. A tunnel 210 feet long has been driven into this vein. For milling purposes, the ores would have to be lowered about 3000 feet to Silver Creek, distant about 6000 feet. The ore is described as argentiferous grey copper, and contains from $20 to $1050 of silver to the ton. While this vein was being opened, another, about 300 feet distant, was discovered. This is much richer, and is called the "Van Bremer." The ore is described as chloride of silver, and the vein contains from $25 to $2403 of silver to the ton. A quantity taken from the out-crop sold at San Francisco for $420 a ton. This vein can be traced for half a mile.

A specimen of the Hope silver-ore—"a yellowish decomposed vein stone"—assayed by Dr. Harrington gave 271·48 ounces of silver to the ton of 2000 lbs. It also contained lead, copper, antimony, iron, arsenic and sulphur.

A specimen from the "Eureka" mine—"a vein-stone of spathic iron with some quartz"—assayed by Dr. Hunt, gave 347·08 ounces of silver to the ton of 2000 lbs., and contained also copper, antimony and sulphur.

"Murphy's Mine."

About two miles above Hope, on the opposite side of the Fraser, a vein occurs which is reported to hold silver to the value of $15 to $45 to the ton. Some work has been done here in former years, and a tunnel 540 feet long driven for the purpose of intersecting the vein.

* See Reports of Minister of Mines of B.C., 1886, pp. 211, 218, 1887, p. 273.

Some work has also been carried on from time to time, but so far without leading to any considerable developments, on veins situated on Yale Creek, near the town of Yale. Ore from the "Queen Mining Company's" claim is reported to contain galena, blende, iron- and copper-pyrites and to have afforded assays as high as $38 to the ton, in silver.* Yale.

Omenica.

The situation and character of the Omenica country has already been noticed in connexion with its gold-placers (p. 41 R). In association with the gold in some of the creeks, arquerite, a species of silver amalgam presenting the outward appearance of native silver, is found in grains and nuggets (p 145 R). This mineral consists of silver combined with mercury.† It has not yet been found in place either here or elsewhere in the Province, but it is worth noting that it constitutes the principal ore in the mines of Arqueros, Coquimbo, Chili. Also, however, in the immediate neighbourhood of the gold-deposits is a number of large veins carrying highly argentiferous galena, which, from the accounts received of them, appear to require only improved means of communication to ensure their profitable working. A number of claims were at one time taken up upon these, but they have probably since been abandoned. The "Arctic Circle" and "Black Warrior" are adjoining claims on Boulder Creek. The former is said to shew a vein twenty feet wide with about four feet of highly metalliferous ore. The latter is described as a vein eight feet wide of nearly pure galena. Other specimens of similar ores have been obtained from several places within a radius of eight miles of these. The "Champion ledge" is situated near Lost Creek and is similar in character, but particulars concerning it are wanting. Another vein on this creek is reported to be twenty feet wide. Assays run from 29·8 ounces to 128 ounces in silver to the ton, the last mentioned representing a galena free from gangue. Some specimens also carry an appreciable quantity of gold.‡ Arquerite. Argentiferous galena ores.

Other Localities.

Still further north-westward, in the same general line, is the Cassiar District (p 43 R), in which practically nothing has yet been done toward the discovery or development of any but placer-mines. Large Discoveries in Cassiar.

* See Reports of the Minister of Mines of British Columbia, particularly report for 1879, p. 245.

† The mineral when pure consists of silver 68·5 per cent. Mercury 13·5 per cent. A nugget from this district, analysed by Messrs. Riotte and Leckhardt, of San Francisco, contained silver 83·30 per cent, mercury 11·00, lead 0·40, copper 0·20, as well as traces of gold, platinum, and iron.

‡ Report of Progress, Geol. Surv. Can., 1879-80, p. 110 B.

veins of quartz are reported to occur in the vicinity of some of the auriferous streams, and an attempt was at one time made to work some of these on a small scale by means of an arastra. Argentiferous galena ores also occur here, a specimen of one of which, from the South Fork of McDame Creek, on assay in the laboratory of the Survey proved to contain 75 ounces of silver to the ton, while still higher assays have been reported.

Silver-ores in Yukon district.

Far beyond the northern boundary of the province of British Columbia, and still following the same belt of country, upon Forty-mile Creek, near the point at which the Yukon crosses the 141st degree of longitude (p. 44 R), argentiferous galenas are again found, one of which, collected by Mr. W. Ogilvie and lately examined, contains over 38 ounces of silver to the ton.

Queen Charlotte Islands.

It is not possible here to include mention of the numerous isolated localities in which discoveries of ores of unproved value have been made, or in which they have been reported. A number of these appear in the list of localities and in the table of assays on later pages. Allusion is elsewhere made to the exceptionally rich, though apparently quite limited gold vein of Mitchell Harbour, in the Queen Charlotte Islands (pp. 17 R, 143 R). This occurrence seems, at least to hold out encouragement for further search in the rocks of the same character as these inwhich it is, and which are very largely developed upon the coast of the Province.

Texada.

During the last few months attention has been drawn to the existence of gold-bearing veins on Texada and a considerable amount of 'prospecting' has been carried out on the island and a large number of claims have been recorded. The ores are said to be pyritous and favourable assays are reported, but I am unable to give any definite particulars respecting them. Their character will doubtless be fully proved during the coming summer.

"Stirling Mine."

Reference may also be made here to the "Stirling Mine," Kokesila River, about twelve miles from tide-water, Cowichan District, Vancouver Island. Some 'prospecting' work has been done here. The ore is an argentiferous galena with some gold, and assays are quoted showing from $10 to $75 in silver to the ton.*

* Report of Minister of Mines of British Columbia, 1880, p. 431.

TABLE OF SELECTED ASSAYS OF ORES FROM BRITISH COLUMBIA, CONTAINING GOLD AND SILVER.

NOTE. *Most of the assays quoted here in summary form, have been made in the Laboratory of the Geological Survey. The various reports in which there are given at length, are denoted simply by the date and page, in the last column. Those to be included in the report for* 1888, *have not yet been published. A few additional authentic assays from other sources, are also quoted.* (*Names of minerals specially prominent in any ore are printed in italics.*)

Cariboo District.

No.	LOCALITY.	ASSOCIATED MINERALS.	GOLD. Ounces.	SILVER. Ounces.	Reference.
1	"Big Bonanza," between Williams and Lightning Creeks, Cariboo. (Highest assay of specimens received)	Quartz with some pyrites	0·554		76-77, p. 478
2	Cariboo, average of 9 samples (separate localities not stated.)		1·424	0·766	77-78 p. 49 G.
3	"Discovery claim," Little Snow-shoe Ck., Cariboo	Rusty quartz with limonite and iron-pyrites	0·408	0·058	87, p. 40 T.
4	"Flynn's diggings," Mosquito Ck., Cariboo	Galena and iron-pyrites	0·182	26·458	87, p. 44 T.
5	"Dufferin ledge," Grouse Ck., Cariboo	Quartz with *pyrites*	2·042	0·292	87, p. 45 T.
6	"Proserpine ledge," Barkerville, Cariboo	Quartz, chlorite, iron-pyrites, galena	0·787	29·738	87, p. 45 T.
7	"Home Rule ledge," Barkerville, Cariboo		traces.	25·521	87, p. 45 T.
8	"Perkins ledge," Burns Mt., Cariboo	Rusty Quartz with galena	2·625	3·033	87, p. 46 T.
9	" " " "	*Galena*, quartz, iron-pyrites	0·365	29 8·6	87, p. 46 T.
10	Hixon Creek Mine, Cariboo		0·403	1·225	87, p. 47 T.
11	" " "	Quartz with copper-glance, copper-pyrites, galena, etc	0 583	29 983	86, p. 37 T.
12	" " "	(Concentrates)	8·021	18·229	86, p. 37 T.
		West Kootanie.			
13	Toad Mountain	Association of Limonite, calcite and quartz, with copper-pyrites, tetrahedrite and iron-pyrites		59 687	1888.
14	Toad Mountain (vicinity of)	Bornite and quartz		119·218	87, p. 50 T.
15	"Silver King Claim," Toad Mt., (assay by Johnson & Matthey)		trace.	771 000	
16	"Silver King Claim," Toad Mt., (assay by Johnson & Matthey)	(Specimens collected by Mr. R. D. Atkins)	trace.	422·000	
17	"Silver King Claim," Toad Mt., (assay by Johnson & Matthey)		trace.	75·800	
18	"Silver King Claim," Toad Mt., average assays of	Contained copper 28·9 p. c	0·108	297·70	
19	trial shipment, in two lots	" " 27·2 p. c	0 072	285·95	
20	"No. 1 Claim," Hot Springs Camp, Kootanie Lake	Decomposed vein-stuff with galena "carbonate ore"	trace.	214·637	1888.

21	"Lu-lu Claim," west side Kootanie Lake	Galena	traces.	15·454	85, p. 26 M.
22	"International Claim," west side Kootanie Lake?	*Galena*, tetrahedrite, etc	2·187	60·871	1888.
23	"International Claim," west side Kootanie Lake	Chiefly galena	traces.	10·719	85, p. 23 M.
24	Fifteen miles up Fish River, Upper Arrow Lake	*Galena*, iron-pyrites and quartz		108·646	1888.
25	Illecillewaet River	Galena, blende, iron-pyrites, quartz	trace.	45·2 8	87, p. 52 T.
26	" " north side	Quartz, iron-pyrites, galena		247·917	87, p. 53 T.
27	" " south side	Galena, tetrahedrite, iron-pyrites, quartz		484·167	87, p 53 T.
28	Three miles up N. Fork Illecillewaet, east side	*Galena* with a little quartz and calcite		80·937	1888.
29	"Minnie F. Claim," six miles up N. Fork, Illecillewaet, east side	Quartz, *galena*, tetrahedrite, iron- and copper-pyrites		139·427	1888.
30	Six miles up N. Fork Illecillewaet, west side	Quartz, *galena*, copper-pyrites	trace.	30·988	1888.
31	"Edmond's Claim," two miles from Illecillewaet station, N. of C. P. Ry	Quartz, *galena*, iron-pyrites, etc		116·302	1888.
32	"Maple-Leaf Claim," Illecillewaet River	*Galena* with calcite, etc		65·625	86, p. 40 T.
33	"Shamrock Claim," Illecillewaet River	*Galena* with calcite		78·750	86, p. 40 T.
34	Illecillewaet (vicinity of)	*Galena*, copper-pyrites and calcite	traces.	79·95	85, p. 28 M.
35	" "	Chiefly galena	traces.	74·521	86 p. 33 T.
36	" "	Quartz with *galena* and blende		142·187	8 , p. 53 T.
37	" "	Galena		66·354	86, p. 34 T.
38	" "	Galena	trace.	74·375	86, p. 34 T.
39	" "	Quartz with tetrahedrite, copper-pyrites, etc	trace.	248·616	87, p. 53 T.
40	" "	Galena, quartz		47·39	87, p. 53 T.
41	" "	Quartz, galena, tetrahedrite, blende, iron-pyrites	trace.	127 604	87, p. 54 T.
42	" "	Galena	trace.	57·604	8 , p. 54 T.
43	" "	Galena and quartz	trace.	54·687	87, p. 54 T.
44	" "	Galena and quartz	trace.	67·813	87, p. 54 T.
45	" "	Galena, tetrahedrite, quartz		180·104	87, p. 54 T.
46	" "	Galena with a little calcite		53·230	86, p. 39 T.
47	" "	Galena	traces.	64·859	87, p. 50 T.
48	" "	Quartz and galena		21·208	87, p. 51 T.

East Kootanie.

49	"Monarch Mine," Mount Stephen	Galena with a little quartz		5·104	1888.
50	Mount Stephen (Tunnel Mt.)	Galena	traces.	3·996	85, p. 24 M.
51	" " "	Galena with a little copper-pyrites	traces.	4·010	85, p. 24 M.
52	" " "	Galena with a little copper-pyrites	traces.	11 302	85, p. 24 M.
53	" " "	Galena with a little iron-pyrites	traces.	3 281	85, p. 24 M.
54	Near Mount Stephen (Tunnel Mt.)	Galena		3·646	86, p. 40 T.
55	" " "	Galena		6·563	86, p. 40 T.
56	Otter-tail River	*Galena*, copper-pyrites, etc		16·771	86, p. 39 T.
57	" "	*Galena, tetrahedrite*, copper-pyrites, quartz, etc		113·749	86 p. 39 T.
58	" "	Quartz, with *galena* and copper-pyrites	traces.	5·823	85, p. 24 M.
59	Near Otter-tail Station, C. P. Ry	Purple copper ore		19·687	87, p. 47 T.
60	"Granger's New Location," Jubilee Mountain	Quartz and dolomite with copper-glance and copper carbonate		39·375	1888.
61	"Wells Claim," Jubilee Mountain	Quartz with galena and iron-pyrites		5·104	1888.
62	"Wells Old Location," Jubilee Mountain	Copper-glance, copper carbonates and hæmatite		22·571	1888.
63	Jubilee Mountain	Copper-glance with copper carbonates and dolomite		11·667	1888.
64	" "	Copper carbonates and ferric hydrate, a little copper-glance		2·187	1888.

No.	LOCALITY.	ASSOCIATED MINERALS.	GOLD. Ounces.	SILVER. Ounces.	Reference.
65	Spillimichene River, Purcell Range	*Galena* and iron-pyrites	traces.	8·094	85, p. 27 M.
66	"Golden Gate Claim," Carborate Creek, McMurdo District	Quartz with *tetrahedrite*, galena, iron-pyrites	traces.	13·887	1888.
67	"Monitor Claim," Middle Fork Spilimichene	Galena	traces.	37·537	1888.
68	Toby Creek	Quartz with *galena*		38·646	1888.
69	North Fork Toby Creek	Coarse crystalline galena	traces.	66·354	1888.
70	Goat River, Kootanie	*Galena* with quartz and iron-pyrites		14·583	86, p. 40 T.
		Big Bend Region.			
71	"Taylor Lead," Big Bend	Quartz, with galena and iron-pyrites	0·175	0·641	86, p. 38 T.
72	"Little Bunting Lead," Big Bend	Quartz, with ferric hydrate and mica	1·925	0·175	86, p. 38 T.
73	Big Bend District	Quartz, with galena	traces.	43·750	86, p. 36 T.
74	"North Lead," Columbia Claim, McCulloch Ck., Big Bend	Rusty quartz, with galena	traces.	16·975	86, p. 39 T.
75	"Silver King Mine," Big Bend	*Galena*, specular iron, quartz	traces.	21·875	86, p. 36 T.
		Omenica.			
76	"Champion Ledge," near Lost Creek, Omenica	Quartz, with *galena* and pyrites	trace.	19·723	78-79, p.24H.
77	"Arctic Circle Claim," Boulder Creek, Omenica	*Galena*, iron oxide		128·078	78-79, p.25H.
78	" " " " " " (Assay by Johnson & Matthey.)			44·2	79-80, p.111B
79	"Arctic Circle Claim," Boulder Creek, Omenica. (Assay by G. W. Hopkins.)		trace.	40·81	79-80, p.111B
80	"Black Warrior Vein," Boulder Creek, Omenica (Assay by Johnson & Matthey.)			29·08	79-80, p.111B
81	"Black Warrior Vein," Boulder Creek, Omenica. (Assay by Riehn, Hemme & Co.)			93·00	79-80, p.111B
82	"Mammoth Ledge," Omenica (Assay by Thos. Price.)		0·1	32·40	79-80, p.111B
83	"Mammoth Ledge," Omenica (Assay by Riehn, Hemme & Co.)		0·314	91·13	79-80, p.112B
84	Vein near Manson Creek, 20 miles from "Dunkeld,"	Quartz, with a little galena	trace.	8·971	75-76, p. 430
		Cassiar.			
85	"Acadia Claim," South Fork of McDame Creek, Cassiar	*Galena*, iron- and copper-pyrites, etc		74·772	1888.
		Yukon District.			
86	Forty-mile Creek, Yukon District	Chiefly galena	traces.	38 646	

Interior Plateau Region.

87	"Carbonate Lode," Rock Creek (Laboratory of Survey)	Galena, somewhat oxidized	trace.	64·166	
88	"Bonanza Queen," Tulameen R. (Laboratory of Survey)	Iron- and copper-pyrites, etc., with some galena, in quartz	1.342	5·133	
89	Cherry Creek Mine	Quartz, with tetrahedrite, galena and zinc-blende	trace.	658·437	77-78, p.50G.
90	" " "	" " " " "	.....	255·937	77-78, p.51G.
91	Cherry Creek (found in sluice-boxes)	Galena	.....	220·937	77-78, p.50G.
92	North Fork of Cherry Creek	Quartz, with galena, pyrites, etc.	0·058	8·254	77-78, p.50G.
93	"Hepburn Claims," near Stump Lake	Rusty quartz, galena	0·759	406.574	87, p. 38 T.
94	"Nicola Mining Company," Stump Lake	Quartz, with *galena*, tetrahedrite, iron-pyrites, copper-pyrites, bornite	0·729	104·271	86, p. 37 T.
95	Stump Lake (vicinity of)	*Galena*, copper-pyrites, etc.	traces.	20·339	87, p. 38 T.
96	" " " "	Quartz, with *galena*, etc.	6·096	90·650	87, p. 39 T.
97	" " " "	Quartz, with tetrahedrite, galena, iron-pyrites and blende	0·729	39·521	86, p. 35 T.
98	" " " "	Quartz, with *galena* and iron-pyrites	traces.	20 927	86, p. 35 T.
99	" " " "	" " " " "	0·729	15·094	86, p. 38 T.
100	" " " "	Quartz, with *galena*, iron-pyrites and copper-pyrites	1·969	17·063	86, p. 38 T.
101	"Zeran Mine," Scotch Creek, Shuswap Lake	*Galena*, copper-pyrites, quartz and calcite	traces.	11·667	86, p. 34 T.
102	" " " " " "	Quartz, with *galena*	traces.	35·000	86, p. 34 T.
103	" " " " " "	*Galena* quartz	traces.	46.667	86, p. 34 T.
104	" " " " " "	*Galena*, iron-pyrites, quartz	traces.	10·208	86, p. 35 T.
105	"Home-Stake," Jamieson Creek, N. Thompson	Rusty quartz, with a little galena	1·108	34·242	1888.
106	"Silver King," Jamieson Creek	Rusty quartz, with small quantity galena and tetrahedrite	0 583	21·525	1888.
107	"Silver Queen," Jamieson Creek	Rusty quartz, with a little galena	0·758	28·992	1888.
108	"Kamloops". Jamieson Creek	Rusty quartz, with galena and iron-pyrites	0·700	25·200	1888.
109	Mad River, N. Thompson, above Clearwater River	Quartz, etc.	4·375	21·350	87, p. 49 T.
110	"Crown Point Ledge," left bank Cayoosh Creek	Rusty quartz.	0 992	.....	1888.
111	"Bonanza Location," right bank Cayoosh Creek	" "	0·991	0 058	1888.
112	" " " " " "	" "	0·722	.....	1888.
113	South Fork Bridge River	Rusty quartz, with carbonates of copper	dist. trace.	20·833	1888.
114	"Big Slide Mine," Fraser R. (assay at Nevada Metallurgical Works)	Quartz, with pyrites, etc.	1·21	2·43	
115	Fraser River, 25 m. above Lytton	Tetrahedrite	trace.	5·833	1888.
116	Fraser River, 23 m. above Lytton	Stibnite	trace.	2·187	1888.

Coast Ranges and Coast.

117	"Eureka Mine," near Hope	Yellowish decomposed veinstone	.....	221·666	76-76, p. 478.
118	" " " "	" " "	.....	271·48	73-74, p. 7.
119	" " " "	" " "	.....	285·60	71-72, p. 66.
120	"Yale Creek Mine," Yale (three assays by J. H. Collins)	Iron-pyrites, blende and a very little copper-pyrites	traces.	13 to 70	
121	"Queen Mine," Yale Creek	Chiefly blende and iron-pyrites	traces.	2·800	85, p. 28 M.
122	"Sterling Mine," Kokesaila River, Cowichen, V.I.	Galena and copper-pyrites in dolomite and quartz	traces.	9 844	79-80, p.20H.
123	" " " " " "	" " " " "	traces.	19 323	79-80, p.20H.
124	" " " " " "	" " " " " "	traces.	8·021	79-80, p.20H.
125	" " " " " "	" " " " " "	traces.	5·104	79-80, p.20H.
126	"Malaspina Copper Mine," Texada I.	Copper-pyrites, iron-pyrites, etc.	trace.	10·209	87, p. 55 T.
127	"Kitamat Ledge," Gardner Inlet	Quartz, with copper-pyrites, blende, galena	trace.	4·433	87, p. 54 T.
128	Six miles up Zymoetz River, Skeena	Quartz, with *galena*, copper- and iron-pyrites	0 029	1·079	77-78, p. 51G

Coal.

Discovery of coal near Suquash.

The discovery of coal in British Columbia antedated that of gold by more than twenty years, but did not at first produce any effect comparable with that of gold upon the history of the country. Dr. W. F. Tolmie was the first to make known the existence of coal, on the coast of the Province, in 1835. He was then stationed at the Hudson Bay Company's post, known as Fort McLoughlin, on Milbank Sound, and specimens of coal were brought to him by Indians from the north-east coast of Vancouver Island,—doubtless from Suquash. The steamer *Beaver*, belonging to the Company, arrived on the West Coast in 1836, and thereafter small quantities of coal were obtained for her, as well as for blacksmiths' use, from this place; being derived from natural outcrops on the beach. In the year 1849, a coal-miner was brought out by the Company, from Scotland, to more fully test the character of the coal on this part of the coast, and in 1851 a further number of miners and some necessary machinery were imported. Exploratory work by sinking and boring was prosecuted along the coast of Vancouver Island, between Port McNeill and Beaver Harbour, till 1853, but without resulting in any very notable discoveries.

Steamer Beaver.

Discovery of coal at Nanaimo.

Meanwhile, in 1850, the existence of coal at Nanaimo had been ascertained by Mr. J. W. McKay, and in the following year it appears that the most of the miners above referred to were transferred from the northern end of the island to that place. Work began in earnest at Nanaimo in 1852, and before the close of 1853, 2000 tons are reported to have been shipped, chiefly to San Francisco. The price of coal at Nanaimo was at this time $11 and at San Francisco $28 a ton. The Hudson Bay Company, under the name of the Nanaimo Coal Company, continued to work the mines thus opened till 1861, when these were sold to the Vancouver Coal Mining and Land Company (limited), by which they are still operated. The total shipment, from October, 1852, to November, 1859, are returned at 25,398 tons.*

Initiation of mining.

Wellington mines.

The Wellington Mines, situated a short distance inland from Departure Bay, near Nanaimo, began to produce coal in 1871, and several hundred tons of coal were shipped in that year. This colliery, like the last, has since continued in active operation, with yearly increasing output, and from the various openings belonging to these two enterprises by far the greater part of the coal product of the Province is obtained.

Other mining enterprises.

In 1871 mining operations were in progress at Cowgitz, Queen Charlotte Islands, and several hundred tons of anthracite were shipped, but the work was not continued. In 1874 the Harewood Colliery, near

* For many details on the early history of the industry see Bancroft's Works. vol. xxxii., pp. 185, 565; also Annual Report Geol. Surv. Can., 1886, pp. 65 B., 69 B

Nanaimo, was opened. It had previously been worked on a small scale in 1864 and 1865. In 1875 the Baynes Sound Colliery, near Comox, was opened out to some extent, and preparations for mining and shipping coal were made, but from various causes, chief among which was the low price of coal, both this and the Harewood were closed down in 1877. In 1882 a shaft was sunk at the East Wellington Colliery, about midway between the Vancouver and Wellington mines, and a certain amount of coal has since been annually produced here.

Work at Comox.

With the exception of the Baynes Sound mine, the collieries above mentioned are all in the Nanaimo area, and the work done in the Comox area (except in the case of the Baynes Sound mine) was of the character of 'prospecting' and exploration only. In 1888, however, the serious development of mining work in the Comox area has been initiated by Hon. R. Dunsmuir at points situated between the old Baynes Sound mine and Comox Harbor, near the edge of the old "Union Claim." A railway, eleven miles in length, has been built to a suitable shipping place, and all preparations are being made for a large output of coal. This enterprise is known as the Union Colliery.

Progress of coal mining.

Since the initiation of coal-mining in the Nanaimo district, this industry has shewn a steady and satisfactory increase, and it has now attained large proportions, as evidenced by the subjoined table of output. Both the exports and the local consumption are constantly increasing, the latter being returned at 115,953 tons in 1888.*

TABLE SHEWING THE ANNUAL PRODUCTION OF COAL IN BRITISH COLUMBIA.†

Annual and total output of coal.

	TONS.‡
Coal mined at Suquash by H. B. Co. at various times between 1836 and 1852 (say)	10,000
Total coal shipped from Nanaimo, October, 1852, to November, 1859	25,398
1859 (Two months)	1,989
1860	14,247
1861	13,774
1862	18,118
1863	21,345
1864	28,632
1865	32,819
1866	25,115
1867	31,239
1868	44,005
1869	35,802
1870	29,843

*This includes the coal used at the mines.

† This table is I believe the first approximately complete statement of the annual output of the mines. I am indebted to Mr. S. Robins and Hon. R. Dunsmuir for the figures relating to years not previously published.

‡ These and other figures relating to coal, (except California imports on following page) refer to the ton of 2240 lbs.

	Tons.
1871 (Exclusive of Wellington Mines)..... 35,643*	
1872 " " " 46,468	148,459
1873 " " " 45,731	
(Wellington Mines, 1871-73..... (21,182)	
1874	81,547
1875	110,145
1876	139,192
1877	154,052
1878	170,846
1879	241,301
1880	267,595
1881	228,357
1882	282,139
1883	213,299
1884	394,070
1885	365,596
1886	326,636
1887	413,360
1888	489,301
Total	4,358,221

Places to which coal is exported.

The exports of coal are chiefly to ports in California, including, in 1888, San Francisco, Wilmington and San Diego. Sundry cargoes were also shipped to Seattle, W.T.; Portland, Oregon; Alaska; Petropavlovsk; Hawaiian Islands; China and Japan. Coal has also been supplied during the year to H.M. Navy, and to U.S. war and revenue vessels as well as to ocean mail steamers and other vessels calling for fuel.

Coal imports of California.

The standing of British Columbia coal in respect to the supply of California, which constitutes the principal market, is well shewn by the subjoined statement of the sources of coal imported into that State in 1888.†

	Tons.
British Columbia	345,681
Australia	271,612
England and Wales	126,167
Scotland	10,680
Eastern States (anthracite, etc.)	30,118
Total from coal mines on or near Puget Sound, W.T., including Seattle, Carbon Hill, Green River, Cedar River, Renton, Newport, South Prairie, etc	568,948
Coos Bay	47,015
Japan	13,808
Coal from various sources, other than British Columbia, received at Wilmington and San Diego, (estimated at)	151,068
Total coal imports of California in 1888	1,565,097 tons.

* Including 565 tons Queen Charlotte Islands anthracite.

†These statistics, and the places of destination of coal above, from Report of Minister of Mines of B.C., 1888, p. 330.

The following particulars for the various collieries in operation in Nanaimo and Comox, are derived from the Report of the Minister of Mines of British Columbia for 1888.— Collieries now in operation.

Nanaimo Colliery.—Description of seams and workings.—South Field No. 2, worked by slope, seam, 6 to 10 feet thick. South Field No. 3, worked by shaft, seam, 5 to 10 feet thick. No. 1 shaft, seam, 5 to 12 feet thick. Total out-put 258,817 tons, 8 cwt.

Wellington Colliery.—Description of seams and workings.—Four working shafts, known as No. 3 pit, No. 4 pit, No. 5 pit, No. 6 shaft (sinking.) Three air shafts. Seams 6 to 10 feet thick. Total out-put 198,392 tons.

East Wellington Colliery.—Description of seams and workings.—Two shafts, known as Nos. 1 and 2 respectively. Total out-put 30,092 tons.

Union Colliery.—(Comox).—Description of workings.—One shaft, one slope, four levels, three tunnels, one air-shaft. Total out-put 2000 tons. (This mine is in process of being opened.)

The number of miners employed in the various Collieries in 1888, is as follows :— Miners employed.

	Boys.	Whites.	Chinese.	Indians.	Total.
Nanaimo Colliery....	30	819	80	16	945
Wellington Colliery ..	10	585	100	None	695
E. Wellington Colliery	2	120	10	None	132
Union Colliery.....	None	90	150	None	240

Total miners employed in 1888. 2012

The wages paid to white miners at present, range from $2 to $4 a day, and the earnings of miners working on contract from $3 to $4·50. Chinese are paid at from $1 to $1·75, and Indians about $2 a day. Wages.

Several serious accidents from explosion of fire-damp have occurred in the history of the Nanaimo mines, viz.—Wellington Colliery, April 17, 1879, 11 lives lost; No. 1 Pit, Vancouver Colliery, May 3, 1887, 150 lives lost; No. 5 Pit, Wellington Colliery, Jan. 24, 1888, 77 lives lost. Accidents.

Coal- and Lignite-bearing Formations of British Columbia.

While the coals of Nova Scotia and of the eastern half of the United States are derived from the Carboniferous formation, of Palæozoic age, those of the Great Plains and Pacific Slope occur in association with much newer rocks, referable to the Mesozoic and Tertiary periods. Though in the western part of the continent rocks of Carboniferous age are known, and frequently appear in great thickness and covering extensive areas, they generally represent the Coal-bearing formations of the East and West.

accumulations which have taken place in sea-bottoms, and consist largely of limestone; the swamps and marshy estuaries which afforded the conditions for the accumulation of vegetable matter elsewhere giving rise to the production of coal-beds, do not, so far as yet known, appear to have occurred during this period, in the West. Conditions of this kind, however, existed very generally in the West during certain stages of the Mesozoic and Tertiary, while rocks of these periods are developed on a comparatively small scale in the eastern half of the continent, and are there seldom found to contain coal.

Coal producing rocks of British Columbia.

In British Columbia, the formations known to contain mineral fuels of economic value, of the character of coals or lignites, are (1) the Cretaceous, or highest member of the Mesozoic, (2) the Tertiary. Respecting the latter, it is not yet clear whether all the coal- or lignite-bearing rocks included under it are referable to a single stage, but it is probable that at least most of them belong to the middle member of the Tertiary, or Miocene.

Fuels of the Cretaceous and Tertiary.

Rocks of Cretaceous age are developed over a considerable area in British Columbia, often in very great thickness, and fuels occur in them in important quantity, in at least two distinct stages, of which the lower and older includes the coal-measures of the Queen Charlotte Islands and those of Quatsino Sound on Vancouver Island, with those of Crow Nest Pass in the Rocky Mountains; the upper, the coal-measures of Nanaimo and Comox, and probably also those of Suquash and other localities. The lower rocks hold both anthracite and bituminous coal in the Queen Charlotte Islands, but elsewhere contain bituminous coal only. The upper have so far been found to yield bituminous coal only. The fuels of the Tertiary rocks are, generally speaking, lignites, but include also various fuels intermediate between these and true coals, which in a few places become true bituminous coals.

All grades of coal represented in British Columbia.

The series of mineral fuels thus presented by British Columbia alone, ranging from anthracites which compare favourably with those of Pennsylvania and Wales, to lignites, in which the original woody structure is still clearly preserved, and all embraced within the upper part of the Mesozoic and the Tertiary, is sufficient to disprove the theory at one time maintained, that the Carboniferous formation is the only one capable of yielding true coals. It is now generally acknowledged, that the character of such fuels depends essentially on the conditions of metamorphism to which they with the rocks containing them have been subjected, and only in secondary degree on their relative or absolute age.

Order of description.

It will, however, be most convenient, in presenting such notes as are here necessary on the various coal-bearing areas of the Province, to begin with those of the Cretaceous period, and this order

is further rendered appropriate by the relative importance of the fuels of that age. As most of the coal-fields are described at length in one or other of the reports of the Geological Survey, to which reference may be made, it is not intended here to enter into details with respect to them.

Principal Coal-fields (Cretaceous).

Queen Charlotte Islands.

The most northern Cretaceous coal-field of the coast is that of the Queen Charlotte Islands. It extends over parts of Graham and Moresby Islands, on both sides of Skidegate Inlet, and is believed to run across the first-named island to the outer or ocean coast, though as yet only partially explored. Its area is considerable, and it has been in part geologically examined and mapped by the late James Richardson and by the writer.* In the vicinity of Skidegate Inlet, the Cretaceous rocks containing the coal are made up of the following sub-divisions, in descending order.—

	Feet.
A. Upper shales and sandstones	1,500
B. Conglomerates	2,000
C. Lower shales and sandstones	5,000
D. Agglomerates (of volcanic origin)	3,500
E. Lower sandstones	1,000
	13,000

The coal, so far as known, is confined to the base of the Lower shales and sandstones (C), and is proved by its associated fossils to be approximately of the age of that member of the Cretaceous formation known as the Gault.

Anthracite at Skidegate.

At Cowgitz, in Skidegate Inlet, the Queen Charlotte Coal Mining Company, about 1871, constructed a wharf, houses, tramway, etc., and attempted to work the coal-seams, which have there the character of anthracite, but met with difficulties in following the seams, of which some portions were also found to be in a crushed and pulverulent state. Though these efforts were not attended with success, the work was not carried far enough to prove that the coal in this vicinity is not of a workable character. Further exploration appears to be fully justified by what is known of the place, and I believe that work of this character is at the present time in progress. The beds containing the anthracite here are almost vertical, and it is evidently on account of the disturbance and local alteration which it has suffered that the coal has passed into the condition of anthracite. The best seam found, had a maximum thickness of a little over six feet, while a second out-crop showed two feet five inches, and other less important out-crops also oc-

* See Report of Progress Geol. Surv. Can., 1878-79.

cur. Mr. Richardson was originally of opinion that several distinct seams exist at this place, but it now appears more probable that the various out-crops represent a single seam, repeated by folding.

Analysis of anthracite.

In composition, the anthracite of the Queen Charlotte Islands compares favorably with that from Pennsylvania. The following analyses by Dr. Harrington* were from samples collected by Mr. Richardson; No. 1 being from the six-foot seam; No. 2 from the so-called three-foot seam (2 feet 5 inches).—

	I.	II.
Water	1·60	1·89
Volatile combustible matter	5·02	4·77
Fixed carbon	83·09	85·76
Sulphur	1·53	0·89
Ash	8·76	6.69
	100·00	100·00

Bituminous coal on Ya-koun River.

Further north, in the same Cretaceous area, on the Ya-koun River, about midway between Skidegate and the head of Masset Inlet, a discovery has lately been made of bituminous coal of excellent quality. The bed is reported to be a very thick one, (18 feet), and several tons of the coal have been brought out, and tested with favorable results. Means of communication with the coast must, however, be provided before this deposit can be utilized. It is not certainly known whether this coal occupies the same position in the Cretaceous series as that of Cowgitz, but it is very probable that it does so.

Analysis.

The character of this coal is shown by the following analysis by Mr. Hoffmann.†—

Hygroscopic water	2·65
Volatile combustible matter	30·59
Fixed carbon	61.33
Ash	5·43
	100·00

Coal-fields of Northern Vancouver Island.

In the northern part of Vancouver Island, the Cretaceous coal-bearing rocks, though occupying but a small portion of the surface as compared with the older formations, have in the aggregate a considerable extent. The principal areas are those of Forward Inlet, Koprino and Koskeemo, all on the shores of Quatsino Sound, and of Suquash, on the north-east coast of the island. Of the Quatsino Sound areas, the only one which has yet attracted much attention is that referred to as the Koskeemo, which is situated on the upper part of Quatsino Sound. In this area, some exploration, both by sinking and boring, has at

* Report of Progress, Geol. Surv. Can., 1872-73, p. 31.

† Annual Report, Geol, Surv. Can., 1887, p. 17 T.

various times been carried out, though so far without resulting in the discovery of a coal-seam of a satisfactory workable character; the greatest thickness of good coal yet proved being about three feet only. The total length of this small Cretaceous area is about seven miles, its greatest probable width about two miles, and its approximate area, not including under-water extensions, about 5630 acres. Particulars respecting this area, with a map and details of borings, etc., may be found in the annual report for 1886.* The coal is bituminous, and is often of excellent quality. An analysis of a specimen, made in the laboratory of the Survey, gives the following result.— Koskeemo.

Analysis.

Hygroscopic water	1·05
Volatile combustible matter	34·38
Fixed carbon	54·01
Ash	10·56
	100·00

In the Forward Inlet Cretaceous area, coal is found at the head of the lagoon above Winter Harbour, but much disturbed locally and thin. It is not improbable, however, that boring operations on Winter Harbour would result in the discovery of better seams.† It appears likely that this area really connects eastward with that of Koprino, which extends along the north shore of the lower part of Quatsino Sound for seven or eight miles, and has a considerable width. Though no coal has yet been found in the last-mentioned area, it is larger than either of the others on Quatsino Sound, and as the beds are regular and little disturbed, it may, on proper investigation by boring, prove to be the most important.‡ Forward Inlet. Koprino.

The coal-field referred to as the Suquash area, extends along the north-east coast of Vancouver Island from Port McNeill to Beaver Harbour, a distance of fourteen miles. Its width inland must be considerable, and it probably also includes Malcolm Island, to the eastward, of which the surface is almost entirely covered by drift deposits. The original discovery and early exploration for and working of coal at this place are elsewhere referred to, (p. 80 R). The coal-seams as yet found here are quite thin, the thickest, at Suquash, not exceeding two feet. In consequence, however, of the flat-lying position of the beds along the shore, the exposures are poor, and but a small part of the thickness of the Cretaceous rocks is shown. The regularity of the beds and their extent are favourable to mining operations should thicker seams be discovered by boring. Particulars respecting this Suquash area.

* Part B, p. 90 B., *et seq.*
† See Annual Report Geol. Surv. Can., 1886, p. 83 B.
‡ *Ibid.* p. 87 B.

district are to be found in the report already referred to.* The coal found at Suquash is of very fair quality, as evidenced by the subjoined analysis.—

Analysis.

Hygroscopic water	5·03
Volatile combustible matter	41·51
Fixed carbon	46·52
Ash	6·94
	100·00

Relative age of the coals.

Respecting the stratigraphical position of these coal-bearing Cretaceous rocks of the northern part of Vancouver Island, it may be stated that the coals of Quatsino Sound generally, are believed to occur at the same horizon with those of Cowgitz, or in Series C, of the Queen Charlotte Islands section, while those of Suquash appear to belong to a higher stage.

Reports on Nanaimo and Comox.

The Comox and Nanaimo coal-fields are the most important in the Province, and the latter is that from which almost all the coal so far raised has been obtained. They have been in large part carefully examined by Mr. Richardson, whose various reports in the annual volumes of the Geological Survey for 1871–72, 1872–73, 1873–74 and 1876–77,† may be consulted for details.

Coal fields of Southern Vancouver Island.

The Cretaceous rocks constituting these coal-fields, border the south-western side of the Strait of Georgia, forming a belt of comparatively low, rolling or hilly country between the mountainous region of the interior of Vancouver Island and the coast. This belt, including the Cowichen area, reaches to within about eighteen miles of Victoria to the south-eastward, and to the vicinity of Cape Mudge in the opposite direction, with a length on the shore of about 130 miles. Its continuity is broken however at two points, near Maple Bay and near Nanoose Harbour, respectively, where the older underlying rock-series comes out to the shore. Beyond Cape Mudge, it runs inland in the same general north-westward bearing, but its extent in this direction is still unknown.

Stratigraphical relations.

The rocks accompanying the coals are sandstones, conglomerates and shales, being largely of the character of littoral formations, but also containing, (particularly in the shaly members of the series) truly marine fossils. They hold also in some layers abundance of fossil plants, and in appearance and degree of induration much resemble the older Carboniferous rocks of some parts of Eastern America. Coals of a workable character have been found only in the

* Annual Report Geol. Surv. Can., 1886, p. 61 R.

† In the last-named report, a general review of the geology is given. See also Annual Report Geol. Surv. Can., 1886, p. 16, R.

lower part of the Cretaceous series, which is represented with closely similar characters in the Comox & Nanaimo areas. The somewhat variable character of the Cretaceous measures as a whole is, however, shewn by the fact that Mr. Richardson found it necessary to adopt a different scheme of sub-divisions for the two areas, notwithstanding their general correspondence. The sections at Comox & Nanaimo are as follows, in descending order.— Sections at Nanaimo and Comox.

Comox.	*Feet.*	Nanaimo.	*Feet.*
Upper conglomerates.....	320		
Upper shales.....	776	Sandstones, conglomerates and shales.....	3290
Middle conglomerates.....	1100		
Middle shales.....	76		
Lower conglomerates.....	900		
Lower shales.....	1000	Shales.....	660
Productive coal-measures...	739	Productive coal-measures....	1316
	4911		5266

The age of the Productive Coal-measures of Nanaimo & Comox is approximately that of the Chico group of California, in which, however, in its typical locality, coals are not found.

The Comox area has probably a greater extent of productive measures and may eventually become more important than the Nanaimo. Mr. Richardson gives a number of carefully measured sections of the Comox area,* shewing its character along various parts of a line, which, following the direction of the out-crop of the beds, is about thirty miles in length. On Brown's River, furthest north, almost the entire mass of the Productive Measures is exposed, with a thickness of 739 feet 6 inches of beds. In this section, nine coal-seams occur, with an aggregate thickness of 16 feet 3 inches, the thickest bed being the lowest in the series, and averaging 7 feet. In a section of 122 feet at the Union mine, ten coal seams, with an aggregate thickness of 29 feet 3 inches occur, the thickest seam being 10 feet. This section represents only a small part of the Productive Measures. In a third section, on Trent River,—again embracing nearly the entire thickness of the Productive Measures,—thirteen seams are found, with an aggregate thickness of only 18 feet 1 inch, the thickest bed being 3 feet 8 inches. On the area of the Baynes Sound Company, in 220 feet 10 inches of measures, two seams of 6 feet and 5 feet 10 inches, respectively, occur. Comox coal-fields.

Mr. Richardson estimates the extent of country underlain by the Productive Measures at 300 square miles, without taking into consideration that which may lie beyond the shore, and not including the unexplored north-western extension of the field previously referred to. Extent and value of this field.

* Report of Progress, Geol. Surv. Can., 1872-3, p. 85 *et seq.*

Computing the total thickness of workable coal in the Union Company's property at a little over twenty-five feet, he calculates the quantity of coal underlying the surface at 25,000 tons per acre, or 16,000,000 tons per square mile for this part of the region.*

The operations now in progress in opening up mines in the Comox area have been alluded to on a former page. The principal seam which it is intended to work has been proved, by boring, to continue with good thickness for at least two miles in length.

Character of Comox coals.

The quality of the Comox coals is equal, if not somewhat superior to that of those of Nanaimo. They contain but a small percentage of water and the ash is also often very low. Several of them yield strong cokes. Proximate analyses of representative specimens are quoted in the table at the end of this chapter (p 98 R). The following analysis by Dr. B. J. Harrington may be quoted here, as probably representing the character of the main seam now being opened out for work. It is of that which Mr. Richardson named the lower or ten-foot seam, which shewed, where he examined it in the natural section, 7 feet 6 inches of clean coal.†—

	Slow coking.	Fast coking.
Hygroscopic water	1·70	1·70
Volatile combustible matter	27·17	32·36
Fixed carbon	68·27	63·08
Ash	2·86	2·86
	100·00	100·00
Coke	71·13	65·94

Nanaimo coal-field.

The area of the Nanaimo coal-field is estimated at about 200 square miles. There are at least two distinct seams of workable thickness in this area, but in consequence of folds and faults it is not easy to fix the equivalency of beds in its various parts. Three collieries are at present in operation here, the Nanaimo, Wellington and East Wellington. The works of the two first-named are on a very extensive scale, embracing numerous shafts and inclines, provided with good machinery, railways and wharves. In the Vancouver colliery, the principal workings are upon a seam which averages from six to ten feet in thickness. A second seam, overlaying the last, and separated from it by by 140 feet of sandstone, is seven feet thick. The seam worked in the Wellington colliery averages about nine feet in thickness, and yields a rather dry steam coal which does not afford a strong coke. The coal from the Vancouver colliery, on the contrary, gives a good coke and produces a large quantity of illuminating gas

*Report of Progress Geol. Surv., Can., 1871-72, p. 80.
†Report of Progress Geol. Surv. Can., 1872-73, pp. 38, 76.

Several proximate analyses are summarized in the table at the end of this chapter. That of the Wellington coal by Mr. C. Hoffmann, may be quoted here in full, as illustrating the character of the larger part of the coal shipped.—* Character of Nanaimo coals.

	Slow coking.	Fast coking.
Hygroscopic water	2.75	2.75
Volatile combustible matter	30.95	38.03
Fixed carbon	59.72	52.64
Ash	6.58	6 58
	100.00	100.00
Coke	66.30	59.22

Weight of one solid cubic foot.....82.64 pounds.

Evaporative power, 13·41 pounds of water (at 100° C.) per pound of fuel.

Besides the coal-fields above described, Cretaceous coal-bearing rocks are known to occur in several additional places upon the shores of Vancouver Island. Mr. Richardson describes the occurrence of rocks of the coal series at the head of Alberni Canal which opens into Barclay Sound, and coal has been found in other localities on the west coast in the vicinity of Clayoquat Sound. The interior of the island being yet comparatively unknown, even geographically, it is not improbable that a geological examination may bring to light coal areas in the valleys and tracts of low country which may prove to be important. A great part of the folding which the rocks have experienced is of post-Cretaceous date, a fact which renders it quite possible that outlyers of the coal-bearing rocks may be found folded into other synclinals besides these already known along the coast-line. Other coal-fields in Vancouver Island.

The character of the coals of Vancouver Island is illustrated by the analyses already quoted and by those in the comparative table (p. 98 R). Their superiority for all practical purposes to any others worked upon the Pacific Coast may be regarded as demonstrated, and is particularly evidenced by the higher price which they command, and by the fact that they are largely exported to California, and compete there successfully with coal produced in the United States, though handicapped by a duty of 75 cents a ton. General composition of Vancouver Island coals.

Dr. B. J. Harrington gives, as representing the average composition of the coals of Vancouver Island, as deduced from fifteen analyses by himself and Dr. T. S. Hunt, (chiefly from Nanaimo and Comox) the following.—†

* Report of Progress Geol. Surv. Can., 1882-84, p. 37 M.

† Report of Progress Geol. Surv. Can., 1872-73, p. 79.

Total volatile matter	30.33
Fixed carbon	60.23
Ash	9.44
	100.00

Coals of Puget Sound.

Though numerous analyses of picked samples from mines in the vicinity of Puget Sound, in Washington Territory, can be quoted, which compare favorably with those of Nanaimo, the fact remains that those actually shipped in quantity from Puget Sound points hold a distinctly inferior market value. This may in part be due to the large quantity of ash which these fuels often contain, a fact well illustrated in the tables of analyses in the U.S. Tenth Census.* On Puget Sound the greatest quantity of coal is shipped from Seattle and this ranks only as a lignite-coal affording no coherent coke. Of the following analyses representing the character of the Seattle coal, the first is quoted by Mr. Bailey Willis in the Census Report just cited,† the second is that given by Macfarlane.‡—

	I.	II.
Water	4·16	11·66
Volatile combustible matter	44·84	35·93
Fixed carbon	43·86	45·97
Ash	7·14	6·44
	100·00	100·00

Relative values of West Coast fuels.

As an impartial estimate showing the superiority of the Vancouver Island coals, the following table establishing the comparative value of these and other fuels for steam-raising purposes, by the War Department of the United States, will be interesting.

One cord (8 feet by 4 feet by 4 feet) of merchantable oak wood is there said to be equal to:—

	Pounds.
Nanaimo Coal (Vancouver Island)	1,800
Bellingham Bay Coal (Washington Territory)	2,200
Seattle Coal (Washington Territory)	2,400
Rocky Mountain Coal (Wyoming, &c)	2,500
Coos Bay Coal (Oregon)	2,600
Mount Diablo Coal, (California)	2,600

The following statement of the weights of steam obtained as the result of working tests from a cubic foot each of various fuels, at a slow rate of combustion, may also be referred to. The water to be evaporated had first been raised to a temperature of 212° F. The experiments

* U.S. Tenth Census, vol. xv, pp. 776-780.
† p. 761.
‡ Coal Regions of America, Third Edition, p. 569.

were made by the Chief Engineer of the U. S. Navy Yard at Mare Island.*—

	Pounds of Steam.
Nanaimo coal	372·64
Rocky Mountain, Monte Diablo, Coos Bay and Seattle	319·98

Cretaceous coals on the Mainland.

Though rocks of Cretaceous age occur on the mainland of British Columbia, and especially in the little-known northern portion of the Province characterize extensive tracts, they have not generally been found to contain coal. It may be stated, however, that specimens of good coal have been obtained from these rocks in the region of the Upper Skeena, (p. 150 R) on the western, or British Columbian side of the water-shed in the Rocky Mountains in the vicinity of the Crow Nest Pass, and in the country adjacent to the Peace River; and that it is probable that many further discoveries of the same kind still remain to be made.

Coals of Crow Nest Pass.

The coals of the Crow Nest Pass, first described by the writer in the Annual Report of the Geological Survey for 1885, (p. 69 B) have since attracted some attention, and have been to some extent explored and opened up. The Cretaceous basin or trough in which they occur is somewhat extensive, and resembles in general character those which occur on the opposite side of the Rocky Mountain water-shed, beyond the limits of British Columbia, in one of which the Cascade anthracite is included. The age of these Cretaceous rocks appears to be nearly the same with that of those of the Queen Charlotte Islands. By the 'prospecting' work which has lately been executed in the Crow Nest Pass, the existence of no less than fifteen workable seams is said to have been determined, two of which are reported as fourteen and thirty feet respectively in thickness (see p. 97 R). An analysis of coal from the thickest of these, (known as the "Jubilee Seam") by Mr. Hoffmann gave:—†

Hygroscopic water	1·79
Volatile combustible matter	25·45
Fixed Carbon	69·14
Ash	3·62
	100·00

Coal-bearing rocks of Skeena.

On the Upper Skeena and its tributaries, Cretaceous rocks, again believed to be of the same age with those of the Queen Charlotte Islands, are extensively developed. One specimen of excellent coal has been obtained from them, at a place about eighteen miles up the

* Ex. Doc. No. 206. 2nd Session, 42nd Congress. p. 30.
† Annual Report Geol. Surv. Can., 1887, p. 12 T.

Watsonkwa, and impure coals have been noted in several localities. It is by no means improbable that an extensive coal-field exists here.*

Coals on Peace River.

To the north of the 54th degree of latitude, the eastern boundary of British Columbia follows the 120th meridian, and the Province therefore, includes a portion of the coal-bearing region of the Peace River. Here, mineral fuels are known to occur at two distinct horizons, one being well down in the Cretaceous series, the other probably of Laramie age. Some of the fuels are true bituminous coals and others lignite-coals. The limited amount of exploration yet carried out has not resulted in the discovery of any very thick seams to the west of the 120th meridian, but the region is still, for the most part, practically unknown in detail.†

Coal and Lignite of the Tertiary.

Tertiary fuels.

The Tertiary rocks of British Columbia occasionally contain true coal, but more usually afford only brown-coal or lignite. Most of these rocks, as already noted, are assigned with probability to the Miocene period, but some of them, particularly those of the vicinity of the Fraser estuary, may be referable to the Laramie, to which stage the greater part of the coal- and lignite-bearing rocks of Puget Sound are now presumed to belong. ‡

Fuels of Puget Sound, etc.

At Bellingham Bay, a short distance south of the International boundary, lignite was discovered about 1851, and in 1869, 20,500 tons were shipped to San Francisco, but the mines were closed down, owing to the inferior quality of their product, in 1878. Lignite-coals of the same age, or but little older, are now very extensively worked, however, in the vicinity of Seattle, and in the Wilkinson coal-field, further southward, as well as to the eastward, near the borders of the Puget Sound coal region, where the better classes of fuels previously adverted to occur. Some of these are, however, probably referable to beds older than the Laramie or of true Cretaceous age.

Fuels of Burrard Inlet and Lower Fraser.

The interest of these facts, in the present connexion, lies in the circumstance that the Tertiary or Laramie coal-measures of Puget Sound and Bellingham Bay are continuous north of the International boundary, and must underlie nearly 18,000 square miles of the low country about the estuary of the Fraser and in the lower part of its valley. Lignite has been found in association with these rocks at Burrard Inlet and other localities, and specimens of a fuel resembling true bituminous coal (and coking on the

* Report of Progress Geol. Surv. Can., 1879-80, p. 104 B.

† See Report of Progress Geol. Surv. Can. 1879-80, p. 134 B.

‡ See Report of Mr. Bailley Willis, U.S. 10th Census. vol. xv, p. 769. Also Dr. C. A. White on the Puget Sound Group, Am. Journ. Sci., vol, xxxvi. Dec., 1888.

application of heat) have been obtained near the Fraser above New Westminster. The remarkably good specimen of coal from the River Chilliwack, of which an analysis, by Dr. Harrington, is given on page 99 of the Geological Survey Report for 1873-74, is probably from this series. The seams yet discovered are quite thin, but the low country underlain by the formation is deeply covered with drift and alluvium, and exposures are few; so that boring operations will be necessary before the existence or otherwise of workable seams of coal or lignite can be demonstrated in this region. Some particulars bearing on this problem, by Mr. Amos Bowman, may be found in the Summary Report of the Geological Survey for 1888 (p. 8), and notes on the more important localities are given at some length on a later page of present report (p. 147 R).* The thickness of Tertiary rocks of which more or less complete exposures occur, is estimated at about 3000 feet.

Value of these fuels.

As probably indicative of the character of some of the fuels to be found in the Lower Fraser region, the following analysis of that of Bellingham Bay may be quoted. †—

Hygroscopic water	8.39
Votalite combustible matter	45.50
Fixed carbon	33.26
Ash	12.66
	100.00

If fuels of this character, in beds of workable thickness, should be found to occur in the strata underlying Vancouver or New Westminster, the time has now arrived when they might be utilized on a large scale for local purposes, even though not so well suited as the coals of Nanaimo and Comox for purposes of export.

Lignites of the Coast.

Tertiary rocks holding lignite are found fringing other parts of the coast in greater or less width. They occur near Sooke,‡ and at various places on the south-west coast of Vancouver Island, and form a large part of the northern portion of the Queen Charlotte Islands. Particular references to the principal places in which lignite is found, are given on a later page (p. 145 R), but with the exception of the Lower Fraser region, none of these localities can be considered as of present importance, in view of the existence and accessibility of the superior fuels of the Cretaceous.

Tertiary coal- and lignite-bearing rocks of the Interior.

Rocks of Tertiary age are known to cover great tracts of the interior of British Columbia, and it can now be shown that in most places the horizontal, or slightly-inclined basaltic and other igneous flows of the

* See also Report of Progress Geol. Surv. Can. 1876-77, p. 188.

† Coal Regions of America, Macfarlane. Third Edition, p. 577.

‡ Report of Progress Geol. Surv. Can. 1876-77, p. 190.

interior plateau, are attached to, and form the latest rocks of the lignite- or coal-bearing series of the Tertiary. From this fact, and the known relations of the beds in a number of localities, it is highly probable that sedimentary Tertiary deposits underlie a great part of the area, where only the later igneous rocks are seen at the surface, and in many places where extensive exposures of these Tertiary deposits occur, more or less coal or lignite has been found in association with them. Very roughly, in our present comparatively slender knowledge of the region, it may be estimated that this formation occupies between the 54th and 49th parallel of latitude, an area not less than 12,000 square miles.

Nicola River and Coldwater.

In the Nicola Valley, near the mouth of the Coldwater, the occurrence of coal has been known for some years. The average of two determinations, by Dr. Harrington, gave the following result.—*

Volatile combustible matter and moisture	36·065
Fixed carbon	61·290
Ash	2·645
	100·000

The seam from which the above specimen was derived, has a thickness of nearly five feet, and is the lowest exposed. Other seams occurring higher in the series approach lignites in composition. The rocks containing these fuels are chiefly yellowish sandstones, which pass beneath massive volcanic accumulations, and are not well exposed except in the vicinity of the mouth of the Coldwater, though the overlying volcanic series extends along the Nicola to its confluence with the Thompson, or for about thirty-seven miles. This locality is the most promising one yet found in connexion with the Tertiary of the Interior. Similar rocks to those here containing the coal are also found to extend far up the Coldwater, and though not satisfactorily exposed, are known to contain more or less coal.†

Kamloops and Thompson River.

The lower beds of the Tertiary are again found to contain coal at a place within three miles of Kamloops. The fuel is of a bituminous character and of good quality, but the seams so far found are less than a foot in thickness. Coal also occurs in the same position, about forty-five miles up the North Thompson, but here again the seams yet discovered are thin.‡

* Report of Progress Geol. Surv. Can., 1876-77, p. 465. Another analysis made from specimens subsequently collected is given in the table. (p. 98 R.)

† See Report of Progress, Geol. Surv. Can., 1877-8, p. 123 B.

‡ Summary Report Geol. Surv. Can., 1888, p. 4. Report of Progress, Geol. Surv. Can., 1877-78, p. 113 B.

Other localities of lignites.

Lignites or brown-coals are found abundantly in other parts of the Tertiary formation. On Hat Creek, near Marble Cañon, a bed of this material surpasses forty feet in thickness, and important deposits also occur on the North and South Forks of the Similkameen. The lignites and lignite formation of Quesnel are described in the reports of the Survey,* but the lignites here are, I believe, of no economic value. They are mixed with clayey matter, and are otherwise poor in quality; and are, apparently, the result of the rather tumultuous deposition of drift-wood and other vegetable matter, by rapidly-moving waters. Lignite of better quality, and apparently, in some instances at least, still resting in the locality where the wood producing it grew, is, however, found in other places, which are enumerated on later pages.

Value and extent of lignites.

These lignites do not, of course, compare favorably as fuels with the coal of the Nicola valley or with those of the Cretaceous, and would scarcely be of value, unless found in thick and accessible seams, and then only for local use or in the absence of other fuels. Comparatively little is yet known about their distribution, for though, as already stated, they probably underlie a great part of the basaltic plateau, the soft character of the associated beds allows them to be easily worn away, leaving hollows into which the basalts and other hard overlying volcanic rocks, readily crumbled by the weather, fall, concealing the lignite out-crops.

Table of analyses.

The subjoined table of proximate analyses gives, in summarized form, the results of a number of examinations of British Columbian coals and lignites. The references are to the published reports of the Geological Survey, where additional particulars with respect to these fuels may be found. The analyses selected are almost exclusively those of worked or workable seams. They shew, as already mentioned, that the fuels of the Province as a whole include all varieties, from anthracite to lignite, and that many of them are of a very high class.

Gas-coal.

Analysis No 15 represents a fuel from a group of seams of the same character, lately discovered in the coal-bearing series of the Crow Nest Pass. The seams are reported to run from 4 to 7 feet in thickness. The specimen of which the assay is quoted, yields no less than 57·71 per cent. of volatile combustible matter by fast coking, resembling a true cannel in its behaviour on heating, and constituting a very excellent gas coal.

*See Reports of Progress, Geol. Surv., Can., 1877-78 pp. 121 B., 130 B., 132 B.; 1871-72 p. 58; 1875-76 p. 257.

Table of Proximate Analyses of Coals and Lignites from the Province of British Columbia.

	LOCALITY.	By slow or fast coking.	Hygroscopic water.	Volatile combustible matter.	Fixed Carbon.	Ash.	Reference.
	(Cretaceous.)						
1	Cowgitz, Queen Charlotte Islands. "Six-foot seam"	F.	1.60	6 55	83.09	8.76	1872-73 p. 81.
2	Ya-koun River, between Skidegate and Masset Inlets. Queen Charlotte Islands	S.	2.65	30.59	61.33	5 43	1887 p. 17 T.
3	Cool Harbour. Koskeemo. Quatsino Sound. Three-foot seam	F.	1.05	34.38	54 01	10.56	1887 p. 16 T.
4	Suquash. N.E. Coast of Vancouver Island	F.	5 03	41.31	46.52	6.94	1887 p. 19 T.
5	Trent River. Comox. 3 ft. 8 in. seam	S.	0.97	26.09	66.42	5.95	1872-73 p. 77.
6	Union Claim. Comox. 4 ft. 4 in seam	S.	1.34	28.11	67.72	2.83	1872-73 p. 77.
7	Union Claim. Comox. Lower seam, 7 ft. 6 in	S.	1.70	27.17	68.27	2.86	1872-73 p. 76.
8	Bayñes Sound Mine. Comox. Richardson seam	S.	1 18	31.13	48.51	16.18	1876-77 p. 468.
9	Wellington Mine, Departure Bay. Nanaimo	S.	2.75	30.95	59.72	6.58	1882-84 p. 37 M.
10	Upper seam. Nanaimo	S.	29.30		55.75	14.95	1871-72 p. 99.
11	Newcastle Island. Nanaimo. Upper seam 3 to 4 ft.	S.	1.57	31.77	58.03	8.63	1872-73 p. 80.
12	Newcastle Island, Nanaimo. Lower seam 4 ft.	S.	35 49		52.57	11 94	1871-72 p. 99
13	Peter seam. Crow Nest Pass	S.	1.79	25.45	69.14	3.62	1887 p. 12 T.
14	Jubilee seam. Crow Nest Pass	S.	1 89	24 88	68.86	4.37	1887 p. 14 T.
15	Seam X., Crow Nest Pass	S.	2.10	44.41	43.63	9 86	
16	Watsonkwa R., 18 miles above Skeena Forks	S.	0.85	39.67	57.51	1.97	1878-79 p. 14 H.
17	The Cañon. Peace River	S.	2.10	21.54	71.63	4.73	1875-76 t. p. 70.
18	Pine River, five miles above the Lower Forks, Peace River District	S.	2.45	27.87	51.58	15.10	1882-74 o. 39 M.
	(Tertiary or Laramie.)						
19	Near Chilliwack R., about 5 miles from Fraser R.	F.	35.73		63.86	0.41	1873-74 p. 99.
20	Mouth of Coldwater River. Five-foot seam	S.	4.45	29.68	57.16	8.71	1876-77 p. 466.
21	Mouth of Coldwater River. Fifteen-foot seam	S.	5.78	27.65	53.69	13 88	1877-78 p. 48 G.
22	Upper Nechacco, South of Fort Fraser. Four-foot seam	S.	10.46	35.01	49 64	4.89	1876-77 p. 467.
23	Kohasganko Stream. South of Tanyabunkut L. Four-foot seam	S.	9.90	37.71	38.85	13.54	1877-78 p. 48 G.
24	N. Thompson. 45 miles above Kamloops	S.	2.84	33 56	52.03	11 57	1876-77 p. 466.
25	Hat Creek. Forty-foot seam	S.	8.60	35.51	46.84	9.05	1877-78 p. 47 G.
26	Lewes River. Lot 62° 15′ Long. 136° 25′	F.	6.03	36 92	49 03	8.02	1887 p. 11 T.

IRON.

Utilization of ores of iron.

Comparatively little attention has yet been given to iron-ores in British Columbia, in consequence of the impression that under the present conditions they possess little or no value. This is no doubt the case with those which are at a distance from the sea-board and remote from means of communication, but the time should not be far distant when such deposits as lie near navigable water, by which communication with the coal-fields may be had, can be utilized extensively in the manufacture of iron.

Character of ores.

Most of the ores of iron so far found in quantity, are magnetites, which occur in association with the older metamorphic rocks of the Province. Clay iron-stones are, however, of frequent occurrence in the coal series of Vancouver and Queen Charlotte Islands as well as in the Tertiary rocks of the Interior. These might, no doubt, in some cases, be profitably worked in conjunction with the coal-seams, as they occur in the same strata, and in some instances are even associated with the coal. The nodules vary in weight from a pound or less up to several tons, and Mr. Richardson says that at the Baynes Sound mine, a sufficient quantity might probably be obtained for the regular supply of a blast furnace.*

Texada Island

The only iron-ore deposits which have yet been worked, are those of the south-west side of Texada Island, the largest exposures of ore occurring about three miles north-west of Gillies Bay. Here the ore-mass is seen to be from twenty to twenty-five feet thick, and constitutes a somewhat irregular contact-deposit between limestone or marble and granite, thin veins of the ore being occasionally found reticulating the limestone. From this point to the northward, for nearly a mile, the ore is occasionally seen, and at one place there is a continuous exposure about 250 feet long and from one to ten feet thick. As regards mining and shipment, the ore is most favourably situated; while in the event of smelting operations being undertaken on the spot, there is an abundance of wood suitable for making charcoal on the island, and Comox Harbour, from which the coal of the Comox area may be shipped, is less than twenty miles distant.†

Analyses of ore

The ore is a magnetite of excellent quality. A partial analysis by Dr. B. J. Harrington, in the laboratory of Survey, shewed 68·40 per cent. of iron, with only ·003 per cent. of phosphorus. A partial analysis by Whitfield,‡ representing a lot of 600 tons, shews iron

*See remarks by Dr. B. J. Harrington, in Appendix iii, to Mr. Richardson's report. Report of Progress, Geol. Surv. Can., 1872-73, p. 82.

† For details see Report of Progress, Geol. Surv. Can., 1873-74, p. 99. Annual Report Geol. Surv. Can., 1886, p. 36 B.

‡ U. S. Tenth Census, vol. xv, p. 580.

65·71, phosphorus ·013. A more detailed analysis carried out by Messrs. P. C. Gilchrist and E. Riley, on specimens sent to the Colonial and Indian Exhibition in 1886, is as follows. *—

Iron	69·85
Manganese	trace
Siliceous matter	2·75
Sulphur	·06
Phosphoric acid	trace
Moisture	trace

Mining of the ore.

At the principal deposit of ore, situated as above described, a wharf has been built, and excellent arrangements made for mining and shipping. The ore is brought to the wharf by an incline nearly a quarter of a mile in length, from the point at which it is quarried out, about 250 feet above the sea-level. Considerable quantities of ore have been shipped from time to time to the works of the Puget Sound Iron Company, situated at Irondale, W. T. The Texada ore is there mixed with from one-ninth to three-tenths bog-ore, found near Irondale, and produces thus, or when smelted alone, an excellent quality of foundry pig.

The shipments in 1885, amounted to 190 tons; in 1886, 3941 tons; in 1887, to 1410 tons; and in 1888 to 7300 tons, valued at $18,400.†

East side of Texada.

Iron-ore deposits of the same character, and in considerable mass, are again found on the opposite or north-east shore of Texada Island, and very probably are more or less continuously developed along the contact of the granites and limestones elsewhere in the island.

Sooke.

Magnetic iron-ores of somewhat similar character occur in the hills to the east of Sooke Harbour, Vancouver Island. The deposits are on Sections 79 and 83, Sooke district, at a distance of about twenty miles from Victoria, near the coast, and well situated for shipment. The deposit is rather of the nature of a *stoke-work* than a true vein, but can be traced for some distance in a N.E.-S.W. direction, and in places shews from ten to twenty feet of nearly pure ore. The country-rock is a coarsely crystalline diorite (?), containing much hornblende. The following assays of various specimens of the ore give the percentage of metallic iron.—

Analyses of the ore.

Wm. Julian, San Francisco	72·40
Thos. Price, " "	51·80
" " " "	57·30
J. T. Bernige, Cornwall	48·90
" "	68·50
J. Kestle & Co., San Francisco	64·50
D. Wallace, Glasgow	61·50
" "	65·00

* Journal of the Iron and Steel Institute, 1886, p. 561.

†Tons of 2240 lbs.

Magnetic iron-ore occurs in considerable mass in the Queen Charlotte Islands, on the east side of the entrance to Harriet Harbour, Skin-kuttle Inlet. No attempt has, however, yet been made to utilize this ore. Occasional strings of pyrites traverse the ore, but it is, as a rule, remarkably pure. Specimens of an average character, collected by myself in 1878 and examined in the laboratory of the Survey, proved to contain 58·06 per cent. of metallic iron, while an exceptionally good fragment yielded 69·88 per cent.* Queen Charlotte Islands.

Very pure specimens of magnetite have also been brought from an island in the Walker group, in Queen Charlotte Sound, near the north end of Vancouver Island. These proved to contain 71·57 per cent. of metallic iron. Another specimen of a similar ore, comes from a deposit, which is reported to be extensive, on the north side of Rivers Inlet, about twenty-five miles up from its entrance. Numerous other localities of iron-ores will doubtless be found when sought for. Such additional occurrences on the coast as appear to be worthy of mention as well as those known in the inland portions of the Province, are enumerated further on. (See p. 151 R.) Other localities

COPPER.

Copper-ores are known to occur in many places, over the entire area of British Columbia. They were among the first to attract notice at several localities on the coast, and during the early years of the Province, various irregular and uncertain attempts were made to open up copper-mines, but none of these resulted advantageously to the promoters, and no copper mining has yet been initiated in British Columbia. Copper-ores in smaller quantity are very frequently found in little veins and joints in the altered volcanic rocks of the Vancouver series, extensively developed on the coast, as well as in the similar rocks of the interior of the Province. Hundreds of such localities have been observed, but only a small proportion of them can be considered at all promising. Such occurrences, however, should receive the attention of the prospector where met with, as the copper-staining of rock-exposures is sometimes the most obvious indication of the presence of ores of the precious metals. Occurrence of copper-ores.

It is further impossible to draw a distinct line between deposits which are to be regarded as ores of copper and those which hold sufficient gold or silver to entitle them to be classed as ores of the precious metals. In consequence of this fact, a number of metalliferous deposits which might with equal propriety have been included here, have already received mention in the pages devoted to the precious metals, to which reference should be made. Thus the Toad Mountain Copper-ores of the interior country.

*Report of Progress, Geol. Surv. Can., 1878-79, p. 54 B.

ores, though owing most of their value to silver, contain, in specimens assayed, from 25 to 47 per cent of copper. The ores of Jubilee Mountain, on the Upper Columbia valley, are again very rich in copper, and some of them in which the percentage of silver is low, must be regarded rather as copper-ores. Copper-pyrites also occur in some quantity in the Stump Lake ores and in those of several other places previously described. A deposit of copper-pyrites which appears to be of importance, is that owned by the B.C. Copper Mining Company, on the upper part of the South Similkameen. Another discovery of grey copper-ore, reported to be extensive, has lately been made between Rock and Boundary creeks.

Howe Sound. In the vicinity of the coast, the copper deposit which has received most notice, is situated near the head of Salmon Arm of Jarvis Inlet and between that inlet and Howe Sound. This is owned by the Howe Copper Mining Company. The ore is chiefly bornite or purple copper and the deposit is not far from the coast, but at an elevation of 3000 feet above sea-level. It was discovered about 1874, and was worked at intervals between the years 1877–83, though rather with the view of developing the property than for the actual extraction of ore for shipment. Three levels have been driven on veins which are reported to be from 2 feet 6 inches to 3 feet 6 inches in width. Assays have shewn 58 per cent of copper and 50 ounces of silver to the ton. An assay of an average specimen, in the laboratory of the Geological Survey, shewed 40 per cent of copper. The veins traverse granitic rocks like those generally met with in the Coast Ranges.

Texada Island. Some exploratory work has also been done on a copper deposit of promising appearance situated on the north-east shore of Texada Island, at the contact of marbles with an intrusive mass of granite. The ore is copper-pyrites, mixed with iron pyrites, and much of it is of very good quality. A specimen collected by myself and submitted to assay in the laboratory of the Survey, contained in addition to copper 10·20 ounces of silver to the ton.* The mining operations at one time attempted at Skincuttle Inlet, Queen Charlotte Islands, in search of copper, do not appear to have been warranted by the comparatively small quantity of copper-ore apparent there, and led to no good result.†

Queen Charlotte Islands.

Sooke. A somewhat peculiar deposit of copper, upon which a shaft was sunk, was discovered near Sooke, on Vancouver Island in 1864. The copper here occurs in the native state, as thin leaves quite apparent to the eye, traversing green chloritic or diabase rock. A specimen subjected to assay, however, proved to contain but 1·02 per cent. of copper.‡

* Annual Report Geol. Surv. Can., 1886, p. 34 R.
† Report of Progress Geol. Surv. Can., 1878-79, p. 53 R.
‡ Annual Report Geol. Surv. Can. 1886, p. 19 T.

Masses of native copper have been found from time to time in various parts of the Province, and nuggets and scales of the same material have been obtained in sluices-boxes in the course of gold-mining in a number of places, occasionally in notable quantity. Native copper to the amount of half a ton, obtained in this way from Quesnel River, near the Forks, was some years ago sent down to Victoria and sold there. None of these occurrences of native copper have yet been traced to their sources, but they may very probably be derived from rocks originally of volcanic origin in beds of which copper may be found to be distributed. Native copper.

In connexion with the mining of the precious metals, the out-put of copper from British Columbia is likely before long to become considerable, and it is only a question of time till copper-ores shall be worked as such in the Province. Copper out-put

Such localities of occurrence of copper as appear to be of interest are enumerated on pages 152 R to 155 R. In this connexion the list of assays of ores of the precious metals (pp. 76 R to 79 R) should also be referred to.

LEAD.

As already explained, a large proportion of the silver-ores lately discovered and now in course of development in the Province, are argentiferous galenas, from which it is evident that so soon as these ores are extensively worked, the Province will become a lead producer to a notable extent. In consequence of the constant association of silver and lead, it has been thought best to include references to lead-ores, for the most part, under the head of silver. In the ores of Mount Stephen or Tunnel Mountain, on the Canadian Pacific Railway, and those of Hendryx Camp, on the east side of Kootanie Lake, may be mentioned as important occurrences of galena in which the value of the lead bears a considerable proportion to that of the contained silver. Both these deposits are now being opened up and shipments have already been made from the first-mentioned place to the smelter lately established at Vancouver. Deposits of galena which is not rich in silver, require to be situated within easy reach of means of transport or markets, before they can be assumed to possess any immediate value. Association of lead and silver.

ZINC.

Zinc blende is frequently found as an accessory mineral in the veins classed as those of the precious metals, as will be seen on reference to the table of assays on pp. 76 R to 79 R. No deposits of the ores of this Zinc blende.

metal which possess economic importance as sources of zinc have, however, yet been found in British Columbia.

Antimony.

Stibnite.

Several occurrences of stibnite or sulphide of antimony are known, in the southern part of the Province, which may prove to possess economic value. Antimony also occurs in small quantities, in combination, in a number of argentiferous ores, but can in such cases be regarded only as an impurity.

Platinum.

Localities yielding platinum.

The occurrence of platinum in association with placer gold is frequent in several parts of the Province, and is alluded to in connexion with the enumeration of localities of gold-mining, in a number of cases. (See pp. 115 R to 144 R.) The metal occurs in notable quantity in the region of the Upper Similkameen and Tulameen, in minute scales where the gold is 'fine' but increasing in coarseness to small pellets and nuggets in places where 'coarse' gold is found. Coarse grains and pellets of platinum have so far been found only on Granite, Cedar and Slate creeks, all entering the Tulameen on the south side. In certain claims on these creeks, the platinum has been found to equal half the weight of the gold obtained. It is estimated that from 1400 to 2000 ounces of platinum were obtained in this district in 1887, and about 1500 in 1888.

Character of the platinum and its value.

Though above referred to as platinum, the metal so named is alloyed with several other metals of the same class, of which osmiridium is the most abundant. Specimens of the native platinum from Granite Creek have been subjected to careful examination and analysis by Mr. Hoffmann, who states that the material "having the composition of the ore here in question would, at this present time, be worth from $2·90 to $3·65 per ounce, troy, in the English market." Osmiridium is employed, on account of its great hardness, for tipping the nibs of gold pens. "For this purpose it is necessary that it should be in the form of natural grains, and these are very carefully selected, the requirements being that they should be solid, compact and of the proper size and shape." This was not, however, found to be the case with that present in the platinum from Granite Creek.*

Probable source of the platinum

Platinum has very rarely been discovered in veins or otherwise in its original matrix, and in the Ural Mountains, whence the greatest quan-

* Annual Report Geol. Surv. Can., 1886, p. 57 T.

tities are obtained, it is almost always found, as in the cases above cited, in association with gold-bearing alluviums. In the northern part of the Government of Perm, however, it has been noted in a few places with little or no accompanying gold, and it then appears to be derived from rocks consisting of serpentine and peridotite with talcose and chloritic schists and chromite. While there is a notable abundance of greenish, chloritic, and hornblendic schists and diabase rocks, (resulting from the metamorphism of old volcanic rocks) in the Tulameen and upper Similkameen region, and chromite and magnetite are here found in the workings in association with the platinum and gold, no peridotite or serpentine is actually known to occur. The circumstances in connexion with the occurrence of the 'coarse' platinum appear to point to the vicinity of an important mass of intrusive diorite as its point of origin. A great part of the associated magnetite is certainly derived from veins in this rock, and it seems not improbable that the platinum, and possibly also a great part of the gold of this district, may occur in scattered grains in this intrusive mass, (compare p. 128 R). Very little vein-stuff occurs in the gravels with which the platinum and gold of this region are associated.

Importance deposits.

It may be added here, that the platiniferous region of the Upper Similkameen and Tulameen, is the most important as yet discovered in North America. Mr. David T. Day states, that owing to the rise in price of refined platinum, considerable enquiry for the crude material occurred in 1887, and that in consequence of enquiries for that material instituted in the West, a total quantity of 448 ounces of platinum was purchased, this being set down as the entire yield of the United States. Part of this platinum came from various places in Oregon, but a portion is stated to have been derived from British Columbia, and doubtless, from the region here referred to, as shipments were not made from other places in which very small quantities only are met with. The average price paid for this crude platinum was, according to the figures given, about $4 an ounce.*

MERCURY.

Occurrence of cinnabar.

It has already been stated (p. 12 R,) that no important deposits of ores of mercury have yet been discovered in British Columbia. Some pieces of cinnabar have been found in several places, and on the Homathco River and Wapta (Kicking Horse) River this ore has been found in place, but apparently in neither locality in workable quantity. Mercury is mentioned as appearing in globules in the native state in some parts of the silver-ore of Silver Peak, near Hope, and it also occurs in combination with silver in the mineral arquerite previously noted.

* See Mineral Resources of the United States, 1887, pp. 2, 142.

Arsenic.

Native arsenic. Native arsenic has been noted in one localtity, where it apparently occurs in considerable mass, to the west of the Fraser River, a short distance above Lillooet. Elsewhere it is known only as a relatively unimportant constituent in mixed ores.

Molybdenum.

Molybdenite. Molybedenite, or sulphide of molybdenum has been observed in a number of localities, but usually in small quantities only. These localities are situated for the most part in or near the Coast Ranges. Fine specimens have, however, been brought from the head of Spuzzum Creek, west of the Fraser, which may indicate the existence of a deposit of economic importance.

Structural Materials.—*Building Stones.*

Supply of building stones. Such demand as has up to the present time occurred for building-stone in various parts of the Province, has, as a rule, been satisfied without much difficulty. It may be stated, however, as a somewhat peculiar feature, that over a great part of the Interior Plateau, the rocks have been subjected to so much stress, and have been so completely crushed and jointed in consequence of disturbance subsequent to the period of their partial or complete induration, that homogeneous stone, suitable for masonry, is there notably scarce over considerabe areas.

Building stones of the coast. On the coast, building stones of excellent quality are met with in the greatest abundance. These consist of granites and granitoid rocks of the Coast Ranges, and of sandstones and freestones of Cretaceous age. Both varieties may frequently be quarried at the water's edge with excellent facilities for shipment. Marbles, suitable for purpose of construction, are also found in several places, and in situations equally advantageous.

Victoria. At Victoria, a considerable quantity of good grey granite has been obtained from the large travelled boulders, which at one time existed in abundance in the vicinity of the city. Granite from the Nelson Island quarry, Jarvis Inlet, has also been employed to a limited extent, and Cretaceous sandstone from the vicinity of Nanaimo and elsewhere has been used in considerable quantities. The greater number of the permanent structures are, however, built of brick, of fair quality, which is manufactured from a sandy clay, of marine origin, which overlies the oulder-clay to a depth of from five to fifteen feet.

In the construction of the dry-dock at Esquimalt, the greater part of the stone employed was a greenish-grey sandstone of Cretaceous age, quarried extensively for the supply of this work, on Admiralty or Salt Spring Island. For portions of the work requiring greater strength, the granite of Nelson Island was used. Stone used in dry-dock.

For Vancouver, the principal building-stone is a very excellent grey granite, quarried on the North Arm of Burrard Inlet, at the water's edge, and lightered thence to the city. Brick is, however, extensively used here and at New Westminster. It is manufactured from clays similar to those of the neighborhood of Victoria, which have like those there used, a red colour. Vancouver.

The granites so far met with in favorable positions for quarrying in the vicinity of the coast, are generally grey in colour and more or less hornblendic. Some excellent stones of a pinkish-grey colour (like that of Nelson Island) also occur. Most of these granites and granitoid rocks are susceptible of a high polish. No distinctively red granites of good quality have been observed in mass or quarried. Granites.

The quantity and quality of the granites of the coast region is such, taken in connexion with their accessibility, as to suggest that they may ere long become the basis of an important industry, and that they will be quarried, not alone for home use, but for export to other places less favorably situated in respect to building-stones.

The greater facility with which the sandstones of Cretaceous age may be worked, renders them more appropriate for certain classes of buildings, and from a commercial point of view, they may be regarded as at least equally important with the granites. Among the coal-bearing rocks of Newcastle Island, Nanaimo, there are beds of brownish-grey sandstone, which afford excellent material for building and flagging. The upper beds are of the best quality, and it was from one of these that Mr. E. E. Emery, of San Francisco, obtained the stone for the construction of portions of the mint in that city. Blocks for pillars were taken out, which, after dressing, were twenty-seven feet six inches in length, and three feet ten inches in diameter. Flagstones, with even surfaces, as much as ten feet square, have also been obtained, and are easily quarried. These sandstones have also been employed for the manufacture of grindstones to a limited extent, and some beds are believed to be well suited for this use. Sandstones.

The marbles of Texada Island and of other localities easily reached by sea, must also be regarded as possessing considerable value for ordinary building purposes. Several of these take an excellent polish, and are already in use, to a small extent, for the manufacture of monuments. The known marbles generally range in colour from grey to white, and include some very handsome mottled and clouded varieties. Marbles.

So little enquiry has, however, yet been made for marble, that it is highly probable that many additional varieties remain to be found.

Building stones of the interior.

Building-stones situated at a distance from the coast or from the line of railway must, of course, be considered as possessing no present value. On that part of the railway which traverses the Coast Ranges, as far inland as North Bend, grey granites of the kind just noted, and well situated for quarrying, are of frequent occurrence. Granites of this character, obtained in the immediate neighborhood, were employed in the construction of the piers of the great cantilever bridge across the Fraser. Further inland, building-stones of good quality are seldom met with near the railway, till the Shuswap Lakes are reached, but it would appear that the silts abundantly developed in banks along the rivers, and forming the latest deposit of the glacial period, are well suited for the manufacture of brick.

Quarries.

On a subsequent page a number of localities are enumerated in which quarries have been opened, or which present all the conditions necessary for the successful quarrying of good stone. In this list, special prominence is given to the southern part of the coast of the Province and to places on the line of railway. It may indeed be stated that localities not included in one or other of these categories are omitted, as, with rare exceptions, such cannot be regarded as of any immediate value.

Slate.

The existence of slate of good quality and easily fissile in large surfaces, has not, so far as I am aware, yet been proved in any part of the province of British Columbia, though reported in several places, particularly at a place six miles and a half east of Golden, on the C. P. Ry. line.

Ornamental Stones.

Materials susceptible of high polish.

Under the head of ornamental stones, such materials as are susceptible of employment in architecture for decorative purposes may be classed. These would include many of the granites and granitoid rocks susceptible of a high polish, together with the marbles, previously referred to. Porphyries, diorites, etc., may also be included here, and these are found in great variety of colour and texture in various parts of the Province. Slabs of a porphyrite-breccia obtained by Mr. Richardson in the Ballinac Islands were found to take a very fair polish, but few experiments have yet been made toward the utilization of such materials. The serpentines which occur in many places in the interior of the Province, can scarcely be regarded as of value for such purposes, as most of them are too much jointed and disturbed to afford blocks or slabs of useful size, free from flaws. They differ in this respect very markedly from the serpentines of the Eastern Townships of the province of Quebec, some of which afford excellent verd-antique.

Limes and Cements.

Importance attaches also to places in which limestone of good quality and well situated for the manufacture of lime and its shipment occurs. Victoria is at the present time chiefly supplied with lime from San Juan Island, W. T., and from Saanich; for though limestone occurs in several places in the immediate vicinity of the city, it is generally of an impure and siliceous character. Vancouver also derives the greater part of its supply from the San Juan quarries. In this connexion, I think attention cannot be too strongly drawn to the fact that pure and excellent limestone, which often assumes the character of marble, occurs in the northern part of Texada Island in quite unlimited quantity, and that this island is scarcely less accessible by water than San Juan, and possesses the additional advantage of proximity to the coal-fields of Nanaimo and Comox. There appears to be an excellent opening here for an important industry. The best places for work and shipment on Texada Island are Marble Cove, on Malaspina Strait, three miles from the north end of the island, and Marshall Bay, at the northern extreme of the island.

Sources of supply.

Opportunity for work.

As entire groups of mountains and hills to the east of the Coast Ranges are frequently composed of limestone, it is naturally impossible to enumerate localities of occurrence of this material generally throughout the Province. It has, however, been considered advisable to mention, on a subsequent page, a few places which from their situation are regarded as of importance, and which have come under my own notice.

Great abundance of lime.

Hydraulic limestone, useful for the manufacture of cement, has not yet been found in the Province, but it must be admitted that in consequence of the very moderate demand which has so far occurred for such material, it has been but little sought after. Nodular calcareous rocks, containing a certain amount of clayey matter, such as occur in the Cretaceous and Tertiary series, sometimes in considerable abundance, appear to be the most probable source of supply of cements, and deserve to be looked after and experimented with in this connexion.

Hydraulic cement.

It is highly probable also that some of the volcanic tuffs of Tertiary age, met with particularly in the region of the Interior Plateau, may be found of value for use in the manufacture of cements in a similar way to the *trass* of the vicinity of Andernach and elsewhere on the Rhine, or the Pozzuolana of Naples. These materials are merely ground and mixed, without being calcined, with a certain proportion of quick-lime, and are then found to possess excellent hydraulic properties.

Trass.

Most of the tuffs actually known to occur in quantity in the Province, are situated at some distance from the line of railway, but it is possible

that some of the tufaceous rocks of the vicinity of Kamloops Lake might be employed in the manufacture of cement. On the coast, I have observed a considerable deposit of material almost identical in appearance with the trass of the Rhine, at Lawn Hill, near the entrance to Skidegate, Queen Charlotte Islands.* Other localities of similar material may also yet be found on the Coast, and should they prove to afford good hydraulic cement, they will possess great value for the construction of wharves, etc., where wooden structures are rapidly destroyed by the teredo.

Precious Stones.

Absence of gem stones.

Gems of the more valuable species, such as the diamond, sapphire, etc., have not been as yet found in any part of British Columbia, and taking into consideration the great amount of placer gold-mining which has occurred, their apparent absence must be considered as rather remarkable; though this is perhaps due to want of observation on the part of the miners. Garnets are of frequent occurence, both imbedded in the crystalline rocks and found loose in sluice-boxes in the course of gold-mining, but none have yet been observed sufficiently free from flaws, or of size or colour such as to render them valuable for jewellery.

Agates.

Agates and chalcedony are very often found in association with the volcanic rocks of the Tertiary, and on the shores of the northern part of the Queen Charlotte Islands, as well as along some of the rivers and lakes of the interior, these may be collected in considerable numbers in the form of rolled pebbles. Jasper also occurs in some places in the Tertiary rocks, and the Indians occasionally employed this material and agate in the manufacture of arrow- and spear-heads. It is more common, however, to find arrow-heads in the interior of the Province, composed of black cherty quartzite, which is there abundant in many places. In the Northern Interior the Indians of the Tinné stock often used obsidian or volcanic glass for the same purposes, the most notable locality for this material being the mountain named Beece or Anahim's Peak, in the upper Blackwater country.†

Obsidian.

Opal.

Siliceous deposits of the character of 'wood opal' are found where siliceous springs have issued during the earlier stages of the Tertiary, particularly in the vicinity of Vermilion Forks on the Similkameen and near Dropping-water Creek, about two miles north-west from the head of Stump Lake. At the last-mentioned place, opaline silica and hyalite have been observed, filling cavities in a slightly cavernous trachyte, which occurs in great mass. Some specimens closely ap-

* Report of Progress, Geol. Surv. Can., 1878–79, p. 85 B.
† Report of Progress, Geol. Surv. Can., 1876–77, pp. 78–79.

proach precious opal in character, and the locality appears to be worthy of further examination, as the rock is identical in character with that yielding the precious opal in Hungary and elsewhere.

Specimens of very beautiful blue sodalite, are found in abundance in the vicinity of Ice River, a tributary of the Beaver-foot, in the Rocky Mountains. The mineral closely resembles lapis-lazuli in appearance, and would possess considerable value as an ornamental stone for jewellery, etc. Closer search than we were able to make would probably lead to the discovery of even larger pieces than those found by us, some of which, however, were several inches in diameter. The mineral occurs in connexion with an intrusive mass of nepheline-syenite.* Sodalite.

Jade or nephrite was highly prized by the Indians of the coast of British Columbia and Alaska for the manufacture of cutting implements of the nature of adzes or 'celts.' It is frequently found in the form of such implements, varying in colour through various shades of green to brown, in the purer varieties quite translucent, but when less pure becoming clouded and opaque. I have elsewhere shown reason for the belief that this mineral occurs in place in the vicinity of the Fraser River, and have since found rolled pieces of it on the Lewes branch of the Yukon.† Some specimens constitute handsome ornamental stones. Jade.

Specimens of lignite from some beds of the Tertiary resemble jet in appearance, but are usually too brittle to be employed for purposes of ornament. True jet may, however, be looked for in assocaition with these rocks. Jet.

Mineral resin in small drops and patches is of frequent occurrence in some of the Tertiary and Cretaceous coals, and a small specimen of true amber was found in the possession of the Indians in the Queen Charlotte Islands and said to have been derived from the west coast of these islands. Amber.

* Annual Report Geol. Surv. Can., 1885, p. 124 B. Trans. Royal Soc. Can. vol. iv, Section iii, p. 81.

† Canadian Record of Science, vol. ii, No. 6, 1887. Annual Report Geol. Surv. Can., 1887, pp 38 B, 147 B.

Miscellaneous Minerals.

Minerals not discovered.

No single specimen of *tin* ore has yet been found in any part of the Province nor have *nickel*, *cobalt*, *manganese* and *chromium* been discovered in anything approaching workable quantity. *Graphite* or *plumbago* is known, but not apparently in useful deposits. *Gypsum* deposits have not been found, and this mineral appears only in the form of selenite

Ochres.

crystals in certain shales and clays. Red and yellow *ochres* occur in several places, making, sometimes, a considerable shewing, but no attempt has been made to utilize them so far. *Baryte* or heavy-spar appears only as an accessory mineral, and no deposits of *rock-salt* or of

Tripolite.

native sulphur have been discovered. *Tripolite* or diatomaceous earth appears forming certain layers in the Tertiary clays on the Blackwater, and may probably elsewhere be found in like situations, and in the beds of some of the very numerous lakes and ponds. *Kaolin* or china-clay

Asbestus.

has not been found. The occurrence of *asbestus* is noted elsewhere, but apparently in small quantity only, though the abundance of serpentine leads to the belief that veins of chrysotile or serpentine-asbestus may

Mica.

be looked for with some probability of success It is also very probable that valuable deposits of *mica* may be found in some of the granitic districts, and some localities of a promising character have already been observed. *Fire-clays* may be expected to occur in the Cretaceous and Tertiary coal-bearing rocks, but so far as known they

Petroleum.

have not yet been sought for or tested. *Petroleum* is not known in the Province, and though rumours were current some years since of its occurrence in the northern extension of the Comox coal-field, these could not be substantiated. Tarry, bituminous matter is, however, found oozing out in several places on the Tar Islands of the Queen Charlotte group.

Mineral and Thermal Springs.

Hot Springs.

Saline or mineral springs are known in a number of widely scattered localities within the limits of the Province. Several of these are noted as hot springs, and it is probable that all the thermal waters contain

Salt Springs.

notable quantities of saline water. Springs characterized by an abundance of common salt are known at Nanaimo and Admiralty or Salt Spring Island, but the flow of these is not so copious or the strength of the brine sufficient to warrant a belief in their economic

Mineral Springs.

importance. Of the other springs, some of which may possess therapeutic value, the only one so far utilized to any considerable extent is that known as "St. Alice's Well," at the lower end of Harrison Lake. A hotel has been built at this place and it is frequented as

a health resort, accommodations for bathing, etc., being provided. There are in the Selkirks and elsewhere a number of springs locally known as "Soda Springs," which are highly charged with carbonic acid gas, and some of which are reported to be excellent as beverages.

In the dry parts of the Interior Plateau region, many more or less saline pools and lakes occur, but the salts in these are usually those resulting merely from the local evaporation of ordinary surface waters. There are also, in the same region, many small saline springs which issue from the superficial deposits or soft Tertiary rocks. These appear generally to contain sulphates of soda, magnesia, etc., and possess no economic or therapeutic importance.

Such notes on individual springs as appear to be of importance are given in connexion with their enumeration on page 162 R.

ANNOTATED LIST OF LOCALITIES OF MINES AND OF KNOWN OCCURRENCES OF MINERALS OF ECONOMIC VALUE IN THE PROVINCE OF BRITISH COLUMBIA.*

GOLD (PLACERS).

Though many of the undermentioned placer-deposits are now abandoned, it has been endeavoured to make the list as complete as possible, for the purpose of indicating the localities of probable occurrence of auriferous veins.

Fraser River.

It is at this date difficult to correctly enumerate and place the principal auriferous 'bars' of the Fraser. The greater part of the work upon these occurred in 1858 and 1859, the first years of the gold excitement. Many bars were then named and worked for a short time only, and of others which were occupied for a longer time and yielded a large quantity of gold, it is not always possible to obtain any statistics or facts of a trustworthy character. The best authority for the names and positions of the more important bars, as far up as Lytton, is the Admiralty map of Vancouver Island and Adjacent Shores of British Columbia, No 1917, corrected to December, 1886. Much information is also contained in Vol. XXXII. of Mr. H. H. Bancroft's works, which that author has been at great pains to collect from innumerable sources of varying authenticity. From statements quoted in Mr. Bancroft's work, the greater part of the details of yield of various bars, given below, has been selected. The names of bars of which the position relatively to the others is not accurately known, are enclosed in parentheses.

The various bars are arranged as far as possible in order, following up the river.

BARS BELOW HOPE.—All these yielded very fine gold only.

Maria Bar.—Twenty-five miles below Hope, near mouth of Chilliwack River. This was the lowest bar on the Fraser which paid for work.

(Several bars of which the names are not known.)

* Unless otherwise specified, the references throughout this list of localities are to the Reports of the Geological Survey, of which the dates are given, but not the full titles.

Hudson Bar.—A ditch a mile long here in 1859. Earnings, $8 to $10 a day.

Cornish Bar.—First known as *Murderer Bar*, four miles below Hope. In 1860, fifteen men were employed here, making from $3 to $4 a day. This and other bars in the vicinity averaged as minimum earnings, $4 to $10 in 1858.

BARS BETWEEN HOPE AND YALE.—Some of these bars yielded good results in 1858 and 1859. In 1865 Chinamen were still making from $2 to $5 on them.

American Bar.—

(*Union Bar.*)—Two miles above Hope.

St. Clara Bar.—

Posey Bar.—

(*Cameron's Bar.*)—On this bar nineteen men are reported to have made $75 a day each for three weeks. This was a mid-stream bar.

Emory's Bar.—Average earnings, $6 to $8.

Texas Bar.—Yielded as high as $15 to $40 a day to the hand.

Hill's Bar.—In 1858, the earnings are stated to have averaged $16 a day to the hand. Another authority places the earnings at from $2·50 to $25. Eight companies were making from $15 to $40. Four men on one occasion sluiced out gold to the value of $1000 in six days. Ten claims, each 26-foot frontage, produced $30,000 in less than four months. (See p. 26 R)

Yale.—Bars here produced $15 to $20 a day per man. Sluicing yielded $25 to the hand. Mining still in progress in 1888.

BARS BETWEEN YALE AND LYTTON.—The bars between Yale and Boston Bar are reported to have given an average yield of $12 a day to the hand, early in 1858.

Sailor Bar.—Five and a-half miles above Yale. In 1858 yielded one to four ounces a day to the hand.

Wellington Bar.—

Washington Bar.—

Spuzzum.—(According to Brancroft, there were between Yale and Spuzzum, named, in addition to the above bars—Pike, Madison, Steamboat, Humbug, Surprise and Kelly bars.)

Chapman's Bar.—

Dutchman's Bar.—

Cross Bar.—

Siwash Bar.—

Big Cañon.—

Nicaragua Bar.—In 1859, five men are stated to have taken out gold to the value of $118 in one day here.

Tehama Bar.—

Island Bar.—

Boston Bar.—Mining begun in 1858. Bench mining in progress in 1888.

Yankee Bar.—

Fargo Bar.—

Mariner's Bar.—

Rancheria Bar.—

New Brunswick Bar.—

Lytton.—Mining begun in 1858. In January, 1859, 100 men at work in this vicinity averaging $8 a day.

BARS BETWEEN LYTTON AND FOUNTAIN.—In 1859, earnings on these bars from $8 to $100. Averaged earnings stated at $9 to $10.

Mormon Bar.—In 1858 one rocker produced gold to the value of $830 in eight days. Another $800 in twelve days.

Spindulum Flat.—Yielding gold to the value of $8 to $10 to the hand in May, 1859.

McGoffery Dry Diggings.—Rich benches. Nuggets valued at 50 cents to $12 found.

Foster Bar.—A party in July, 1858, obtained here, with rockers, in six hours, three to five ounces to the man. In May, 1865, miners reported to make, with rockers, $3 to $8 to the hand. Sluice company producing at the rate of $8 a day to the hand.

Willow Bank.—Nuggets weighing four to six ounces found here.

Great Falls.—Reported at one time as yielding $10 to $30 a day to the hand in coarse gold. Nuggets weighing six ounces found.

Lillooet.—(Known as "Coyoosh" in 1858 and 1859.)

French Bar. (Just above Lillooet). In 1859 yielding $4 to $6 with rockers; $8 to $12 by sluicing.

Robinson's Bar.—In June, 1858, 100 miners making, at first, $80 to $90 a day each. Yield soon fell to $5 to $6.

Horse Beef Bar.—In 1859 yielding $2 to $6 a day to the hand.

Upper Mormon Bar.—Opposite Fountain. The diggings here and in the vicinity of Fountain were regarded as among the best. In 1858 five rockers were averaging $47 each a day. There were also good, dry diggings, thirty yards away from the river.

BARS BETWEEN FOUNTAIN AND ALEXANDRIA.—

Day Bar.—Two miles above Fountain. Earnings made of $8 to $12.

Haskell Bar.—Eighteen miles above Fountain. Earnings at rate of $6 to $12 with rockers; $16 to $20 by sluicing.

Big Bar.—Rockers yielded $5 to $6.

Island Bar.—Reported as giving good yield.

BARS ABOVE ALEXANDRIA.—In 1859 several of these became rather noted.

British Bar or *Cornish Bar.*—Thirty miles above Alexandria. In 1860 a ditch five miles long had been made here.

Ferguson Bar or *Rich Bar.*—Three miles above last. Sixty dollars a day to the man made here for some time.

Long Bar.—Seven miles above Quesnel has been worked almost continuously from early years. Earnings still about $3 a day.

Spanish Bar.—Thirteen miles above above Quesnel; some work still carried on.

Cottonwood Cañon.—On a high flat here some fairly coarse gold was worked.

Tributaries of Fraser River and Places in its Vicinity not included under Subsequent Headings.

Yale Creek.—Near Yale. A little coarse and rough gold obtained here in late years.

Coquihalla River.—More or less coarse gold has been found along nearly the whole course of this stream, particularly where it cuts an area of the Anderson River slaty rocks, but it has never been extensively worked. In 1864 diggings yielding $5 a day found on lower part, near Hope. Good prospects found on *Ladner's Creek* and on *Pierre River*, tributaries, and in 1861-62 a good bar worked on the Coquihalla just below the mouth of the last-named creek.

Anderson River.—Some coarse gold found at one time ten miles above mouth, but not enough to pay.

Main River Thompson.—Heavy gold found on this river up to *Nicoamen*, where, it is believed, the first placer gold in paying quantity in British Columbia was found. This region chiefly worked by the Indians of the country, who, I am assured, have obtained many thousand dollars in specially favourable years. River-bars worked here and there, as far up as Kamloops Lake.

Lillooet River.—Flowing into Harrison Lake. Along this stream, in 1859, gold to the value of $2 to $4 a day obtained with rocker; $5 to $8 by sluicing. Similar earnings in 1867.

Portage between Seton and Anderson Lakes.—In 1880 Indians reported to be making small earnings here.

McGillivery Creek.—Enters Anderson Lake eighteen miles from head on west side. Coarse gold found in 1880. Value $18·50 per ounce. Gold to the amount of $1032 obtained in workings near mouth of creek in 1881, and further working abandoned.

Cayoosh Creek.—Diggings discovered in spring of 1886 by Chinese.

Gold worth $18 to $18·50 per ounce. In 1886 yielded 725 ounces. Yield in 1888 estimated at about $52,000. Remunerative work has been carried on here uninterruptedly since the discovery. The gold obtained is on the lower ten miles of the creek, below the outcrops of certain gold-bearing quartz-veins, from which the placer gold is supposed to be derived. (See p. 71 R.) This creek affords a remarkable instance of rich placer deposits which have remained long undiscovered in a country supposed to be well known. Mr. Phair, Mining Recorder, writes:—"It seems almost incredible that this creek, within an hour's walk of the town of Lillooet, should have been passed by for a quarter of a century by hundreds, aye, thousands of the best practical white miners and prospectors of the Pacific Coast, and now at this late date the prize falls into the hands of Chinese." (Report of Minister of Mines of B. C., 1886, p. 207. See also same report for 1887 and 1888, pp. 273 and 312.)

Bridge River.—Discovered in 1858, and soon prospected nearly to its sources and some mining done throughout. Coarse gold for ten miles up from mouth, further up generally scale gold. Some nuggets found on lower part of river of from one to two ounces in weight, and one said to have been worth $300. This stream at first worked by whites, afterwards chiefly by Chinese and Indians. In 1866 Chinese said to have obtained gold to value of $66,000 to twelve men, by wing-damming. A good deal of the mining has been done of late years on the South Fork, which is reached by a journey of three or four days from Lillooet, *via* Seton Lake and across the mountains. Gold worth $16·50 per ounce, coarse, nuggets worth $10 to $22 having been found.

Gun Creek.—A tributary of Bridge River, fifty miles by trail from Lillooet. Placers discovered in 1859 yielding $6 to $15 a day.

Cadwallader Creek.—A tributary of Bridge River. Good prospects found here in 1886.

Hat Creek.—Small quantities of gold have been found here.

Scotty's Creek.—A tributary of Bonaparte River. Prospects reported to be good, but boulders in the valley render mining difficult.

Chilcotin River.—Gold in some quantity said to have been found near the mouth of this stream.

Nechacco River.—Colours obtained near Fort Fraser, and also abundant near its junction with the Fraser River.

Chilacco River.—In certain banks near its mouth, eight or nine colours to the pan may be obtained. A small quantity of coarse gold found in a lateral creek by one of the men connected with the Canadian Pacific Railway survey in 1876.

Cariboo District.

WILLIAMS CREEK.—For description see page 34 R. Discovered 1861, and has yielded more gold than any stream in British Columbia. As examples of the yield in early years it may be stated that Steele's claim gave a maximum yield of 409 ounces or $6524 a day. Over $100,000 in all taken from this claim of eighty by twenty-five feet. In 1862, Cunningham's claim produced gold to the value of nearly $2000 a day for the season, while on several days as much as fifty-two pounds weight of gold was taken out. The Adam's claim yielded to each of its three partners $40,000, clear. These claims were above 'the cañon' in shallow ground. The deep ground below 'the cañon' was first bottomed near the end of 1861 by the Barker Co. (whence Barkerville). The Diller Company was the next successful in this, and it is credibly stated that here, on one occasion, 200 pounds of gold worth $38,400 was obtained in one day. In 1863, three claims below 'the cañon' yielded $300,000, and twenty claims were steadily producing from 70 to 400 ounces a day. Four hundred miners were at work on Williams Creek in this year,—'the Golden year.' The aggregate yield of Williams Creek, for the first seven years of working, for which no returns are available, was very large. In 1888 about twelve hydraulic claims were being worked.

The tributaries of Williams Creek, in order down stream, are as follows:—

Mink Gulch.—Joins from the west. Hydraulic work at outlet has paid well.

Walker's Gulch.—Joins from the west at Richfield Court House. Deep work. Good prospects at different times and some quantity of gold taken out at its month, but has not held out. Hydraulic work still in progress.

Grub, or *Black Jack Gulch.*—Joins from the west. A mere ravine of no great length, being all embraced in one claim. Has afforded good pay by hydraulic method, but now worked out.

Stout's Gulch.—Joins from the west, below 'the cañon.' Very rich, but now worked out for drifting. Hydraulic method employed.

Conklin Gulch.—Joins from the east, opposite Barkerville, discovered 1874, and has since proved very rich; the Ericson claim in that year yielding 400 to 500 ounces a day. Ground very deep for so small a valley, being ninety feet in lower part and twenty feet in highest; drifting claim, one mile and a-half up; probably rich for hydraulic working.

McArthur's Creek.—Two miles below Barkerville and one mile above Lane and Kurtz shaft-house; joins from the south-west. Paid well in

drifting deep ground, but now worked out for this method. No hydraulic work in progress.

Creeks entering Willow River.—

Lowhee Creek.—Discovered, 1861. Runs northward, nearly parallel to Williams Creek, and empties into Jack-of-Clubs Lake, which also receives Jack-of-Clubs Creek, and is the source of the Willow River. Good pay found in both shallow and deep diggings, and some good ground still being worked. Gold, especially near source of creek, very coarse and rough, often including fragments of quartz. Found difficult to obtain water for hydraulic work here, but otherwise promising. The Jordon and Abbott claim in 1861, yielded from eighty to a hundred ounces daily, and in 1884, the Sage-Miller claim yielded for a time from 300 to 400 ounces a day.

Jack-of-Clubs Creek.—All deep work on this creek, gravel being 150 feet in depth near the mouth, where a few claims paid well. This creek is a favourite among those which are considered yet unproven, the impression being that an old channel exists which has not been found.

Musquito Creek and *Red Gulch.*—Entering Willow River from the south below the last have been very rich. The ground was fifty feet deep at mouth; now worked out for drifting. Hydraulic work has paid well.

Whip-saw Creek.—Three miles below Mosquito Creek, on the same side. In former years, from $10 to $12 per day per hand taken out, and more or less work carried on for many years by ground-sluicing and drifting. No work now in progress but considered promising.

Several creeks below Whip-saw Creek on the south-west side of Willow River, have afforded no pay; fair prospects have been obtained in some creeks on the north-east side, but no rich paying ground found.

Hardscrable Creek.—Joins Willow River from the north. Drifting and hydraulic work has been carried on, but without very important result.

Slough Creek.—Joins Willow Creek from south and east, seven miles below Jack-of-Clubs Lake. Chiefly bench and shallow diggings. Main valley never bottomed, but considered promising.

Burns' Creek.—Tributary of the last, from the north. Has yielded a good deal of gold from both deep and shallow diggings.

Devil's Cañon.—Joins Slough Creek from the south, half a mile below last. Bench mining still going on.

Coulter Creek.—Tributary of Slough Creek. Gold worked some years ago.

Nelson Creek.—Joins Slough Creek from the south-west four miles below Jack-of-Clubs Lake. Hydraulic work.

New Creek.—Tributary of Slough Creek. A little work done here a few years ago.

Dragon Creek.—Tributary of Willow River. Two miles of the lower part of this creek worked four years ago.

Rouchon Creek (sometimes called *Russian Creek*).—Joins Willow River from south, thirteen miles below Jack-of-Clubs Lake. Sluicing yielded $4 to $5 a day to the man. Mining still going on.

Barry or *Berry Creek.*—Joins Willow River from south-west fifteen miles below lake. Shallow diggings.

Archer Creek.—A little work on shallow diggings some years ago.

Deadwood Creek.—Joins Willow River from the west five miles below last. Shallow diggings.

Sugar Creek.—A branch of Valley Creek, which joins Willow River from the east a short distance above Deadwood Creek. Some good prospects, but never much pay. Some hydraulic work has been carried on.

Cañon Creek.—A stream running into Willow River far down its course, and reached by a trail twenty miles long from Beaver Pass House. Prospecting has been carried on here, but no rich placers found.

Creeks lower down Willow River are known to hold some gold, but have not yielded it in paying quantity.

LIGHTNING CREEK.—Discovered in 1861, and in that year $200,000 worth of gold taken from Campbell's Discovery claim and the adjacent Whitehall claim. Attempts were made almost from the first to reach the deep channel of this creek, but after much work, these were abandoned in 1864. Sinking was, however, resumed in 1870, and having proved successful, led to the subsequent great developments. The rich character of some of the ground on this creek may be illustrated by stating that at one time the Butcher claim yielded 350 ounces a day, the Aurora, 300 to 600 ounces, and the Caledonia, 300 ounces. For description see page 34 R.

The tributaries of Lightning Creek, in order, down stream, are as follows:—

Amador Creek.—No good pay yet found.

Van Winkle Creek.—Discovered, 1861. About 2000 feet of the lower end of this valley paid well. In 1861 a company of four took out an average amount each of $600 worth of gold during the season.

Dead Man's Creek.—

Perkins' Creek.—Some gold obtained here of late years.

Chisholm Creek.—Good pay in shallow workings. Deep ground unproved, though great efforts have been made to test it.

Last Chance Creek.—Estimated that $250,000 worth of gold taken out

of this creek in a length of half a mile. Rich ground now probably worked out.

Davis Creek.—Good pay in shallow ground.

Anderson Creek.—Good pay in shallow ground.

Jaw-bone Creek.—No good pay found.

Peter's Creek.—Joins Lightning Creek from the south-east, a mile below Beaver Pass. Reported to have afforded a considerable quantity of gold. Not recently worked.

Basford Creek..—Tributary of the last. Work has been carried on here.

Campbell's Creek.—Also a tributary of Peter's Creek. Gold found and worked, but no particulars.

French Creek and *Canadian Creek.*—Joining Pleasant Valley from the south, have both yielded some gold and were found locally rich, though paying ground run was through where the working was carried on. Probably not exhausted.

Grouse Creek.—Six miles east of Barkerville, heading with Antler Creek. Discovered 1860. Mined to some extent in 1861 and 1862, but with renewd vigour in 1864. The deep ground was very rich, and extended for about a mile near the upper part of the creek, giving out farther down. Deep ground worked out. Appearances favorable for hydraulic work.

Antler Creek.—Discovered 1859, but no work done till 1860. Heads in Bald Mountain, opposite Williams Creek, and was one of the first creeks worked in this part of the country. Shallow ground for two miles, paid well, and has been worked out. The deep ground has not yet been much tested, owing to the absence of clay, and consequent large quantity of water met with in sinking. All the gulches joining Antler Creek from the source down, have paid (*Wolf*, *California*, *Stephens'*, and *Begg's Gulches.*) The creek has never been bottomed where these side valleys fall in. Chinese have been at work, and get pay on benches 100 feet above the stream, a long way down. Antler Creek yielded gold to the amount of $10,000 a day for some time in 1861. It is stated that one company of three men obtained in three weeks washing, $83,300, and that in some spots the ground yielded $1000 to the square foot.

Nugget Gulch.—Tributary of Antler Creek. Good pay found at mouth. Upper part not tested.

Victoria Creek.—Tributary of Antler Creek. Has been mined near the mouth.

Branch of Eight-mile Creek.—(Five miles north of Barkerville.) A little mining work carried on here in early years.

Pleasant Valley.—A transverse depression, four miles in length, uniting the valleys of Williams and Antler creeks, and joining the former about three miles below Barkerville. Has never been bottomed or much prospected, but might be embraced in a scheme for draining the valley of Williams Creek. (See p. 37 R.)

Bear River, and country about Bear Lake.—Gold has not been found here in paying quanity.

Swamp River.—Has attracted some attention, but no good pay has yet been found.

Cunningham Creek.—Discovered 1860, but not much worked till 1864. In early days, a crevice containing 600 ounces of gold was found on this creek, about twelve miles from its mouth. Several hydraulic claims have been worked here. Since 1864, attempts to reach the deep ground have been made, but have not succeeded. It has always been supposed that the deep ground in this creek would turn out rich, and if once proven to be so, a large amount of work would immediately be undertaken.

Harvey Creek.—The first gold in paying quantity in the Cariboo district proper was found here in 1860, but comparatively little work was done till 1864. One claim—the Minnehaha—has been exceedingly rich. Another at the junction of Swamp River, has paid well. The Cummings Company bottomed it at one place, and drifted up in a small cañon (unsuccessfully,) but found pay on entering wide ground. The upper part of the creek is deep, and has not yet been thoroughly proven.

Creeks flowing into Cariboo Lake.—In *Nigger*, *Pine*, and *Goose Creeks*, small quantities of gold have been found. On the last-named, much money was spent in putting in a flume, but with small result.

Keithly Creek.—Discovered in autumn of 1860. The main creek has only moderately deep ground, (twenty to twenty-three feet,) of which some is yet unworked; it being expensive to open on account of the great quantity of water. Benches 100 feet above the stream have paid for open work, and some of them for drifting also, while a number of Chinese, who worked about the mouth, also got good pay. A little hydraulic work has been attempted here with fair results.

Main Snow-shoe Creek.—Tributary of Keithly Creek. Has been mined about one mile up, affording good pay. Ground deep. A tunnel about three-quarters of a mile long is being driven to work the bed-rock.

Little Snow-shoe Creek.—Tributary of Main Snow-shoe Creek. This is considered to be one of the most promising creeks of which the deep ground (though not extensive) has not been worked. Good pay

obtained from shallow workings. Hydraulic work has been steadily carried on for some years and pays well.

French Snow-shoe Creek.—Tributary of Snow-shoe Creek. Worked at one place, near the cañon, where the ground was shallow. Elsewhere, the deep ground has not been tested.

Four-mile Creek.—Tributary of Keithly Creek. Hydraulic mines and drifting near the mouth. Good pay.

Duck Creek.—Chinese have worked here. No recent mining of importance.

Spanish Creek.—Falls into North Fork of Quesnel River from the south (draining Spanish Lake) six miles below Cariboo Lake. Mining carried on at different times, but not recently. Prospects still considered favourable.

Black Bear Creek.—North Fork of Quesnel. Much prospecting and mining have been done here and coarse gold found, but no rich pay. Not yet considered faily tested, the ground being hard to work.

Kangaroo Creek.—Joins North Fork of Quesnel about two miles above its junction with the South Fork. Paid well at one time.

Cedar Creek.—Discovered in 1862, but scarcely worked till 1866. One pretty rich claim was worked here,—the Aurora—which yielded $20,000 in 1866. There were some other good claims in this year and the next. Pay-dirt six to eight feet thick. The creek is now worked by Chinese, who use the hydraulic method on a pretty large scale.

Coquette Creek.—Near the last. Discovered 1866, but soon given over to Chinese and worked by them for some years. Not worked in 1886.

Hazeltine's Creek.—Some encouraging 'prospects' have been obtained here.

Moorhead Creek.—Some work done here, but without good result. Prospecting still going on. (1886)

Quesnel River.—Discovered 1859. Most of the work done on bars of river, though many workings on benches one hundred to one hundred and fifty feet above the water pay well. The gold is all fine. This region is now altogether in the hands of Chinese who resort chiefly to the Forks and South Branch. Several hundred Chinese work in this district during the summer, and winter at the Forks. The North Branch is said to have afforded profitable diggings as far up as Cariboo Lake.

Swift River.—Rather inaccessible, and hard to work, being a rapid stream with many heavy boulders. Considerable quantities of gold have been taken from it from time to time, and Chinese still at work.

Fountain Creek.—A tributary of Swift River, nine miles west of Mount Agnes. Chinese mining.

Cañon Creek.—A second stream of the same name, joins the Fraser from the east above Quesnel. Diggings first reported in 1865. A considerable quantity of gold obtained here formerly, some of it very coarse and mixed with quartz.

Hixon Creek.—Discovered, 1866. A branch of the last. A nugget worth $700 was found here, and considerable placer-mining carried on for a length of two miles and a-half on the creek.

Terry Creek.—A tributary of Cañon Creek. Discovered, 1867. Shallow diggings yielded $6 to $8 a day.

Goat River.—Discovered, 1886. East of the lower part of Willow River and flowing into Upper Fraser River. A trail cut out to the creek in 1887, and some mining carried on.

Smoky River.—Discovered 1887. A tributary of Upper Fraser River from the north, some distance below last. Prospects of $3 to $4 obtained with rocker, and considered encouraging.

Horse-fly River.—South of Quesnel Lake. Discovered and prospected in 1859 and 1860, in which years some paying work done on Horse-fly Creek, the branch connecting Horse-fly Lake with the main river. A party of five here took out at one time 101 ounces of gold in a week. Renewed excitement in 1867. More or less mining has since been carried out on this river and tributaries, particularly by Chinese. But no really important developments have occurred.

McLennan Creek.—Thirteen miles from Tête Jaune Câche, running into Cranberry Lake. Gold found in 1876, reported at $4 to $5 a day, but owing to heavy boulders in the stream and expense of supplies, has not been worked.

Similkameen, Rock Creek and Okanagan.

Main River Similkameen.—(Below Vermilion Forks.) Gold found in sharp unwashed particles at mouth in 1853, by Captain McLennan's party. In the cañon, near the 49th parallel, a considerable quantity of gold obtained in 1859-60; the largest piece worth $22·50. Few Whites remained on the river after the first few years, but much work was done by Chinese. In 1866, a little excitement occurred, and forty or fifty Chinese went in to work. After this the river was almost abandoned for some years, but about 1882, mining revived, and a few Chinese have been at work, scattered along the river from Vermilion Forks to the 49th parallel, ever since. Work confined to river-bars and low flats bordering the river. Gold all scaly or fine.

Creek, six miles above Boundary.—(South side of river.) Chinese have lately been working here.

Ashtinoulou River.—Joining Similkameen from the south. Scale gold found but Indians object to its being worked.

Siwash Creek, or *Five-mile Creek.*—Below Vermilion Forks on north side. Prospects obtained, but nothing to justify extensive work.

Wolf Creek.—Joins Similkamean about nine miles below Vermilion Forks on south side. This heads with the source of a small stream which joins the South Fork of Similkameen, about nine miles above Vermilion Forks, a low valley running through. Miners think that this valley represents an old channel of the river, and attempts have been made to bottom it, but without success.

South Fork Similkameen.—Gold discovered by government prospecting party under Mr. Allison in 1860, and Whites and Chinese have been working off and on ever since. $10 to $20 a day to the hand obtained occasionally in early years on bars. Gold fairly coarse for thirty miles up from mouth and also found above this point, but not worked. Chinese have worked also in a little creek about sixteen miles up on west side. (See Report 1877-88, p. 156, B.)*

Whip-saw Creek.—Tributary to South Similkameen, from the west. Worked in a desultory manner since discovery of gold on the river, the workings extending three or four miles up. Gold rather coarse. The bed-rock here and in the neighboring part of the Similkameen consists of Tertiary strata. It seems not improbable that richer deposits may be found beneath these in the pre-Miocene valley which they fill.

Skagit River.—'Prospects' found in several places in early years, but no mining north of 49th parallel. On *Ruby Creek*, a tributary further south, gold discovered and working began in 1879.

Nine-mile Creek.—A tributary of the last, heading near Granite Creek. Worked last summer for a mile or two from mouth. Gold rather coarse. More or less platinum found in this and on the streams previously mentioned.

Tulameen or *North Fork of Similkameen.*†—Some work done on this river as early as 1862, and though nearly all the white miners were drawn away to Cariboo about that time, it is nearly certain that Chinese have been working off and on ever since. Working resumed by whites as well as Chinese about nine years ago. River proved rich from mouth up for about two miles, and paying work still in progress at various places all the way up to two miles above Eagle Creek—twenty-three miles from mouth. Gold often coarse, and on lower two miles does not appear so much washed as further up. On this part of river, three years ago, one company aver-

* See foot-note p. 115 B.

† Localities in this vicinity are referred to in greater detail, as no published description of them has yet appeared in the Reports of the Survey.

aged earnings of $8 to the hand. Four years ago, several miners made as high as $20. All the work on the lower part of the river has been river-bar mining. Platinum is found everywhere along the river with the gold, and native copper in scales and nuggets weighing as much as an ounce is occasionally found. Above Slate Creek, low benches and flats are mined by sluicing as well as the bed of the river by wing-damming, and Indians work here and there with rockers. It is thought that the extensive benches in the angle between the Tulameen and South Similkameen would pay for hydraulic work, but it is difficult to obtain water for this. Pellets of silver-glance, strung through with gold, have been found in sluice-boxes above Otter River.

Granite Creek.—Joins Tulameen from the south, nine miles above its mouth. Gold discovered in 1885 and caused considerable excitement, resulting in a great rush to the creek in the same year. Benches or terraces 200 to 300 feet high occur at mouth of creek, but these have been cut through as the drainage-level lowered, leaving a flat delta or fan, on which the town is built. Just above this the valley becomes narrow or V-shaped and runs back between bold mountains which rise about 2000 feet above it. At the bottom of the valley is a cañon 200 to 300 feet deep which continues for nearly four miles. Above this the upper part of the creek and its branches are wider and with lower grades and have not been bottomed. Nearly all the gold has been obtained below the First Fork or in the first three miles and a-half in length of the creek, in which the bed-rock was found at a depth of a few feet. There is very little bench- or side-ground along this part of the creek, though an old higher channel, with good pay, is occasionally found running across points (as at the Gladstone claim). One or more runs of heavy gold are found in the 'fan' at the mouth of the creek, which has yielded in places two ounces to a set of timbers, 10 x 5 feet. The bed-rock has, however, not been reached below the mouth of the cañon. The greater part of the rich ground on this creek has been worked out, being quite limited. The gold is coarse and rough, and the platinum, which sometimes amounts to half by weight, has the same character, denoting a very local origin. About half a mile above the First Fork, a patch of silicified Tertiary argillite occurs in the bottom of the valley, shewing that the gorge is of pre-Miocene age, and the greater part of the erosion to which the concentration of the gold is due probably also dates from this early period. Forty Whites, and about the same number of Chinese on the creek in 1888. Several nuggets worth from $90 to $100 have been found. The yield of the creek is estimated at $90,000 in 1885 ;$170,000 in 1886, and $90,000 in 1887.

Collin's Gulch.—South side of Tulameen opposite Otter River. Heavy gold found and a little work done. A small ravine only.

Cedar Creek.—South side of Tulameen above the last. Gold rather heavy. A little work done. One claim gave $10 a day to the hand the first season. Coarse platinum found with the gold.

Slate Creek.—South side of Tulameen four miles above Otter River. Gold discovered 1885. Work in progress since 1886. Best result in 1887, $7 a day to the hand. Small hydraulic claim working at mouth. Gold coarse and associated with coarse platinum.

Bear Creek.—North side of Tulameen one mile above last. Creek runs on bed-rock at mouth, and here a nugget worth $320 was found. Above the mouth ground deep and has not been bottomed. Much gold on the Tulameen below mouth of this creek, which appears to deserve further work.

Hine's Creek.—A small gulch above the last, on the opposite side of the river. 'Prospect' of coarse gold.

Eagle Creek.—Joins Tulameen from north-west two miles and a-half above Bear Creek. Coarse gold found but not much mining done.

Champion Creek.—Joins Tulameen from south-east, about six miles above last. A large stream affording good prospects, but the ground has never been bottomed.

Boulder Creek.—Joins Otter River from the west, near its mouth. Apart from Granite Creek and the main river, most of the work in 1888 done here. Worked for about a mile and a-half up from mouth.

Rock Creek.—East of Osoyoos Lake; a tributary of Kettle River. Gold discovered in 1859 or 1860. The narrow valley of the creek paid well for about a mile up, yielding generally one to two ounces a day to the man. Some of the benches also paid, in one case, yielding half an ounce a day to the hand for a season's work. In 1861, 300 miners were at work here, but it was nearly abandoned in the following year. Working was renewed to a considerable extent in 1866. In 1868, $8 to $10 a day to the hand was obtained by ground-sluicing, and a bed-rock flume was constructed. In 1870 the Flume Company took out $6000 at their first 'clean up.' At the mouth of the creek, a large quantity of gravel had been deposited where the valley widened, and this was all thoroughly worked over, chiefly by Chinese, who have never quite abandoned these diggings. Desultory work among large boulders, which obstruct the channel, was carried on for many miles up the creek in early years, and lately a good deal of successful placer work has been done about ten miles up the creek. It is near the last-mentioned place that the 'quartz' discoveries elsewhere mentioned (p. 68 R) have taken place.

Boundary Creek.—Joins Kettle River from the north-east. Developed

a little later than the last. Some very coarse gold found here, and a good deal of desultory work done, but pay 'spotted.' Like the last, the valley of this stream is narrow and cañon-like, and most of the mining was done near its mouth, and in places further up, where it widened locally.

Kettle or *Nehoialpitkwa River.*—'Prospects' found and small quantities of gold obtained on this river and several of its tributaries, nearly to the head, but no mining of importance ever carried on. Country very thickly wooded and difficult of access.

Okanagan River and Lake.—Scattered diggings found in 1859-60, but most of these soon abandoned; some because of want of water for working, and others probably left at the time of Cariboo excitement. In 1851, Mr. Cox, Gold Commissioner at Rock Creek, writes:—"We prospected nine streams, all tributaries of the lake, and found gold in each, averaging from thirty to ninety cents a pan."

Mission Creek.—Joining Okanagan Lake from the east, is the only one of the streams above mentioned on which mining of importance has occurred. Mining began on this creek about 1875 or 1876 and has continued more or less actively since, attempts being made to use hydraulic machinery. Paid at one time at rate of two to three ounces to two to three dollars a day to the hand. Gold worth $18·50 an ounce. The greater part of the gold was obtained at a place about seven miles up the creek, where it issues from a narrow, rocky gorge into a wider valley. The stream-bed gave the best returns, but benches and flats have also been worked. The modern gravels here rest on soft Tertiary shales, and are more or less cemented by calcareous matter in their auriferous layers. It is quite possible that a second channel remains to be found here beneath the edge of the Tertiary. Gold coarse. (See Report 1877-78, p. 157 B, also p. 48 R of this report.)

Cherry Creek.—Tributary of Shuswap River, thirty-five miles east of head of Okanagan Lake. Gold mining has been prosecuted here with varying success for thirteen years or more. The richest ground has been found in the lower three miles and a-half of the south branch. Bed of creek here originally worked by wing-damming, and considerable work on benches and flats. In 1877 the best claim was paying about $10 a day to the hand. Nuggets worth $40, $90 and $130 have been found, and the gold generally is coarse. Assay value $15·60 to $16 per ounce, the alloy of silver being rather high. (See Report, 1877-78, p. 158 B. Also p. 68 R of this Report.)

East and West Kootanie. (*South of line of C. P. Railway.*)

Wild Horse Creek.—Discovered to be auriferous in 1863, and became an important camp, with four hundred miners, early in the following

year. Ordinary claims were then paying from $20 to $30 a day to the hand. In 1865, estimated that one thousand men were here and forty to fifty claims were working, producing one to three ounces to the hand. Nuggets valued at $100 have frequently been obtained. The portion of the valley rich in gold is about two miles only in length. The bed-rock was found at no great depth below the present stream-bed in this part of the valley. The lower part of the old channel deepens rapidly and has never been reached. Profitable work has never ceased on this creek since its discovery, though the yield has fallen off after the first years. The value of gold obtained from 1878 to 1887 (ten years) is returned at $231,380. The greater part of the gold is now obtained by the hydraulic method, five companies being at work in 1888. Yield in 1888, $24,400, though only a portion of the flumes and sluices were 'cleaned up' before winter. The gold is worth $18·25 an ounce. (Report 1885, p. 152 B.)

Bull River.—Ten miles southward from Wild Horse Creek, coarse gold has been obtained from time to time in paying quantity near the cañon, but can be worked only at low water.

Findlay Creek.—Thirty-two miles northward from Wild Horse Creek. Diggings discovered in 1865, and more or less mining from time to time. Much trouble from freshets, but prospects considered excellent. In 1886, an English company obtained a grant of about four miles on upper part of the creek where gravel benches prospect well. A ditch five miles long has been constructed, and hydraulic work begun. A second hydraulic company is at work further down on the creek.

Dutch Creek.—Lower end Upper Columbia Lake. Gold has been worked here to a limited extent from time to time.

Toby Creek.—Lower end of Lower Columbia Lake. Diggings found in 1864, and considerable excitement for a time. Renewed interest in in 1885, when twenty men went to work on it, but in 1887, no work was in progress.

Cañon Creek.—Five miles south of Golden Station, C. P. Ry. Discovered 1883. Some coarse gold obtained and a few miners reported to be making $8 a day in 1884. In 1887, no work. Work to be resumed by a company in 1889.

Quartz Creek. Falling into Columbia River near Beaver Station, C. P. Ry. Gold discovered in 1884, but not at that time in paying quantity. About eighteen miles from Donald. Nineteen locations taken up in 1888, and active work expected. Ground ten to fifteen feet deep.

Porcupine Creek.—A tributary of Quartz Creek. Eighteen miles from Donald Station, C. P. Ry. Five claims worked in 1888, averaged $16 to the hand a day.

Perry Creek.—A branch of St. Mary River. Coarse gold found in 1867. In the following years claims reported as generally yielding an ounce a day. In 1869, a large number of miners on the creek. Mining carried on since with little interruption, but generally in a desultory manner. Below the falls a "clay bed-rock" was met with, beneath which was a deeper layer of auriferous gravel. This was reached in some places, but the water generally prevented work. Reported that in 1869, gold to the value of $1500, was obtained in the deep gravel, from eight square feet of ground. The Perry Creek Gold Mining Co., are now at work here on a somewhat extensive scale, and with fair prospect of success. They have a tunnel over 550 feet long at the present time, running for bed of old creek, three miles above the site of the old mining camp. Their shaft, five miles above the same place is temporarily abandoned, owing to water.

Moyie River.—Placer camp located here in 1869. Mining has been carried on ever since with varied results, but never very extensively. Diggings said to be 'spotted.' Earnings of $3 to $4 a day to the man have been obtained. Gold worth over $18 per ounce, and often coarse. Only three Chinese at work in 1888.

Pend d'Oreille River.—Somewhat extensive work in early years yielding from $3 to $4 a day.

Weaver Creek.—Flows into Moyie Lake. Very coarse gold found. High assay value. More or less work has been irregularly carried on for many years. In 1888 about $5000 in coarse gold obtained.

Palmer's Bar Creek.—Empties into Moyie River about four miles above lake. More or less work for a number of years, but no striking developments. Coarse gold. Yielded $1023 to a company of four Chinamen in 1888.

Boulder Creek.—Flows into Kootanie River about twenty-five miles from Bonner's Ferry. Coarse gold found.

Nigger Creek.—Situated between Weaver Creek and Palmer's Bar. Some work for a number of years. Coarse gold but 'spotted.' Abandoned in 1887.

Kootanie River.—Chinese have obtained fair wages near Tobacco Plains and below, but no regular work.

Gold Creek.—Flows into Kootanie River near Tobacco Plains, close to the Boundary line. Fine gold, not found in paying quantity.

Deer Creek.—Flows into Upper Arrow Lake about the middle, from the west. Prospect of heavy gold at time of Big Bend excitement.

Fish River.—Enters north-east arm of Upper Arrow Lake. Known to be auriferous.

Mosquito Creek.—A western tributary of the Columbia, between Upper and Lower Arrow Lakes. Gold found.

Lardo River— Entering Kootanie Lake at north end, from the west. Gold found.

Slocan River.— Joining Kootanie River from the north below the lake. Gold found.

Howser Creek.—On this and another stream tributary to Duncan River, which flows into the north end of upper Kootanie Lake, coarse gold has been found. No work of importance.

Salmon Creek.—Flows into Pend d'Oreille River, near its mouth. Work here in 1865 and later, and some good results.

Forty-nine Creek.—Flows into Kootanie River below the lake. Work in 1867 and later. In 1867, reported to yield coarse gold to the value of $6 to $18 to the hand. This creek and the last, head toward the Toad Mountain area, where quartz developments, elsewhere described, are in progress. Bed-rock not worked.

Cottonwood Creek.—Joins lower end of west arm of Kootanie Lake. Prospects obtained.

Columbia River.— Wherever suitably circumstanced bars occur along this stream, to the north of the 49th parallel, fine gold is found in greater or less quantity. In 1865, several hundred Chinese were at work within a short distance above Fort Shepherd. On bars five miles above Revelstoke, $1·50 to $2·50 a day is obtained at low water.

Big Bend Country.

French Creek.—Tributary of Gold Creek nine miles from its mouth. Fifty miles north of Revelstoke, C. P. Ry. Discovered 1865, and in that year yielded at least $32,000. In 1866 the Big Bend excitement occurred, and this creek is reported to have produced gold to the value of $100,000. In this year or the next, four, six and even twelve ounces to the hand a day was obtained on some claims, and one nugget worth $253 was found. French Creek was the richest in the Big Bend region. Lower part of valley all deep ground which has never been bottomed. The creek was entirely abandoned for a number of years, but work was resumed in 1886, attention being chiefly turned to the unexplored deep ground, with promising indications. Creek and hill claims, however, still being worked with some success. Mr. G. M. Sproat estimates that this creek and its tributaries affords about twenty-five miles of mining ground. A company at work in 1888 did very well toward the autumn, when they lost the pay streak. (See Reports of Minister of Mines of B.C., 1886, 1887, 1888.)

McCulloch Creek.—A tributary of Gold Creek, four miles lower down than the last. Reported as a short creek, about four miles only in length. History like that of French Creek, and as in the case of

that creek said to have yielded about $100,000 in 1866. Yielded $100 a day to the hand in some claims in early years, and nuggets and rough gold with quartz attached found on it. Surface diggings worked out and deep ground found very difficult and full of boulders. Work resumed in 1886, and has been continued to date, companies driving tunnels for deep ground with good prospects. A bed-rock flume company obtained a considerable amount of coarse gold in 1888 on the lower part of the creek. (See Reports of Minister of Mines of B.C., 1886, 1887, 1888.)

Downie Creek.—Flows into Columbia River from the east, thirty-five mile above Revelstoke. A large stream, but appears never to have been systematically prospected. Moderately good pay said to have been found at one place eight or ten miles up it in 1867.

Carne's Creek.—East side of Columbia River, twenty miles north of Revelstoke. Discovered 1865. This creek is six miles long to its forks, and each of the branches is supposed to be about the same length. A cañon quarter of a mile from the mouth; wide gravel banks below cañon; valley narrow above it. Mining on bars in early years, the old valley not having been followed owing to water. Coarse gold. For a time, below the cañon, earnings were $15 a day. Work renewed in 1886 in several places, one company making $8 to $10 a day to the man on the average. Bed-rock conjectured to be from forty to seventy feet deep. Work difficult on account of floods. Creek considered promising mining ground, and the benches suited for hydraulic work. (See Reports of Minister of Mines, B.C., 1886 and 1887.)

Smith's Creek.—A large stream joining the Columbia from the west opposite Gold Creek. In 1886 fifteen white miners here making $2 to $11·20 a day to the man. The creek is twenty-five miles long and is considered promising. Fair 'wages' made here in 1888. A company putting in a long flume. (See Report of Minister of Mines of B.C. 1887.)

Fernie Creek.—Joins Columbia River eight miles above last. Coarse gold. In early years, $8 a day to the hand made by four men for a whole season. Mr. Sproat remarks that there are, including this and Smith's Creek, nine large creeks on the west side, and three on the east side of the Columbia, between Gold Creek and the mouth of Canoe River, in which pay gold was found in 1887, all worthy of being carefully prospected.

Frenchman's Creek.—The second stream up Canoe River on the east. Gave good pay found for a season, some years ago.

North Fork Illecillewaet River.—Gold has been found here, but little worked.

Kamloops Region and North and South Thompson Rivers.

Nicola River.—Scale gold found for about twenty miles up the Nicola, or as far as the mouth of Spioos Creek, also on Spioos Creek and its north-west branch, Prospect Creek. Only a little desultory mining done.

Nicola River, above Douglas Lake.—Some gold found in 1887, and worked to a limited extent by Whites and Indians.

Guichon Creek.—Prospect of fine gold reported in stream flowing in from the east below Mamit Lake.

Deadman River.—Joins Thompson River from the north below Kamloops Lake. A Chinese company worked on the east branch, in the cañon a short distance above the forks, for one season. Ground probably poor.

Tranquille River.—Enters Kamloops Lake from the north. Gold discovered 1858, and appears to have been worked with little interruption ever since, chiefly by Chinese. For many years twenty to thirty Chinese have been continuously employed here, but latterly the number has decreased and the earnings are now supposed to be small. The gravels worked are those of the banks and bed of the stream, and flats adjacent to it. Gold has been found for a distance of eight miles, in all, up the stream. It is mostly scaly and some platinum is associated with it. The rocks cut through by the stream are Tertiary volcanic materials, and the origin of the gold is obscure. (See Report of 1877-78, p. 155 B.)

Cherry Bluff Creek, Kamloops Lake.—Gold has been found here, and a little work was attempted at one time.

North Thompson River.—A few of the river-bars, not far above Kamloops, at one time paid to work.

Jamieson Creek.—Thirteen miles up North Thompson, west side. Some mining has been carried on here.

Louis Creek.—Twenty-nine miles up North Thompson, east side. Some mining said to have been done here as early as 1861, when $8 to $10 a day was reported to be made. Chinese and others have occasionally worked here since, chiefly in and just below the cañon, near the mouth of the creek. Higher tributaries to the south-eastward considered promising.

Barrière River.—Thirty-two miles up North Thompson, east side. Mining said to have been carried on here with good results in or about 1861.

Adams River and Lake.—Some mining was carried on here in early years, and gold reported lately on some small streams flowing into the lake, but nothing of importance developed.

Shuswap River.—More or less fine gold said to occur on bars along whole course. Some work done in early years.

Scotch Creek.—Flows into lower part of Great Shuswap Lake. Some mining done here at different times previous to 1877 but abandoned for a number of years. Mining renewed in 1885 and in 1886, gold to the value of $22,000 produced. In the following year, the yield fell to $4000, and the creek is now again abandoned except by a few Chinese. Mining was carried on as far up as the forks, eight miles from mouth of creek. Gold coarse, sells at $17 an ounce.

Omenica Region and Peace River.

Vital Creek.—Tributary of Omenica River. Gold found 1869. First work done one mile and a-quarter from mouth in ground from two to four feet deep. One-tenth of metal found 'silver' (arquerite) of which some nuggets were three ounces in weight. Some work still in progress in 1886.

Silver Creek.—Tributary of the last. 'Two-and-a-half-dollar' diggings found in 1870.

Omenica River.—More or less gold on the bars.

Germansen Creek.—Discovered in 1870 and soon became the principal mining locality. Flows into Omenica River on south side, and heads in lake near head-waters of Vital Creek. In 1870 good shallow diggings for three miles, yielding half an ounce to three ounces of gold a day to the man. Total yield in this year $70,000. In 1871 much work going on. Three men, near the mouth, took out ten ounces a day to the man, but there were many blanks. Some hydraulic work on benches has been successfully carried on. 'Silver' (arquerite) also found in this creek. Some work still in progress in 1886.

Mansen Creek.—Flows into Mansen Lake. Gold discovered 1871. Yielded $20 a day to the man in some places, and nuggets worth $80 and $100 were found. Two companies sank shafts to deep channel, with good results in this year. Only two companies at work in 1875 and making little. Some work still going on in 1886.

Slate Creek.—A tributary of the last. Found rich in 1872, but fell off greatly in the following year. Miners stated to be making expenses in 1875.

Lost Creek.—A tributary of Mansen Creek. The "Irwin Company" of five men took out 192 ounces in a week in 1871. Another company sank fifty to seventy feet to the deep channel and got large pay. Most of the deep channel never bottomed. Little work in 1875. Some work going on in 1885.

Skeleton Creek.—A tributary of Mansen Creek.

Elmore Gulch.—Some gold obtained. Mining profitable in 1874.

Black Jack Gulch.—A tributary of Mansen Creek. Five men in 1871 made $200 a day continuously here.

Mansen River.—(Below the lake). Diggings reported in 1871 but appear to have been soon abandoned.

Kildare Gulch.—Yielded a little gold in 1881 and 1882.

May Creek.—(Osalinka of maps). A tributary of Omenica River. Yielded a little gold in 1882.

Finlay River.—This large river is well thought of by all the miners who have seen it, but has not been thoroughly prospected, and none of its tributaries above Omenica River have been examined. Fine gold on all the bars, and in 1861, on a bar three miles up from its mouth, three and four ounces a day to the hand obtained.

Nation River.—A tributary of the Parsnip from the west. Streams near head-waters known to be auriferous but very little prospected.

Parsnip River.—The lower portion of this river proved highly remunerative for a limited time. Bar mining and fine gold. Its eastern tributaries appear to be well worth prospecting.

Iroquois Creek.—Between Forts St. James and McLeod. Gold reported. (Report, 1875-76, p. 257.)

Peace River.—Formed by the confluence of the Parsnip and Finlay. To the east of the Rocky Mountains, gold was found by a couple of prospectors from Quesnel in 1861. Scale and flour gold along the whole course. Many of the bars at first yielded $10 to $15 a day to the hand.

Cassiar District.

(Facts relating to gold mining in Cassiar district are given in somewhat greater detail, and in connexion with its geological features, in Annual Report, 1887, Part B.)

Stikine River.—Gold discovered 1861. Very fine gold all along river, but little profitable work below Clearwater. The good ground extended thence to Grand Cañon, above Telegraph Creek. Coarse gold was found in a few places above Telegraph Creek, in the cañon. Bars on Stikine at first averaged $3 to $10 a day to the man, and as much as two to three ounces sometimes obtained. Work has now practically ceased, possible earnings being reduced to $1 to $3. The circumstances appear to indicate the existence of an old channel above the present river-bed and beneath the basalts, in the cañon. Below Telegraph Creek, extensive benches at various levels which should pay for hydraulic work. (See p. 47 R.)

Tahl-tan, or *First North Fork of Stikine.* Heavy gold found and worked for a number of miles up this stream. Pellets of 'silver' (arquerite) also found.

Tooya, or *Second North Fork of Stikine.*—'Prospects' obtained, but no serious work known to have occurred.

Dease Creek.—Joins Dease Lake from the west. Discovered 1873. Formerly yielded from $8 to $50 a day to the hand, from the mouth for about six miles up. Further up, some isolated good claims worked. The bed of the creek is nearly worked out, the ground having been shallow. A few bench claims still yielding fairly. Hydraulic work on a small scale. Gold coarse and generally well rounded; worth $15 50 to $16 per ounce.

Thibert Creek.—Joins Dease Lake from the west, near lower end. Discovered 1873. Good ground for about six miles up from mouth. Yield at about same rate as last. Creek bed worked out, but benches and side-ground being worked by hydraulic method and drifting. Gold coarse, worth $16 an ounce.

Mosquito Creek.—A tributary of the last. Very good 'prospects' have been obtained here; as much as $40 to a six-foot set of timbers.

Defot Creek.—A tributary of Cañon Creek, which is on the same (west) side of the Dease, with the last. Gold coarse, rough and often full of quartz. Large nuggets, including one of fourteen ounces. Has been, for a limited area, (about a mile in length) one of the richest pieces of ground in the district. The gold is evidently derived from massive deposits of quartz, which occur at the head of the creek, at a considerable elevation.

Beady Creek.—Dease River, east side. A little bar-mining in 1874 and 1875, but nothing of importance developed.

Eagle River.—Dease River, east side. Good prospects, but no mining carried on.

McDame Creek.—Enters Dease River from the north. Discovered 1874. Highest earnings from $6 to $100 a day, when mining at its best. Gold coarse, worth $17·75 to $18 an ounce. Comparatively little work done in the stream-bed, the best ground being an old high-level channel, worked in places for fifteen miles up. Bench claims run for about seven miles up. Valley wide, with numerous tributaries, most of which yield gold. Gold has also been found on heads of streams flowing to the north, beyond the McDame water-shed.

Snow Creek.—A tributary of the last. Discovered 1875. The richest single claim in Cassiar was near the mouth of this creek, and paid for a week 300 ounces for six or eight men. Seventy-two ounces washed from one pan of dirt in 1876. Now nearly worked out. Gold worth $18 an ounce. Decomposed rusty quartz containing gold, found on this creek.

Quartz Creek.—A branch of Trout Creek, tributary of McDame Creek. Discovered 1875. Highest average $5 to $20 a day. Gold coarse and rough, with quartz attached. Nearly worked out.

Rosella Creek.—Tributary of McDame Creek. Discovered 1876.

Highest average per day $5 to $15. Gold worth $18·25 an ounce. Abandoned.

Patterson Creek.—Discovered 1877. Highest average per day $5 to $20, generally paid 'wages' at $6. Gold worth $18 an ounce. Abandoned.

Dennis Creek.—Discovered 1877. Returns about same with last. Gold worth $18·25 an ounce. Abandoned.

Gold Creek.—Discovered 1877. Best earnings per day $5 to $50. Gold worth $18 an ounce. Bench and creek diggings. Abandoned.

Slate Creek.—Discovered 1877. Highest average earnings $10 a day. Gold worth $18 an ounce. Bar diggings. Abandoned.

Somer's Creek, or *First North Fork of McDame.* Discovered 1876. Earnings of $10 to $100 a day made. Gold worth $18 an ounce. Abandoned.

Third North Fork of McDame.—Discovered 1877. Creek and hill diggings. Abandoned.

Spring Creek.—Discovered 1877. Earnings of $10 to $20 a day were made. Gold worth $18·25 an ounce. Principally hill diggings. Abandoned.

Fall Creek.—Discovered 1877. Some gold obtained. Abandoned.

Rapid River.—Dease River, below McDame Creek. Prospects obtained, but no mining of importance.

French Creek.—Dease River, north side, below McDame Creek. Some gold obtained.

Walker Creek.—Discovered 1876. Said to be distant about seventy-five miles in an easterly direction from mouth of McDame Creek. Probably a tributary of Black River. Some gold obtained, but results have never been satisfactory.

Black, Turnagain or *Muddy River.*—Reached by same trail as last, and said to be about ninety miles distant from McDame. Fine gold obtained on bars, and supposed that coarse gold may occur near headwaters, but has not yet been discovered.

Lower Liard River.—(Below confluence of Dease).—Here Messrs. Thibert and McCullough first discovered gold, and for some years a good deal of work was carried on upon river-bars, the gold being fine. The best known bars, in order down the river, were—*Porcupine Bar*, about fifty miles below the mouth of the Dease, north side of river; *Bed-rock Bar*, about five miles below last, on south side of river; *McCulloch's Bar*, near site of Old Fort Halkett.

Upper Liard River.—(Above confluence with Dease). 'Prospects' and more or less river-bar mining in a number of places. In gravel-beds resting on old rocks at the Lower Cañon, 'wages' at $4 a day can be obtained with rocker.

The following creeks in Cassiar District, which are reported as having yielded some gold, I am unable to place:—*Mitchell's Creek, Brown's Gulch, Poorman's Gulch* or *Creek, Fred Hart Creek.*

Yukon District.

This district is beyond the northern boundary of the province of British Columbia, which is constituted by the 60th parallel. A summary of the few facts relating to its placer deposits is, however, included here. The two localities first referred to below, are naturally attached to the Cassiar district, and have been prospected from that district.

Sayyea Creek.—Joins Upper Liard from the west, about fifty-five miles above the Frances. Good prospects were obtained here in 1875, of coarse gold. Little work has been done, but reported that the paying ground gave out.

Finlayson River.—Joins Frances Lake from the west. Prospecting done at mouth, ten or twelve years ago, gave earnings at $8 to $10 a day. Many streams in this region have a very favourable aspect, and have never been prospected. (Report 1887, p. 113 B.)

Lewes River.—Gold discovered, 1880. Mining began, 1881. Remunerative river-bars occur all along this river below the mouth of the Tes-lin-too or Newberry, but the richest so far worked are within a distance of seventy miles below this point. Many bars yield $10 a day to the hand. Cassiar Bar, which has proved the best, is said to have yielded $30 a day to the hand in some cases, but is now worked out. Gold all fine. The whole length of this and other rivers will, doubtless, eventually be worked when the county becomes more accessible. (Report 1887, p. 180 B.)

Tes-lin-too River.—A tributary of the last. Bars similar to those of the Lewes as far up as Tes-lin Lake. (See Report 1887, p. 156 B.)

Ni-Sutlin-hi-ni.—The main feeder of Tes-lin Lake. Similar river-bars. A little work has been done on them. (Report, 1887, p. 156 B.)

Big Salmon River.—A tributary of the Lewes. River-bars, with more or less fine gold, along whole course, but no good paying bars yet worked. (Report, 1887, p. 152 B).

Upper Pelly River.—Remunerative river-bars discovered in 1882, and some of these, between the mouth of the Lewes and the Macmillan, have been worked. More or less gold on bars as far up as they have been prospected. (Report, 1887, p. 134 B.)

Ross River.—A tributary of the last. This stream is believed to be the one on which several miners made at the rate of $18 a day some years ago. (Report, 1887, p. 134 B.)

Stewart River.—Tributary of Pelly or Yukon, from the east. Gold discovered, 1885, and in this year and 1886 as much as $100 a day to

the hand made on river-bars. Probably $100,000 worth of gold already obtained. Gold all fine, but reported to become somewhat coarser far up the stream. Very little black sand found with the gold, but garnet sand common. More or less platinum associated with the gold here and on all the streams in the Yukon basin.

Sixty-mile Creek.—Between Forty-mile Creek and Stewart River, west side of Pelly or Yukon River. Pieces of quartz containing gold found in drift. Prospects of alluvial gold found, but no placer work carried on.

Forty-mile Creek.—Tributary of Pelly or Yukon, from the west. Discovered, autumn of 1886. Coarse gold and nuggets found here, the only place, so far, in the Yukon district. Earnings as high as $100 a day to the man occasionally. A number of miners making $14 a day in 1887, but in 1888 earnings small, owing to continued high water. The stream is said by the miners to be a 'bed-rock creek,' *i. e.* one without deep drifting or sinking ground.

Region of the Coast Ranges and Skeena River.

Seymour Creek.—Burrard Inlet. Some gold got here at one time, but work abandoned.

Prospect Creek.—East Branch Homathco River, above Tatlayoco Lake. Some fine gold found here by men connected with C. P. Ry. survey in 1875.

Homathco River.—Prospects obtained, but no mining done so far as known.

Lorne Creek.—Skeena River; discovered 1883. Valley reported deep and narrow. Gold obtained principally in bed of creek, though side-ground and benches favorably spoken of. Much trouble has been experienced from floods. Yield reported in 1884, $17,000; 1885, $18,000; 1886, $12,000; 1887, $3,795.

Bone's Gulch.—Skeena River. Producing a little gold in 1886 and 1887.

Douglas Creek.—Kitsumgalum, Skeena River. Prospecting in 1886 and a little gold got, but work abandoned.

Other streams flowing from Cascade Range.—Prospects have been obtained in a number of these, but details are wanting and no important placer-mining has been developed.

Vancouver Island.

Leech River.—This stream has proved auriferous for four or five miles of its length, where it flows along the strike of a belt of slaty argillites. It was discovered in 1864, and within a few years thereafter

yielded gold to the value of $100,000 to $200,000, according to various estimates. Gold often coarse and nuggety, and earnings as high as $34 a day to the rocker were reported in 1864. The rich ground found in the present river-bed is supposed to be exhausted, though desultory mining has been carried on ever since at intervals. A good deal of 'crevicing' has been done on bed-rock. Benches rather extensive and all contain more or less fine gold. The "Gordon Hydraulic Mining Company (Limited)" have lately acquired an extensive tract about half-way between Sooke River and the North Fork of Leech River, and are putting in hydraulic machinery. For details on Leech River see Report, 1876-77, p. 95.

Sooke River.—(Below its junction with Leech River).—Fine gold only found here and probably derived from Leech River.

Goldstream Brook.—Runs on strike of Leech River slates, further east. 'Colours,' but no pay, found here.

Jordon River.—Discovered and worked about the same time with Leech River. Coarse gold obtained, largely by 'crevicing.' It has been estimated that $30,000 worth of gold was taken out within a few months after discovery.

Nanaimo River.—Attracted some notice in 1877, but has never proved rich. A few Whites and Chinese work here almost every year, making small wages. They follow the river up to its head, which is not far from that of China Creek, Alberni Canal.

San Juan River.—Entering San Juan Bay at about twenty miles above salt-water. Some coarse gold obtained by 'crevicing' on a short length of this stream. Formation reported to be slate.

Cowichan River.—Mr. Brown, of the Vancouver Island Exploring Expedition, (1864) reports gold on all the bars of Cowichan River in quantities of one quarter of a cent to three cents to the pan.

Foley's Creek.—(Cowichan Lake ?) Mr. Brown reports: "'Prospects' to $2 per day and one which ought, to an experienced miner, to pay from $5 to $8 per diem."

China or *Atlat Creek.*—Situated about seven miles down Alberni Canal from its head, on south side; not named on chart. Discovered about 1871 and worked steadily for three years, chiefly by Chinese. A little work still going on. Paid for a distance estimated at twenty miles up from mouth and gold found to sources. Earnings of Chinese supposed to have been about $5 a day. Some prospecting for 'quartz,' with hopeful results, has been done in mountains about this creek.

Awatsish Creek.—At 'First Narrows,' lower down inlet than last, but rising in the same mountains with it. Some coarse gold has been found, but ground very bouldery, and no serious work has been attempted.

Bear River.—Head of Clayoquot Sound. An excitement about this place got up in 1862 and 1863, and again in 1887, when twenty to thirty Whites and many Chinese visited it. Fine gold found but not in paying quantity. Mr. Buttle, of Vancouver Island Exploring Expedition, reported occurrence of coarse gold on one of the sources of this river.

Gold River.—Nootka Sound. Prospected on several occasions. Fine gold found, but not in paying quantity.

Cape Commerell.—North end of Vancouver Island. Beaches with black sand containing gold. Little has yet been done to ascertain whether the gold is in remunerative quantity.

Cape Cook.—Two smaller streams on outer end of this cape, and one on south side, give 'prospects,' but bars quite limited and never worked.

Ou-ou-kinsh Inlet.—A small stream here known to yield a fair 'prospect.'

Streams tributary to Puntledge Lake and a little stream just east of Cape Commerell are also known to contain gold in small quantity.

For some of the above notes relating to Vancouver Island, I am indebted to Mr. J. Jacques.

Queen Charlotte Islands.

No paying gold-placers have ever been found in these islands, though gold is present in fine scales in deposits of magnetic iron sand, which are met with about Cape Fife, and possibly elsewhere. (Report 1878-79, p. 33 B.)

Gold (Auriferous veins).

The principal known occurrences of gold-bearing veins, as distinguished from placer deposits, are enumerated in the table of assays of the precious metals, pp. 76 R *to* 79 R. *In Mr. Bowman's report on the Mining Disirict of Cariboo about* 100 *localities of quartz-veins in that district, known or reputed to be auriferous are catalogued and described, and these it is not oonsidered necessary here to repeat. A few localities only which are not included in the table of assays, or in Mr. Bowman's report, are mentioned in the subjoined short supplementary list.*

Mitchell or *Gold Harbour, Queen Charlotte Islands.*—Rich gold-bearing vein, referred to on p. 17 R, exact position marked on Admiralty Chart No. 2168, and in Geological Map of Queen Charlotte Islands, published in Report for 1878-79. Mr. Woodcock, who again prospected this place in 1878, informed me that the original vein was probably

not over three feet thick, and appeared to be worked completely out in an excavation thirty feet long by twelve feet deep. The vein was quite vertical. Green crystalline country-rock, probably diabase. Mr. Woodcock found some small quartz seams about a mile and a-half from the original locality which contained visible gold.

Sebastopol Creek.—About sixty miles up the Skeena River and above Kitsalas. "Sebastopol ledge," situated about two miles up the stream. Assay by Mr. Tiernan, of Victoria, reported as giving—gold, $42·18, silver, 13·47 to the ton.

Clinton.—Loose specimens of hæmatite and quartz containing visible gold, found here in 1886, but not traced to their origin. Reported to yield gold to the value of $300 to the ton on assay. (Report of Minister of Mines of B. C., 1886, p. 207.)

Near Cottonwood Creek.—(Near Toad Mountain, West Kootanie.) A number of claims located on free-milling gold-ores; reported to be rich, and high assays are quoted by Mr. Sproat. (Report of Minister of Mines of B. C., 1888, p. 299).

Near Lardo River.—(West Kootanie.) Free-milling gold-quartz, reported to contain $4 to the ton, has been found. (Report of Minister of Mines of B. C., 1888, p. 304).

Findlay Creek.—(East Kootanie.) Free-milling gold-quartz reported. (Report of Minister of Mines of B. C., 1888, p. 307).

Big Bend Region.—In addition to the places mentioned in the table of assays, it may be stated that rich specimens of gold-bearing quartz derived from the "Homestead" and "Big Bend" claims, have been received.

Vicinity of Rock Creek.—Free milling gold-ores reported here, in addition to silver-ores. Rich hand specimens received. Referred to p. 68 R.

Monashee Mine.—Between Cherry Creek and Kettle River. Free gold reported. Referred to p. 68 R.

The following claims covering veins known or reported to contain gold, generally in association with some silver, are in the vicinity of the Lower Fraser, "Teague's" Harrison Lake; "Seymour Creek," "Lottie," "No Surrender" and "Vancouver," at various places on or near Burrard Inlet. I am unable to furnish any authentic particulars respecting these.

Texada Island.—Gold-ores recently discovered here, and many claims recorded. No particulars yet available. See p. 74 R.

SILVER.

The principal known localities of silver-ores have already been enumerated, either on pp. 56 R *to* 74 R, *or in the Table of Assays, pp.* 76 R *to* 79 R. *See also some references under Copper, p.* 101 R. *It would serve no useful purpose to endeavour to name the many hundred individual claims which have lately been recorded on silver-ores, even if it were possible to do so. This supplementary list contains known occurrences of silver amalgam (arquerite) or native silver, so far found only in connexion with gold-washings.*

Vital Creek, Omenica District.—Considerable quantities of arquerite, often in nuggets, found here in the placer-mines. A specimen subjected to analysis contained 83·30 per cent. of silver. See p 73 R.

Similkameen River.—(Near Vermilion Forks.) Small quantities of native silver or arquerite found in gold-washings, occasionally weighing two to three pennyweights. (Report 1877-78, p. 162 B.)

Mission Creek, Okanagan Lake.—Pellets of native silver or arquerite found occasionally with the gold. (Report 1877-78, p. 162 B.)

Similkameen River, near the Boundary-line.—Small pieces of native silver or arquerite occasionally found in gold-washings.

Nicoamen, Thompson River.—Native silver occasionally found in gold washings. Small pieces of this material have been obtained and prove to be silver and not arquerite. In 1858 and 1859 pieces of considerable size are reported to have been discovered.

Tahl-tan River, Cassiar District.—Arquerite found in gold-washings. (Report 1887, p. 80 B.)

COAL AND LIGNITE.

In the following list of localities of coal and lignite, no attempt is made to enumerate the very numerous occurrences and outcrops in the well known coal-fields of Nanaimo and Comox, nor even to mention individually the various workings upon these, which have already been described, and for information upon which the foregoing pages, as well as the various Reports of the Survey, must be consulted. In the less known regions, I have endeavoured to mention all the scattered discoveries which have come under my notice.

Queen Charlotte Islands.

Cowgitz, Skidegate Inlet.—Anthracite coal referred to on page 85 R. (See also Report, 1878-79, p. 71, B, 1872-73, p. 56.)

South Side of Skidegate Inlet.—Anthracite coal, much disturbed small out-crop. (Report 1878-79, p. 68 B.)

Ya-koun River.—Bituminous coal of good quality and reported to be 18 feet thick, referred to on p 86 R. (See also Report 1887, p. 17 T.)

Chin-oo-kun-dl Brook.—Lignite. Impure and thin seams. (Report 1878-79, p. 85 B.)

Ya-kan Point.—Lignite. Irregular deposits on the beach. (Report 1878-79, p. 86 B.)

Skon-un Point.—Lignite. Beds of some thickness on the beach. (Report 1878-79, p. 86 B.)

Ma-min River, Masset Inlet.—Lignite in thin seams six miles up this river. (Report 1878-79, p. 88 B.)

Naden Harbour.— Stream on east side. Drift lignite in the brook. (Report 1878-79, p. 89 B.)

Vancouver Island.

Nanaimo District.—Bituminous coal which has been worked for many years. Described on p. 90 R. (See also Reports 1876-77, p. 170, 1871-72, p. 81, 1873-74 p. 96, 1874-75 p. 82.)

Comox District.—Bituminous coal, now being opened up on an extensive scale. Described on p. 89 R. (See also Reports 1876-77 p. 161, 1871-72 p. 76, 1872-73 p. 32, 1873-74 p. 95.)

Campbell River.—This stream flows into Discovery Passage. Bituminous coal reported on it about twelve miles inland. (Report 1886 p. 19 B.)

Kuhushan Point.—Coal reported in stream which reaches the coast, half a mile south of this point. (Report 1886, p. 18 B.) This locality and the last are included in the northern continuation of the Comox coal-field.

Forward Inlet area, Quatsino Sound.—Bituminous coal. Thin seams only found as yet, noted on p. 86 R. (See also Report 1886, p. 83 B.)

Koprino area, Quatsino Sound,—Requires exploration by boring. No coal outcrops known. Referred to on p. 87 R. (See also Report 1886, p. 86 B.)

Koskeemo area, Quatsino Sound.—Bituminous coals, noted on p. 86 R. (See also Report 1886, p. 89 B.)

Suquash.—Coal. Noted on previous pages (p. 80 R, 88 R.) (See also Report 1886, p. 62 B., *et seq.*)

Kliksiwi River.—Coal seam near here of sixteen inches in thickness. (Report 1886, p. 62 B, *et seq.*)

Kī-uk River and vicinity.—Bituminous coal in thin seams. (Report 1886, p. 62 B. *et seq.*) This locality, and that preceding it are included in the Suquash coal-field.

Saanich Inlet.—Thin coal-seams found in several places in this vicinity, but none, so far, of value. Included by Mr. Richardson in Cowichen area. (Report 1876-77, p. 187.)

Sooke.—At the entrance of the harbour,and elsewhere in that vicinity, lumps of coal or lignite found upon beaches. Probably derived from Tertiary rocks of which an area there occurs. A boring was at one time made to a depth of 139 feet, but did not pass through any coal. (Report 1874-75, p. 83, 1876-77, p. 190.)

Head of Alberni Canal.—Coal is reported here and rocks of the Cretaceous coal-bearing series occur, but have not been fully examined.

Clayoquot Sound and *Ucluelet.*—Bituminous coal found in several places in this vicinity, but no geological examinations yet made.

Cowichen Bay.—Small fragments of anthracitic coal have been found in sandstone here by Mr. Richardson.

Koquesila River.—Specimens of impure anthracite obtained some distance up this stream. A little prospecting work has been done here.

Mainland of British Columbia.

Sandstone River.—North-east side Malaspina Strait. Coal or lignite, in thin irregular layers. There is a considerable area of sandstones etc. here, probably of Cretaceous age, but a small thickness only is exposed in the river. (Report 1886, p. 31 B.)

Vicinity of Vancouver.—Burrard Inlet. Two series of lignites or lignite-coals come to the surface here. The upper series is seen near the Brewery, Brewery Creek, half a mile south of False Creek and elsewhere, both east and west of that point. The lower series is seen near Ostranders Point, Stanley Park, and again on the line of strike, to the eastward, within half a mile to a mile west of Hastings. All the seams so far found are quite thin, seldom exceeding a few inches.

Kanaka Creek.—Near Haney Station, C. P. Ry. At about four miles above the mouth of this stream, seams a few inches thick, of coal or lignite-coal occur.

Warnock Creek.—Near Warnock Station, C. P. Ry. Two-thirds of a mile up from mouth of creek, small seams of coal or lignite.

Stave River.—Half a mile above mouth of river, a small seam of coal or lignite.

Mission Hills.—About five miles up Stave River. Some fragments of coal or lignite reported, but have not been traced to source.

Slalets Mountain.—Near Sumass Mountain. At this place, about five miles south of Frank Wade's store and landing, a seam over twenty inches in thickness of excellent coal has been found.

Chilliwack River.—Irregular 'bunches' of good bituminous coal found in sandstones about three miles and a-half south-west of Chilliwack village (Centreville) near the road from that place to Capt. John's village, and about half a mile north-east of the road-crossing of

the river. Many other occurrences of similar coal are known in the Cultus Lake range of hills, which skirts the Sumass valley. (See analysis No. 19, p. 98 R).

(The above notes on places near the Lower Fraser are suppled by Mr. A. Bowman, and are given at greater length, as they are not elsewhere available in published form.)

Junction of Nicola and Coldwater Rivers.— Coal, noted on page 96 R. (Report 1877-78, p. 125 B.)

Coldwater River. — Coal, of same formation with last, in several places. (Report 1877-78, p. 126 B.)

Quilchena. — On McDonald's River, which enters Nicola Lake at this place, at about three miles and a-half from the lake. Lignite of poor quality. Thickest seam exposed about two feet.

Guichon Creek.—Joining Nicola River from the north. Lignite of good quality found three to four miles up this stream, but bed not fully exposed.

South Fork of Similkameen River.— (Above the mouth of the Pasayten) Lignite reported in micaceous sandstone. (Report 1877-78, 133 B.)

South Fork of Similkameen River.— (Four miles above Vermilion Fork) Lignite. (Report 1877-78, p. 130 B.)

South Fork of Similkameen River.— (Quarter of a mile above Vermilion Fork, south bank.) Lignite or lignite-coal of good quality, which has been worked lately to a small extent for local use. Where opened, shews an upper seam nine feet thick, with a few small shaly partings, below this, some feet of mixed lignite and shale, and then a seam of clean lignite-coal four feet or more in thickness, the bottom being below water-level.

Tulameen River.—(Three miles above Vermilion Fork) Lignite seven feet thick with one shaly parting of three inches. (Report 1877-78, p. 132 B.)

Rock Creek.—(Half a mile from mouth on Kettle River.) Lignite, thickness not known.

Kamloops.— (Three miles south-west of town.) Good coal in base of Tertiary rocks, but so far thin seams only found. See p. 96 R. (Summary Report, 1888, p. 5.)

Crow Nest Pass.— Rocky Mountains. Bituminous coal, near Marten Creek. See pp. 93 R, 97 R. (Report 1886, p. 69 B., 1887, p. 12 T.)

North Kootanie Pass.— Rocky Mountains. Coal in thin seams on western slope of "West Summit." The coal actually observed here is not of workable thickness, but the measures are the same with those of Marten Creek, and it is highly probable that important coal-seams may be found here. This is the nearest part of the "Elk River Cretaceous Trough" to the Kootanie valley, from which it is only twelve

miles distant by the valley of the Wigwam River. (Report 1885, p. 64 B.)

Fording River.— A tributary of Elk River, Rocky Mountains. Coal in several thin seams, the thickest seen in small natural exposures being two feet. (Report 1885, p. 109 B.)

Green Hills.— Elk River valley, Rocky Mountains. Near the summit of these hills, about four miles south of the last locality, a coal seam several feet in thickness, poorly exposed.

The above three localities, with that of Marten Creek, are all situated on the Elk River Cretaceous Trough, on the western water-shed of the Rocky Mountains. There can be little doubt that there is here an important coal-field. Other Cretaceous areas in the Rocky Mountains being to the east of the water-shed are not included in the province of British Columbia. (See Report 1885, with accompanying map.)

Kootanie Valley near Bull River.—Lignite. So far found only in loose pieces. (Report 1885, p. 151 B.)

North Thompson River.— (Forty-five miles above Kamloops.) Bituminous coal of good quality in thin seams. (Report 1877–78, p. 113 B.)

Fraser River.—(East side, a short distance above the cantilever bridge.) Lignite. Thin seams.

Nicoamen, Thompson River.— Lignite. Seams so far found thin and impure.

Hat Creek, near Marble Cañon.— Lignite forty feet thick. (Report 1877-78, p. 140 B.)

Fraser River.— Between Soda Creek and Fort George, and at Quesnel. Lignite seams frequently exposed. That at Quesnel of poor quality. See p. 97 R. (Report 1875-76, p. 257.)

Lower Nechacco River.— (East of Fraser Lake.) Extensive Tertiary formation, but drift-lignite only known. (Report 1876-77, p. 82.)

Upper Nechacco River.— (South of Fraser Lake.) Lignites seen in several places about eight miles south of the lake. Thickest bed four feet. (Report 1876-77, p. 82.)

Blackwater River.— Drift lignites at Upper and Lower Cañons and along intervening portion of river. (Report 1875–76, p. 256.)

Chilacco River.— Drift lignite only found.

Nazco River.— Drift lignite found near Cinderella Mountain. (Report 1875–76, p. 254.)

Ko-has-gan-ko Stream.— South-west of Tanyabunkut Lake. Lignite of good quality, four feet or more in thickness. (Report 1876–77, p. 76; 1877-78, p. 48 G.)

Boyd's, or *Cold Spring Home.*—Lightning Creek, Cariboo. Lignite bed, 6 to 10 feet thick, and of fair quality.

Bear River.—(Near crossing of old C. P. Ry. surveyed line, lat. 54°). Coal reported and said to be about eighteen inches thick.

Parsnip River.—Lignite in place, and abundant in loose pieces. (Report 1875-76, p. 71.)

Kitseguecla, Skeena River.—Impure coal observed in Cretaceous rocks. (Report 1879-80, p. 103 B.)

Babine Portage, near Babine Lake.—Impure coal, observed. (Report 1879-80, p. 104 B.)

Upper Skeena.—Two localities, 9 and 20 miles respectively above Skeena Forks. Impure coals, like the two preceding. (Report 1879-80, p. 105 B.)

Watsonkwa River.—(Eighteen miles above Skeena Forks.) Bituminous coal, reported to occur in quantity. Noted on p. 93 R. (Report 1879-80, p. 105 B.)

Pine River Cañon.—(Five miles above Lower Forks). Peace River district. Bituminous coal in four thin seams, the thickest being 2 feet. (Report 1875-76, p. 53.)

Coal Brook.—East Branch of Pine River. Peace River district. Coal in several thin seams. (Report 1879-80, p. 117 B.)

Cañon of the Mountain of Rocks.—Peace River. Bituminous coal in thin seams, of which the thickest observed is 2 feet. (Report 1879-80, p. 119 B.)

Tahl-tan River.—Cassiar district. Lignite reported to occur in Tertiary rocks.

Rapid River, Cassiar.—Lignite-coal about two feet thick reported near mouth.

Dease River.—(Eight miles above mouth.) Cassiar district. Lignite in thin beds. (Report 1887, page 95 B.)

Liard and *Frances Rivers.*—(Below and above their confluence.) Yukon district. Lignite. Thickest observed bed 3 feet. (Report 1887, p. 111 B.)

Chilkat Pass.—(Near the head of Chilkat River, 40 or 50 miles north-west of head of Chilkat Inlet.) Bituminous coal, which, in specimens examined, seems to be of good quality. Reported to occur in quantity in an area of sandstones, shales, etc., which runs in a north-westerly direction.

Lewes River.—(Lat. 62° 15′, long. 136° 25′.) Yukon district. Lignite coal. Several seams, but none observed of great thickness. (Report 1887, p. 148 B.)

Pelly, or *Yukon River.*—At Coal Creek, five miles below Forty-mile Creek, on east side of river. Two seams of coal or lignite-coal, reported by W. Ogilvie, of 5 and 7 feet in thickness respectively.

IRON.

South-west Shore, Texada Island.—Magnetite. Described on p. 99 R. (Report 1886, p. 36 B.)

North-east Shore, Texada Island.—Magnetite. Irregular masses in limestone, with a more or less stratiform aspect. Thickest mass seen, 4 feet. (Report 1886, p. 39 B.)

Island in the Walker Group.—Magnetite of exceptionally rich quality. This occurs on a small rocky inlet near the north end of the Walker Group, in Queen Charlotte Sound. The deposit has not been examined. (Report 1872-73, p. 82.)

Rivers Inlet.—About 25 miles up the inlet on the north side. Magnetite, resembling the Texada ore. Deposit said to be extensive.

Entrance of Rivers Inlet.—West side of Fitzhugh Sound. Magnetic iron ore reported. (Report 1873-74, p. 101.)

Harriet Harbour, Queen Charlotte Islands.—Magnetite. Noted on p. 101 R. (Report 1878-79, p. 54 B.)

North side Skincuttle Inlet, Queen Charlotte Islands.—Magnetite. (Report 1878-79, p. 53 B.)

Cape Commerell.—North end of Vancouver Island. Magnetic iron sands along the shores, but scarcely in sufficient quantity to be of economic importance. (Report 1886, p. 77 B.)

Knight Inlet.—One mile up river, at head of inlet, on left bank, 1200 feet up mountain. Magnetite reported. (Report 1873-74, p. 100.)

Opposite Seymour Narrows.—About six miles inland from Menzie's Bay. Iron ore. Reported to be a considerable deposit. (Report 1873-74, p. 101.)

Skidegate Inlet, Queen Charlotte Islands.—Clay ironstone in numerous and large nodules in several places in the coal-bearing rocks.

Baynes Sound Mine, Comox.—Clay ironstones in considerable quantity in association with the coal seams. Two specimens, examined by Mr. Hoffmann, gave 36·83 and 29·78 per cent. respectively of metallic iron.

Alberni Canal.—Magnetite. About a mile below China or Atlat Creek. Considerable veins traversing the rock on the shore.

Sooke.—(East side of harbour). Magnetite. Noticed on page 100 R. (Report, 1886, p. 17 T.)

Sooke.—(near the last). Hæmatite. Seen in exposure on the beach, but deposit apparently not extensive.

Near Hope.—A good specimen of magnetite. Reported as occurring about ten miles from Hope.

Near Nicoamen.—Ravine at the mill, about half a mile below Nicoamen. Vein or irregular deposit of magnetite with iron pyrites. The latter in such large quantity as to render the ore valueless.

Loadstone Mountain.—Near old "Brigade Trail," from Tulameen River to Hope, nine miles south-west of mouth of Otter River. Magnetite in numerous veins, traversing an intrusive mass of diorite. Veins actually observed, near the summit of the mountain, about six inches in thickness.

Iron Mountain.—On Nicola, near mouth of Coldwater River. Specular iron-ore in numerous small veins. Veins several feet in width reported but not actually observed. (Report, 1877-78, p. 122 B.)

Similkameen Valley.—(Three miles above Keremeoos, north side.) Schistose hæmatite found. (Report, 1877-78 p. 86 B.)

Bull River Cañon.—Kootanie Valley. Massive hæmatite, occasionally coloured with copper carbonate. Found loose in considerable quantity. (Report, 1885, p. 151 B.)

Cherry Bluff, Kamloops Lake.—Magnetite, in numerous, irregular veins traversing a greenstone mass. Some veins observed as much as three feet in thickness. The ore is of excellent quality. Specimens were found to contain 66·83 per cent. of metallic iron, with very little sulphur or phosphorus. (Report, 1877-78 p. 118 B.)

Watkinson's, Fraser River.—(about 23 miles above Lytton.) Magnetite. Vein said to be twenty feet in thickness,

Quesnel. — Clay ironstone in Tertiary rocks, often converted into hæmatite by the natural combustion of adjacent lignite-bed. Similar clay ironstones occur in many places in the Tertiary rocks of the Province in greater or less quantity.

Copper.

(*See also Table of Assays of ores of the Precious Metals, pp.* 76 R *to* 79 R.)
Near head of Salmon Arm, Jarvis Inlet.—Deposit of bornite and copper-pyrites. (See p. 102 R.)

Knight's Inlet.—Ore similar to the last, very rich in hand specimens, locality not examined.

Entrance to Howe Sound.—(Three miles north of Atkinson Point Lighthouse) Copper pyrites found in 1865, and a considerable amount of prospecting work done at one time, but now abandoned.

Texada Island.—(Malaspina Mine.) Copper- and iron-pyrites in gangue of calcite and quartz. Accessory minerals, andradite, tremolite, chlorite and molybdenite. See p. 102 R. (Report 1886, p. 34 B.)

Sansome Narrows.—Copper-pyrites. Some prospecting work done a number of years ago, but now abandoned. The ore appears to follow cleavage-planes in the rock.

South-west side Dean Canal.—Specimens of vein-stone with yellow and purple copper ores, collected by Mr. Horetzky.

Head of Kitimat Inlet.—Small deposit of copper-pyrites and galena observed by Mr. Richardson.

Homathco River.—Entering head of Bute Inlet. Many specimens of vein-stones containing copper-pyrites and some purple ore, have been brought from this river, not examined.

Gnarled Islands,—North of Dundas Island, Dixon Entrance. Copper pyrites, small veins only seen.

Ellerslie Channel.—Near Milbank Sound. On the west shore of Nikus Arm some work was done several years ago on a vein containing pyrrhotite or magnetic iron-pyrites and copper-pyrites. This deposit is known as the "Hebrew mine," and appears to deserve further examination as a copper-ore.

Port Simpson.—"Chimseyan Ledge". On the hill behind the village. Pyrrhotite with copper-pyrites in quartz gangue. A little prospecting work done.

Discovery Passage.—(Two miles and two-third south of Otter Point) Quartz vein with copper pyrites, not large. (Report 1886, p. 44 B.)

North side of Skinkuttle Inlet, Queen Charlotte Islands.—"Old copper mine," copper pyrites in small quantity with magnetite. See p. 102 R. (Report 1878-79, p. 53 B.)

Copper Islands, Skinkuttle Inlet.—Small irregular strings and bunches of copper pyrites in many places. (Report 1878-79, p. 52 B.)

Copper Bay.—(Between Cumshawa and Skidegate, Queen Charlotte Islands.) Copper-ores occur here and some prospecting work done at one time. (Report 1878-79, p. 29 B.)

Small Island off Port Frederick, Queen Charlotte Islands.—Copper-ore reported by Captain Stuart, H. B. Co.

Coast two miles east of entrance to Sooke Harbour.—Copper-ore discovered 1864. Shaft sunk 120 feet, now abandoned. Native copper and copper-pyrites. See p. 102 R. (Report 1886, p. 19 T.)

South Similkameen River.—(East bank, six miles above mouth of Whip-saw Creek.) "British Columbia Copper Co's. Claim." Deposit consisting chiefly of copper-pyrites, said to assay $20 to the ton in silver, appears to be rather irregular. Prospecting work done in 1882-83. The same belt of rock with that containing the copper is said to have been traced in a north-westerly direction to Whip-saw Creek, and to shew more or less copper throughout.

Near head of Wolf Creek.—(About twelve miles above Vermilion Forks, Similkimeen.) Large body of copper ore reported to have been discovered by Mr. Jamieson, in 1888. Said also to contain silver. (Report of Minister of Mines of B.C., 1888, p. 318.)

Tulameen and *Similkameen Rivers.*—Native copper in small grains, and occasionally in pellets weighing several pennyweights, found in gold washings.

Between Rock and Boundary Creeks.—Deposit of grey copper ore found in 1888. Reported to be extensive and several claims taken up on it.

Toad Mountain Region.—The silver-ores of this locality contain a large percentage of copper. See p. 102 R.

Jubilee Mountain, Columbia River.—Though referred to on a previous page as deposits of the precious metals, composed largely of copper sulphurets. See p. 102 R.

Stump Lake Region.—Many of the ores found here, though chiefly valuable for the precious metals, contain a high percentage of copper.

Brisco Range, Rocky Mountains.—(Opposite lower end of Upper Columbia Lake.) Rich copper-ore consisting of chalcocite, bornite and copper-pyrites. Holds no gold or silver. (Report 1885, p. 27 M.)

Copper Island, Shuswap Lake.—Beds of talcose or nacreous schists, about six feet thick, impregnated with a considerable quantity of copper-pyrites. (Report 1877-78, p. 98 B.)

Copper Creek, Kamloops Lake.—Irregular veins or impregnations of copper-ore in trap rocks. Native copper is also reported to have been obtained here by the Indians in former years. (Report 1877-78, p. 116 B.)

Cherry Bluff, Kamloops Lake.—Copper-ores with magnetite near the west end of the bluff. (Report 1877-78, p. 117 B.)

Watkinson's, Fraser River.—(About 25 miles above Lytton). Grey copper (tetrahedrite) in considerable mass.

Thompson River.—(Rock-slide about six miles above Spence's Bridge, east bank). Copper-ores in irregular deposits, associated with breccia, etc. Apparently unimportant.

Thompson River.—(Six miles below Spence's Bridge). Rich purple ore found loose.

Thompson River.—(Nine miles below Spence's Bridge). A rough fragment of native copper found here, weighing several ounces.

Fraser River, near Hope.—("Murphy's Mine.") Vein containing copper, rather wide and well defined. Said also to contain $15 to $45 in silver. A long tunnel run in 1859, and work resumed for a time in 1879.

Fraser River.—(About 30 miles above Fort George). Nugget of native copper weighing several pounds, found loose.

Fraser River.—(Ten miles below Lillooet). Small lumps of native copper found in gold-placers.

Bate's, or 150-*mile house, Cariboo Waggon Road.*—Nugget of native copper, weighing about 15 pounds, found near here.

Vital Creek, Omenica.—Pellets of native copper found in gold washings.

Quesnel River, near The Forks.—More than half a ton of native copper, in nuggets, obtained here during gold placer-mining. The precise locality appears to be "Twenty-mile Creek," which enters the river a little below Morehead Creek.

Boulder Gulch, Thibert Creek, Cassiar.—Mass of native copper weighing about 15 pounds, found here. Also found in small nuggets in gold workings on other streams in Cassiar district. (Report 1887, p. 82 B.)

NOTE.—As elsewhere stated, traces of copper ores and small irregular deposits in veins and jointage-planes, or disseminated through rock-masses, have been observed in a great number of places, which it is not considered necessary to enumerate here.

LEAD.

Most of the localities in which ores of lead are known to occur have already been noted in connexion with silver-ores. See pp. 56 R *to* 75 R. *Districts or localities likely to yield a considerable proportion of lead in connexion with silver-mining are, therefore, here merely mentioned. Reference should be made in this connexion to the Table of Assays of Ores of the Precious Metals, pp.* 76 R *to* 79 R.

Mount Stephen, or *Tunnel Mountain.*—Extensive deposits of galena, holding a large percentage of silver. (See p. 66 R.)

Illecillewaet Region.—Large deposits of galena, often rich in silver. (See p. 63 R.)

Hot Springs Camp, Kootanie Lake.—Large deposits of galena and 'carbonate ores,' often rich in silver. (See p. 61 R.)

Hendryx Camp, Kootanie Lake.—Extensive deposits of galena, containing a moderate amount of silver. (See p. 62 R.)

Rock Creek and Vicinity.—Galena ores, often containing a high percentage of silver. (See p. 68 R.)

Omenica Region.—Veins of galena abundant; generally rich in silver. (See p. 73 R.)

Nass River.—Specimens of galena ore given to the late Mr. J. Richardson by Mr. W. Lyons. Precise locality was not stated, and the specimens have not been tested for silver.

Lower Cañon, Upper Liard River.—Galena in irregular veins. Percentage of contained silver not known.

Chilcotin River.—Specimens of galena collected by Mr. Tiedemann. Percentage of contained silver not known.

Near Indian Village, Cumshewa, Queen Charlotte Islands.—Numerous small veins in agglomerate, holding a little galena and iron pyrites. (Report 1878-79, p. 77 B.)

Galena is also present in greater or less quantity in a number of the Cariboo mines, but does not appear to be so rich in silver as in the Selkirk region. Of veins in Cariboo in which galena occurs in notable quantity, the "*Home Rule Ledge*" near Barkerville, and the "*Holmes Ledge*" on Break-neck Ridge, Snow-shoe Plateau may be mentioned.

Antimony.

Near Watkinson's, Fraser River.—About two miles below the iron ore locality already mentioned, and say 23 miles above Lytton. Vein about 14 inches wide, containing much stibnite, with quartz and calcite. Contains also traces of gold, and 2·187 ounces of silver to the ton. (Report 1887, p. 58 T.)

Cumshewa, Queen Charlotte Islands.—Specimens containing antimony and arsenic, probably from this place, obtained by Captain Stuart, H. B. Co.

Platinum.

Upper Similkameen and *Tulameen Region.*—Platinum, often in nuggets, observed in a number of localities where gold-mining is carried on. (For the names of these places see p. 104 R.)

Tranquille River, Kamloops Lake.—Found in fine scales with gold. (Report 1877-78, p. 155 B.)

Fraser River.—Mentioned as occurring in very fine scales, with gold, particularly at a place ten miles below Lillooet.

Yukon River.—Found in small quantities, in fine scales, with river-bar gold on all, or nearly all, the tributaries of the Yukon which have been worked.

Mercury.

Wapta (Kicking Horse) Valley, Rocky Mountains.—("Ebenezar Mine," three miles from Golden.) Bright red cinnabar disseminated in gangue of calcite. Deposit prospected to some extent, but not proved to be of economic importance. (Report 1886, pp. 41 D., 9 T.)

Homathco River.—Cinnabar found here during railway survey. Lode reported well defined and traceable for three-quarters of a mile. Country rock slate. The precise locality is, north side of Homathco River, nearly opposite station 3300, Cambie's Location Survey of 1875.

Fraser River.—Grains of cinnabar obtained in gold-washing near Boston Bar.

Fraser River, 12 miles above Kelly's Lake Creek.—Some way up a stream which flows in from the west, at this place, rich specimens of cinnabar containing native mercury, found.

Vicinity of New Westminster.—A rich specimen of cinnabar, reported by Mr. A. J. Hill, to have been found loose here.

Silver Peak, near Hope.—Globules of native mercury seen in some parts of the silver-ore found at this place.

Molybdenum.

Near head-waters of South Fork Spuzzum Creek, Fraser River.—Molybdenite in quartz veins. Fine specimens received.

Point east of Carrington Bay, Cortez Island, Strait of Georgia.—Molybdenite in small quantities in quartz veins.

Texada Island.—Molybdenite at Malaspina copper mine, in the vein.

Near head of Salmon Arm, Jarvis Inlet.—Molybdenite in association with copper-ore at the locality previously noted. (See p. 152 R.)

Knight Inlet.—Molybdenite reported.

Upper part of Cowichen River.—Specimens of molybdenite brought from here.

Lillooet River.—Specimen of molybdenite received from this vicinity per Mr. A. J. Hill.

Structural Materials.

Building Stones, etc.

(*Mention is here made merely of several localities in which stone has been quarried, and of some others which are so circumstanced as to appear to be of importance.*)

Nelson Island, Jarvis Inlet.—Pinkish-grey granite. Takes a good polish, and has been used in the construction of the dry-dock at Esquimault. Well situated for quarrying.

North Arm of Burrard Inlet.—Grey granite, easily quarried in blocks of any size, at the water's edge, and used in construction at Vancouver.

Admiralty or Salt Spring Island.—Greenish-grey sandstone of excellent quality. Easily quarried and shipped. Used in construction of dry-dock at Esquimault.

Pender Island.—Sandstone of good quality quarried to a limited extent. Known as "Browning Island stone."

Newcastle Island, Nanaimo.—Sandstones quarried here has been used in the construction of the mint in San Francisco, etc. (See p. 107 R.)

Near Nanaimo.—Sandstones from an extension of the measures at Newcastle Island. Quarry opened in 1875.

Chase River Quarry, near Nanaimo.—Sandstones similar to those above noted.

Texada Island.—Grey, white and blotched marbles in unlimited quantity. These have been quarried to a small extent at Marble Cove on the north-east shore, three miles and a-half from the north point of the island. Useful for ordinary purposes of construction, and taking a good polish. (Report 1886, p. 34 B.)

Beaver Cove, north-east coast of Vancouver Island.—Half a mile up the stream, which enters at head of cove. Grey marbles, often handsomely variegated, have been quarried to a limited extent.

White Cliff Island.—(Between Chatham Sound and Grenville Channel.) Marble, white, grey and pinkish. Attempt made to open a quarry in 1878.

Marbles occur in many other places at which no work has occurred, on or near the coast of British Columbia. Among these may be mentioned :—

Nimpkish Lake.—Grey and mottled marbles in great abundance.

Near Horne Lake, between Qualicum and Alberni.—According to Mr. J. Richardson, a great variety of ornamental marbles suitable for almost all purposes. (Report 1873-74, p. 101.)

The following eight localities are those noted in the course of a somewhat minute examination of the shores of the Strait of Georgia and Queen Charlotte Sound in 1885, as well adapted for the opening of quarries of building stone of good quality. None of them have yet been utilized :—

Near entrance to Squirrel Cove, Cortez Island.—(West side of entrance.) Pale greyish hornblendic granite. (Report 1886, p. 23 B.)

Walsh Cove, Redonda Island.—Pinkish-grey granite. (Report 1886, p. 24 B.)

Bay on south side of Hardy Island, near Jarvis Inlet.—(West end of island) Granite. (Report 1886, p. 31 B.)

Otter Cove, Discovery Passage.—Pinkish granite. (Report 1886, p. 45 B.)

Small Island opposite Chatham Point, to the north.—Granite like the last. (Report 1886, p. 47 B.)

West shore of Port Harvey, Johnston Strait.—Grey granite, also in several other places in this vicinity. (Report 1886, p. 50 B.)

Haddington Island, Broughton Strait.—Grey calcareous sandstone. An extensive quarry might be opened here with facility. (Report 1886, p. 57 B.)

Ledge Point, Port McNeill.—Near the last locality. Sandstone, but

harder and less favourably circumstanced for working than the last. (Report 1886, p. 61 B.)

Of localities of building-stone in the interior of the Province it is possible only to mention a few in the immediate vicinity of the line of Railway :—

Near Cantilever Bridge, Fraser River.—Excellent grey granite quarried here, for use in construction of piers.

North Bend, Fraser River.—Similar granite quarried here, to a limited extent. This and the foregoing place may be taken as representing a large number of localities which might be utilized along this part of the Fraser.

South Side of Kamloops Lake.—Nearly opposite Tranquille, cliffs of tufaceous sandstone and brown dolerite occur which might afford building-stone of fair quality.

South Thompson River.—(Seven miles below outlet of Little Shuswap Lake.) Granite of fair quality comes out on the line of railway. (Report 1877-78, p. 165 B.)

On the Shuswap Lakes abundance of moderately good building stones, (granites and other cyrstalline rocks) occur, and stones which may be used for construction are also found at intervals along the line of railway eastward.

Lime and Cement.

Of limestones suitable for making lime, it is possible merely to mention a few localities in which lime has been burnt, or which appear to be so situated as to be of immediate importance.

Victoria.—Several beds of limestone occur here in metamorphic rocks, and a little lime has been made from them from time to time, but the stone is to impure to afford a good lime.

Saanich.—Limestones affording excellent lime found in several places and burnt for use in Victoria.

Texada Island.—The northern part of the island, already mentioned as a locality of marble, affords abundance of excellent material for the manufacture of lime, and is readily accessible, (see p. 109 R.)

Near Agassiz Station, C.P.Ry.—Limestone occurs here. Of specimens of three varieties examined in the laboratory of the Survey, two proved sufficiently pure to make good lime. (Report 1888, p. 56 T.)

Near Popcum, Lower Fraser River.—Limestone, apparently of good quality, in a stream on north side of Cheam Mountain, situated about half a mile from the Fraser. Reported by Mr. A. Bowman.

Near Hope Station, C.P.Ry.—Limestone has been burnt here to a limited extent, at a place near Murphy's mine, about one mile above

Hope Station, and the same distance back from the railway. Lime has also been made about four miles above Hope, on the east side of the river, but was said to be impure.

About six miles above Yale.—Limestone or marble which has been burnt, but most of which is too siliceous to afford a good lime.

Near Forty-mile Post, Waggon Road, Fraser River.—Grey laminated limestone, about 100 feet thick and apparently of good quality. (Report 1877-78, p. 163 B.)

About seven miles above Spence's Bridge.—Limestone of good quality appears on the line of railway and also on the opposite side of the river, where it continues for several miles. (Report 1877-78, p. 163 B.)

North Thompson, six miles and a-half above Kamloops.—(East side of river.) Good limestone.

North Thompson, seventeen miles above Kamloops.—(West side of river, near Venn's.) Here and at several places a few miles further up, abundance of good limestone for burning.

South Thompson, ten miles above Kamloops.—(North bank.) Extensive exposures of good limestone. (Report, 1877-78, p. 80 B.) This and the two preceding localities are in communication by water with Kamloops, etc.

Shuswap Lakes.—Limestone suitable for burning in numerous places along the shores. (For details, see Report, 1877-78, p. 163 B.)

Qailchena, Nicola Lake.—(near mouth of McDonald River.) Good limestone, which has occasionally been used for the manufacture of small quantities of lime.

Near Stump Lake.—(a mile and a-half south from 'Palmer's,' on the hill.) Good limestone outcrops here, and may possess importance from its proximity to the Stump Lake mines.

For other occurrences of limestone in the southern interior of the Province, See Report, 1877-78. Limestones occur in great abundance and of good quality in that part of the Rocky Mountain range which is traversed by the railway. (Consult Reports, 1885. Part B., 1886, Part D.)

Near Skidgate, Queen Charlotte Islands.—Volcanic tuff resembling 'trass,' which may probably afford the basis of a hydraulic cement. (See p. 109 R.)

Ornamental and Precious Stones.

The marbles included in the above enumeration, might be mentioned under the head of Ornamental Stones. For remarks on other materials see p. 108 R. *Such localities as might be noticed under Precious Stones are mentioned on pp.* 110 R, 111 R, *and need not here be repeated.*

MISCELLANEOUS MINERALS.

Arsenic.—Native arsenic in considerable mass in veins seven miles up Watson Creek, west side of Fraser River, 25 miles above Lytton. (Report, 1886, p. 86 T.)

Bismuth.—In long prismatic crystals of the sulphide, in quartz. Little Shuswap Lake, north side, a mile and three-quarters from head of lake. (Report 1877-78, p. 162 B.)

Iron-pyrites.—Specimen of massive pyrites, said to occur in large quantity, brought from Copper Island, Barclay Sound.

Plumbago.—Large deposit of disseminated plumbago at Alkow Harbour, Dean Canal.

Plumbago.—Specimens obtained by the Vancouver Island Exploring Expedition in the country north-east of Port San Juan.

Nickel.—Nickeliferous sand obtained in gold-washings on the Fraser River, consists of magnetite, and pyritous grains attracted by the magnet, which consist of oxides of iron and nickel. (J. Blake, M.D., Proc. Cal. Acad. Sci., V. p. 200.)

Asbestus.—Thibert Creek, Cassiar. Specimens of a rather coarse and brittle variety of serpentine-asbestus.

Asbestus.—Stewart River, Yukon district. Small specimen of good serpentine-asbestus obtained. (Report, 1887, p. 27 B.)

Mica.—At a place about 120 miles north-east of Clinton, a large deposit of mica is said to occur. Specimens of good size have been brought out, but having been obtained from the surface, are somewhat weathered.

Mica.—In large crystals in veins traversing granites near the extremity of the north-east arm of Shuswap Lake, and may prove to occur of useful dimensions here or elsewhere in the same mountain region. (Report, 1877-78, p. 162 B.)

Nitre.—Filling cavities in a cavernous calcareous tufa on the Nazco River. (Report, 1875-76, p. 265.)

Nitre.—Specimens received from Big Bar, Fraser River, where it probably occurs under circumstances similar to the last.

Bitumen.—Oozing out on the beach. Tar Islands, Queen Charlotte group. (Report, 1878-79, p. 60 B.)

Amber.—A rounded fragment found in possession of the Indians, and said to be derived from the west coast of the Queen Charlotte Islands. (Report, 1878-79, p. 85 B.)

Mineral and Thermal Springs.

Nanaimo.—Salt spring. Issues from the Cretaceous coal-bearing strata near the Douglas seam, and according to Mr. Richardson, has a flow of two to three gallons a minute. The Hudson Bay Company at one time attempted the manufacture of salt here, but it was soon abandoned. The brine has been analyzed by Mr. Hoffmann, who found it to contain 52·154 parts of saline matter in 1000. Of this thirty-nine parts were common salt and the remainder largely calcium chloride. According to an analysis quoted by Pemberton, it contained 49 parts of salt in 1000 in 1854. (Report 1872-73, p. 82. Facts and Figures relating to Vancouver Island, etc., p. 159.)

Admiralty Island.—Salt spring. According to analysis quoted by Pemberton in the place above cited, the spring contains 65 parts of saline matter to 1000, but with more impurities than the last.

Harrison Lake.—Hot springs, known as "St. Alice's Well." According to Dr. Selwyn there are two principal springs, with temperatures of 120° to 150° F. respectively, and both copious. The water has been analysed in the laboratory of the Survey and the results will appear in the annual report for 1888.

Near Lillooet River—About five miles from head of Harrison Lake. Hot Spring, known as "St. Agnes' Well," no particulars.

Near Upper Columbia Lake.—Hot spring. At about two miles below the lower end of the lake, on a hill on the east side of the valley. Estimated to yield about twenty gallons a minute, at a temperature of 112° F. The outflow produces a calcareous deposit. A qualitative analysis has been made by Mr. E. B. Kenrick. (Reports 1885, p. 154 B., 1886, p. 15 T.)

Sinclair Pass.—Rocky Mountains. Hot springs, on south side of Berland's Brook, near the point at which it issues from the mountains into the Upper Columbia valley. Three springs reported, and said to be copious. Mr. John McKay, who discovered these springs, states the temperature of one as 108° F., of another as 118° F.

Elk River Valley.—Rocky Mountains, about Lat. 50° 7′, warm sulphur-spring reported on east side of river by Mr. H. M. Hatfeild.

Kootanie Lake.—Hot springs, giving its name to the "Hot Springs Mining Camp." Situated on west side of lake, directly opposite the "Blue Bell Claim." Several springs occur near the edge of the lake and some below the water-level. Temperature estimated at about 100° F.

Upper Arrow Lake.—Hot spring. On the east side of the lake, twelve miles from its head, and one hundred and fifty yards from the lake. Said to be about as hot as can comfortably be borne in bathing.

Albert Cañon Station C. P. Ry.—Hot spring. About a mile to the north of the Station. Temperature about the same as the last.

Near Upper Arrow Lake.—Hot spring reported by Indians at some distance back from the lake, on the flat land at the west side of the lake, three or four miles from its southern end.

Near Albert Cañon Station.—'Soda spring.' One mile and a half west of the station on south side of the track. This and the following springs are known as 'soda springs' in consequence of the presence of large quantities of carbonic acid gas.

Near Carne's Creek.—On west side of Columbia River and opposite the mouth of Carne's Creek. Group of springs with copious escape of carbonic acid gas.

Near Downie Creek.—'Soda spring.' Is situated about three-fourths of a mile north-west of the trail from Downie to Gold Creek and about four miles from the latter.

Four miles above Smith's Creek.—West side of Columbia River. Springs with considerable escape of carbonic acid gas, and deposition of iron-oxide, reported.

Skeena River.—Left bank, about fourteen miles above "Inverness Cannery." Hot spring No particulars.

Stikine River.—Hot spring. Situated a short distance above Buck's Bar and directly opposite the Great Glacier. No particulars.

Kennicot Lake.—At head of south branch of Taku River. Hot spring. Said to feed the lake. (Alaska and its Resources. Dall. p. 628.)

Hot Spring Island.—Queen Charlotte Islands. Hot springs with a slight smell of sulphureted hydrogen and a barely perceptible saline taste. Temperature over 100° F. (Report 1878-79 p. 22 B.)

Vermilion River.—Vermilion Pass, Rocky Mountains. About six miles west of the summit, on the north side of the valley, copious chalybeate springs, depositing ochre, from which the name of the pass is derived. (Report 1885, p. 120 B.)

Maiden Creek.—"Dougherty's spring." South of Clinton, and about three miles up the stream from the waggon-road crossing. Mineral spring, highly charged with carbonic acid, which escapes in such large quantity as to prove fatal to small birds approaching the spring. A qualitative analysis by Mr. Kenrick. (Report 1886, p. 13 T.)

McDonald's 'Oil Spring.'—Head-waters of Omenica River, lat. 56°. This spring is marked as above on Trutch's map of British Columbia. It is not, however, an oil spring, but is described as a small mound in the centre of which a hollow exists charged with carbonic acid to such an extent as to prove fatal to birds and small mammals.

Spallumsheen Arm.—Shuswap Lake. A spring known to the Indians as Pilpilpoopil, issues near shore of lake. Gas or air escapes with the water in considerable quantity. (Report 1877-78, p. 25 B.)

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON THE

MINING & MINERAL STATISTICS

OF CANADA

FOR THE YEAR 1887;

BY

EUGÈNE COSTE, M.E.,
Diplomé of "l'Ecole Nationale Supérieure des Mines de Paris, France."
Mining Engineer of the Geological Survey of Canada.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.

1888.

To Alfred R. C. Selwyn, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

Sir,—I have the honor to forward herewith my report on the mining and mineral statistics of Canada for the year 1887.

As regards silver, iron ore, phosphate and pyrites, the statistics are supplemented by short notices giving details of the recent developments at the mines or of the mode of occurrence of the deposits.

The report "on Canadian Precious Stones" was kindly supplied by Mr. George F. Kunz, of New York, to whom our best thanks are due.

Cordial thanks are also due for the uniform courtesy and kind assistance accorded us in our inquiries for statistics, and I desire to mention especially in this connection the Departments of Mines of Nova Scotia and of British Columbia, and the Department of Customs at Ottawa. The help afforded me by my assistant, Mr. H. P. Brumell, of the Geological Survey, was very efficient, and deserves also a specal mention.

I am, Sir,

Your obedient servant,

E. COSTE.

June, 1888.

NOTE.—Throughout this report the ton is of 2,000 lbs., and the year the calendar year, unless otherwise specified.

The fiscal year begins on the 1st of July.

SUMMARY OF THE MINERAL PRODUCTION OF CANADA IN 1887.

Name of Product.	Quantity.	Value.
Antimony ore ..... tons.	584	$ 10,860
Arsenic ..... "	30	1,200
Asbestus ..... "	4,619	226,976
Baryta ..... "	400	2,400
*Bricks ..... thousands.	181,581	986,689
*Building stone ..... cub. yds.	262,592	552,267
Cement ..... bbls.	69,843	81,909
Charcoal ..... bush.	1,610,900	88,823
Chromic iron ore ..... tons.	38	570
Coal ..... "	2,368,891	4,758,590
Coke ..... "	40,428	135,951
Copper ..... lbs.	3,260,424	342,345
*Fertilizer ..... tons.	498	25,943
*Flagstone ..... sq. ft.	116,000	11,600
Gold ..... ozs.	66,270	1,178,637
Granite ..... tons.	21,217	142,506
Graphite ..... "	300	2,400
Grindstone ..... "	5,292	64,008
Gypsum ..... "	154,008	157,277
*Iron ..... "	31,527	1,087,728
Iron ore ..... "	76,330	146,197
Lead (fine, contained in ore) ..... lbs.	204,800	9,216
*Lime ..... bush.	2,269,087	394,859
Limestone for iron flux ..... tons.	17,171	17,500
Manganese ore ..... "	1,245	43,658
*Marble and Serpentine ..... "	242	6,224
Mica ..... lbs.	22,083	29,816
*Mineral Paint ..... tons.	100	1,500
*Miscellaneous clay products	.....	182,150
*Moulding sand ..... tons.	160	800
Ochre ..... "	385	2,233
Petroleum (*a*) ..... (bbls. of 35 imp. gals.)	763,933	595,868
Phosphate ..... tons.	23,690	319,815
Pig Iron ..... "	24,827	366,192
Platinum ..... ozs.	1,400	5,600
Pyrites ..... tons.	38,043	171,194
Salt ..... "	60,173	166,394
Silver	.....	349,330
Slate ..... tons.	7,357	89,000
Soapstone ..... "	100	800
Steel ..... "	7,326	331,199
Sulphuric acid ..... lbs.	5,476,950	70,609
*Tiles ..... thousands.	14,658	230,068
Whiting ..... tons.	75	600
Estimated value of mineral products not returned	abt.	1,610,499
Total	abt.	$15,000,000

* Incomplete.

(*a*) The total given by the direct returns from the refineries was finally adopted as the most correct.

EXPORTS OF MINERALS AND MINERAL PRODUCTS MINED OR MANUFACTURED IN CANADA DURING THE YEAR 1887

ARTICLES.	VALUE.	ARTICLES.	VALUE.
Antimony ore	$ 9,720	Forward	$3,651,010
Asbestus	158,829	Manganese ore	34,855
Coal	1,695,783	Mica	3,480
Copper ore	109,336	Oil, mineral, coal & kr'sne.	13,831
" fine	29,100	Phosphates	433,217
Glass and glassware	1,030	Plumbago	3,017
Gold	920,329	Salt	11,526
Grindstones	28,769	Sand and Gravel	30,307
Gypsum	146,542	Silver	205,884
" ground	13,953	Slate	1,253
Iron & Steel, all sorts, abt.	412,000	Stone & Marble, unwrought	53,986
Iron ore	42,634	" " wrought	14,009
Lead ore	724	Other articles	212,990
Lime and Cement	82,261		
Forward	$3,651,010	Total	$4,669,365

EXPORTS OF MINERALS AND MINERAL PRODUCTS MINED OR MANUFACTURED IN CANADA DURING THE FISCAL YEAR 1887

FORWARDED TO	VALUE.	FORWARDED TO	VALUE.
United States	$3,358,005	Forward	$4,264,636
Great Britain	623,216	Belgium	8,611
Newfoundland	150,000	Japan	5,250
Germany	46,851	France	5,012
Sandwich Islands	27,664	British East Indies	4,673
St. Pierre	15,978	Chili	4,341
Australia	12,356	British Africa	2,006
Argentine Republic	11,879	China	1,176
British West Indies	9,966	Other countries	4,785
Spanish " "	8,721		
Forward	$4,264,636	Total	$4,300,490

IMPORTS OF MINERALS AND OF PRODUCTS CHIEFLY MANUFACTURED THEREFROM DURING 1887.

ARTICLES.	VALUE.	ARTICLES.	VALUE.
Alum & aluminous cake..	$ 22,148	Forward.....	$23,727,320
Antimony	6,479	Lime	8,090
Arsenic.....	1,541	" chloride of.....	53,472
Asbestus, mfrs. of.....	8,489	Litharge	28,705
Asphaltum	9,403	Lithographic stones.....	6,369
Baryta.....	276	Manganese, oxide of.....	3,169
Borax	19,891	Marble.....	82,958
Brass, and mfrs. of.....	501,367	Mercury.....	16,386
Bricks.....	15,502	Mineral waters.....	38,771
" and Tiles, Fire....	62,329	Ornamental stones.....	21,611
Buhrstones	3,535	Paints	534,451
Building stone.....	73,291	Petroleum	435,481
Cement	12,138	Plaster of Paris.....	5,622
" Portland.....	169,469	Platinum.....	1,636
Chalk	5,223	Potash salts.....	21,860
Clays, all sorts.....	50,980	Precious stones.....	259,328
Coal "	9,547,052	Salt.....	286,676
Copper, and mfrs. of.....	315,959	Sand and Gravel.....	30,508
Copperas.....	5,741	Slate.....	25,214
Earthenware	207,847	Soda salts.....	304,109
Emery and Pumice.....	16,527	Spelter.....	22,250
Emery wheels.....	3,425	Sulphur.....	31,616
Fertilizers	43,745	Sulphuric acid.....	39,210
Flagstones.....	20,269	Tiles, drain & sewer pipes glazed	90,380
Glass and Glassware.....	1,234,522	Tiles, all others.....	7,449
Graphite, and mfrs. of....	14,044	Tin, and mfrs. of...	938,737
" Pencils.....	62,338	Whiting.....	19,360
" Blacklead.....	16,876	Yellow metal.....	42,965
Grindstones.....	19,274	Zinc, and mfrs. of	83,263
Iron, Pig Iron and Steel, all sorts, about.....	11,000,000		
Lead, and mfrs. of.....	257,640		
Forward.....	$23,727,320	Total.....	$27,166,966

ABRASIVE MATERIALS.

Grindstone.

Grindstone was the only abrasive material for which returns were received for the year 1887. Small quantities of infusorial earth and whetstones from Canadian deposits were probably also marketed during the year, but particulars have not been obtained. As to emery, corundum, buhrstones, pumice stone, and other abrasive materials, it is believed that no quantity has ever been obtained commercially from deposits in Canada.

Summary.

The total production of grindstones during the year was 5,292 tons, valued, manufactured, at the quarries, at $64,008. This is an increase of 1,292 tons, and $17,463, over the returns of 1886, but as the returns last year were incomplete, this does not show the real increase of production.

Production by provinces.

The above production was from the provinces of New Brunswick and Nova Scotia, respectively, as below :—

	Quantity.	Value mfd. at quarries.
New Brunswick, 7 producers	3,582 tons.	$38,988
Nova Scotia, 2 producers	1,710 tons.	$25,020

Exports and imports.

The following tables show the exports and imports of grindstone, as well as the imports of buhrstone, emery and pumice stone :—

EXPORTS OF GRINDSTONE.

PROVINCE.	1886.	1887.
Ontario	.....	$ 500
Quebec	$ 1	12
Nova Scotia	9,400	10,425
New Brunswick	14,784	17,832
Totals	$24,185	$28,769

IMPORTS OF GRINDSTONE.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	862	$ 9,587	1,255	$13,718
Quebec	222	2,718	442	4,576
Nova Scotia	....	69	....	35
Manitoba	30	832	30	466
British Columbia	18	488	9	479
Totals	1,132	$13,694	1,736	$19,274

IMPORTS OF BUHRSTONE.

PROVINCE.	1886.		1887.	
	No.	Value.	No.	Value.
Ontario	618	$1,203	366	$1,184
Quebec	....	696	1,865	2,325
British Columbia	....	.....	....	26
Totals	....	$1,899	....	$3,535

IMPORTS OF EMERY AND PUMICE STONE.

PROVINCE.	1886.	1887.
Ontario	$10 461	$10.781
Quebec	3,225	3,968
Nova Scotia	103	360
New Brunswick	1,250	1,413
Manitoba	1	1
British Columbia	33	2
Prince Edward Island	12	2
Totals	$15,085	$16,527

IMPORTS OF EMERY WHEELS

PROVINCE.	Value.
Ontario	$ 759
Quebec	1,831
Nova Scotia	60
New Brunswick	642
Prince Edward Island	4
Manitoba	55
British Columbia	74
Total	$3,425

ANTIMONY.

Summary.

The antimony ore in 1887 was nearly all produced in Nova Scotia, only 34 tons having been exported from the Lake George mine, York Co., N.B., which was not worked during the year. Some preparatory work was done at the Lake Nicolet mine, South Ham, Quebec. The total production was 584 tons, valued at $10,860.

Nova Scotia.

According to Mr. Gilpin's report to us, the production in Nova Scotia, at the Rawdon mines, was 550 tons, worth at the mine about $18 per ton, or $9,900. This shows a great decrease in the value of the ore, and a poorer quality of ore obtained than during last year.

Exports and imports.

The tables of exports and imports are appended.

EXPORTS OF ANTIMONY ORE, YEAR 1887.

TABLE 1.

PROVINCE.	Tons.	Value.
Nova Scotia (*a.*)	195	$8,760
New Brunswick (*b.*)	34	960

(*a.*) Shipped to Great Britain.
(*b.*) " " United States.

IMPORTS OF ANTIMONY, YEAR 1887.

TABLE 2.

PROVINCE.	Pounds.	Value.
Ontario	47,880	$3,551
Quebec	28,343	2,746
Nova Scotia	112	8
New Brunswick	2,016	174
Totals	78,351	$6,479

ARSENIC.

There were 30 tons only of refined arsenic shipped during the year 1887 from the Deloro mine, Ontario, compared with 120 tons in 1886. The value of this shipment at the mine was $1,200, or $40.00 per ton, and the cost of placing it on the New York market was $7.50 per ton. Only a small quantity was sold in the crude state. Summary.

Analyses of this arsenious oxide are appended :—

Mean of a car load by P. de P. Rickets, Columbia College	$As_2 O_3$	99.84	Analyses.
	impurities.	0.16	
		100.00	
By Baker Edwards of Montreal	Refined arsenic,	97.5 $As_2 O_3$	
	Crude arsenic,	92.8 "	

Much more of this practically pure arsenic could be manufactured at this mine as the ore, which contains also a considerable percentage of gold, is very rich in mispickel or arsenical sulphuret of iron. The United States market requiring from 1,500 to 2,000 tons every year, according to the statistics of imports of that country and the Deloro arsenic having been well received in the United States, there seems to be no reason why the Deloro mine should not supply at least a much larger proportion of the demand of that country.

No other mine in Canada produced arsenic in 1887.

The following table gives the imports for 1886 and 1887 :— Imports.

Province.	1886.		1887.	
	Pounds	Value.	Pounds.	Value.
Ontario	12,741	$351	13,136	$ 456
Quebec	12,828	533	26,536	937
Nova Scotia	2,412	85	3,837	144
New Brunswick	.....	....	100	4
Manitoba	200	10	.....	....
Totals	28,181	$979	43,609	$1,541

ASBESTUS.

Summary.

According to the direct returns received, the total quantity of asbestus marketed during the year in Canada was 4,619 tons, valued at the mines at $226,976. This shows an increase of 1,161 tons in quantity, and $20,725 in value, over the returns of 1886.

Statistics of previous years.

In the report for 1886 a table was given of the shipments of asbestus from Canadian mines since the first production in 1879; this table was made up from the returns furnished by the producers. We have since been favored by Mr. James R. Woodward, General Manager of the Quebec Central Railway, with the following table of the asbestus shipments from Thetford and Black Lake stations:—

Fiscal years.	Tons.
1882	410
1883	724
1884	1,104
1885	1,327
1886	1,882

If to this is added 900 tons to cover all the shipments before June 30th 1881, plus about 1,500 tons shipped in the second half of the year 1886, and 515 tons which were delivered from other mines and were included in the table of the last report, we have a total of 8,362 tons to compare with the total of 10,024½ tons given in the 1886 report. This shows the figures in the table above referred to to be about 16 per cent too high, the producers, probably, sometimes returning the output and not the quantities shipped.

Production by provinces. Quebec.

Except 400 tons the whole is from Quebec, and mined by ten different producers at Thetford, Black Lake, Danville and Coleraine. The shipments from Thetford mines and Black Lake mines were 3,661 tons according to the direct returns received, while a detailed statement, kindly supplied by Mr. Woodward, give 3,513 tons as follows:—

Thetford Mines ..... 2,560 tons.
Black Lake " ..... 953 "

Ontario.

In Ontario 400 tons of a somewhat different article, valued at $6,000 at the mill, and used principally for asbestos roofing, were produced by Messrs. James & Taylor, of Bridgewater.

The following table 1 represents only the exports from 1st of July to the end of the year, as before that date there was no separate entry for asbestus in the returns of the Customs department. Table 2 gives the imports of the manufactured article :— Exports and imports.

EXPORTS OF CRUDE ASBESTUS DURING THE SECOND HALF OF 1887.

TABLE 1.

Quality.	Tons.	Value.
1st class Asbestus.....	1,761	$130,707
2nd " "	566½	23,296
3rd " "	184	4,826
Total half year 1887....	2,511½	$158,829

IMPORTS OF MANUFACTURED ASBESTUS, YEAR 1887.

TABLE 2.

PROVINCE.	Value.
Ontario	$3,485
Quebec	3,848
Nova Scotia.....	312
New Brunswick.....	576
Manitoba.....	32
British Columbia.....	236
Total.....	$8,489

COAL.

The total production of coal in 1887 was 2,368,891 tons, valued at the points of production at $4,758,590. Total production and comparison with 1886.

This is an increase, as compared with the returns of 1886, of 276,915 tons, and $741,365, but as the production in New Brunswick and in Manitoba is included in the returns of this year and were not last year, the real increase in the other districts, that is :—in Nova Scotia, the North west Territories, and British Columbia, is 266,475 tons, and $717,358, or from 12 to 17 per cent.

Production by provinces.

The following table gives the total production of each province:—

PRODUCTION OF COAL DURING 1887, BY PROVINCES.

PROVINCE.	Tons.	Value at mine.	No. of men employed.	No. of Prd'cers.
Nova Scotia	1,871,338	$2,923,966	4,367	20
British Columbia..	413,360	1,653,440	1,463	3
North West Terr..	73,752	156,777	321	10
New Brunswick...	10,040	23,607	110	16
Manitoba	400	800	4	1
Totals.....	2,368,890	$4,758,590	6,265	50

Nova Scotia.

Tables A, B, C and D, taken from the report of the Inspector of Mines, give the details of the production and of the sales of coal in Nova Scotia in 1887; table E, from the same source gives the yearly production since 1870.

PRODUCTION, SALES AND COLLIERY CONSUMPTION OF COAL IN NOVA SCOTIA DURING THE YEARS 1887, 1886, 1885 AND 1884.

TABLE A.

Period.	Production.	Sales.	Colliery consumption.
1887 First quarter, tons..	230,948	155,472	34,992
1887 Second " " ..	474,840	421,315	47,696
1887 Third " " ..	626,480	629,040	34,036
1887 Fourth " " ..	539,070	496,219	39,826
Totals.....	1,871,338	1,702,046	156,550
1886 "	1,682,924	1,538,504	159,512
1885 "	1,514,470	1,405,051	142,939
1884 "	1,556,010	1,413,048	130,781

DISTRIBUTION OF NOVA SCOTIA COAL SOLD DURING THE YEAR 1887.

TABLE B.

Market.	Tons.
Nova Scotia :—	
Transported by land	297,926
" by sea	227,874
Total	525,800
New Brunswick	208,892
Newfoundland	91,899
Prince Edward Island	56,689
Quebec	738,961
West Indies	6,877
United States	82,759
Other countries	169
Total	1,702,046

COAL TRADE BY COUNTIES IN NOVA SCOTIA DURING THE YEAR 1887.

TABLE C.

Year 1887.	CUMBERLAND.		PICTOU.		CAPE BRETON.		OTHER COUNTIES		Total.	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.
First Quarter	112,712	103,141	50,133	44,239	68,104	8,094	....	....	230,949	155,471
Second "	140,880	132,167	87,132	71,425	246,827	217,723	....	....	474,839	421,315
Third "	146,600	138,156	145,963	134,592	333,916	356,291	....	....	626,479	629,039
Fourth "	159,217	147,501	147,866	129,462	231,876	219,190	112	67	539,071	496,220
Totals.	559,408	520,965	431,094	379,718	880,723	801,295	112	67	1,871,338	1,702,045

PRODUCTION OF COAL IN NOVA SCOTIA BY COLLIERIES DURING 1887.

TABLE D.

	Colliery.	Tons.	Colliery.	Tons.
Cumberland Co.	Chignecto	18,458	Forward	1,141,798
	Joggins	18,647	Francklyn	6,073
	Lawson	134	Glace Bay	89,058
	Spring Hill	522,170	Gowrie	143,894
Pictou Co.	Acadia	258,284	International	122,532
	Barton	364	Ontario	8,700
	East River	1,282	Reserve	99,511
	Intercolonial	171,164	Sydney	191,276
Cape Breton Co.	Blockhouse	8,597	Victoria	68,384
Inverness Co.	Bridgeport	21,577	Mabou	112
	Caledonia	121,121	Total	1,871,338
	Forward	1,141,798		

YEARLY PRODUCTION OF COAL IN NOVA SCOTIA SINCE 1870.

TABLE E.

Year.	Tons.	Year.	Tons.
1870	700,861	1880	1,156,635
1871	754,031	1881	1,259,182
1872	984,664	1882	1,529,708
1873	1,117,643	1883	1,593,259
1874	977,446	1884	1,556,010
1875	874,905	1885	1,514,470
1876	794,803	1886	1,682,924
1877	848,395	1887	1,871,338
1878	863,081	Total	21,024,218
1879	882,863		

The following tables F & G, compiled from the reports of the Minister of Mines of British Columbia, show respectively the details of the coal trade there in 1887, and the yearly output since 1874:—

COAL TRADE OF BRITISH COLUMBIA DURING THE YEAR 1887.

TABLE F.

Name of colliery.	Coal raised. Tons.	cwts.	Sold for home consumption. Tons.	cwts.	Sold for exportation. Tons.	On hand January 1st, 1887 Tons.	cwts.	Unsold, including coal in stock, Jan. 1st 1888. Tons.	cwts.	Number of men employed.
Nanaimo.....	138,712	11	23,491	12	114,815	882	10	1,288	9	618
Wellington ..	239,217	4	72,464	4	187,193	20,711		271		715
E. Wellington.	35,431		1,000		32,831	2,000		1,340		130
Totals..	413,360	15	96,955	16	334,839	23,593	10	2,899	9	1,463

PRODUCTION OF COAL IN BRITISH COLUMBIA FROM 1874 TO 1887 INCLUSIVE.

TABLE G.

Year.	Tons.
1874	81,000
1875	110,000
1876	139,000
1877	154,000
1878	171,000
1879	241,000
1880	268,000
1881	228,000
1882	282,000
1883	213,000
1884	394,070
1885	365,000
1886	326,636
1887	413,360

North West Territory.

Returns have been received from ten different producers of coal in the North West Territories, and the total of their production for 1887 was 73,752 tons valued at the mines at $156,777. This, it is believed, represents the total production of the Territories within about 200 tons. It was mined at Lethbridge, Anthracite, Bow River Coal Mine near Cochrane Station, and near Edmonton. This is an increase of about 30,000 tons over the production of 1886.

New Brunswick.

From New Brunswick 15 returns were received, all from the Grand Lake district, representing 8,360 tons sold for $20,247 at the mines. Estimating the total missing returns at about 1,200 chaldrons, or 1,680 tons, we have about 10,000 tons as a close estimate of the total production. As coal mining in New Brunswick is only done in a desultory way, it is therefore very difficult to obtain more complete statistics.

Exports and imports.

The total exports during 1887 were 670,063 tons, of which 89,098 tons were foreign coal previously imported.

The imports amounted to 1,440,152 tons of anthracite and 1,218,333 tons of bituminous coal, which shows a remarkable increase of 47 per cent in the importations of anthracite, due, no doubt, to the removal of the duty.

The following tables 1, 2 and 3, give respectively the exports by Provinces in 1886 and 1887, the exports from Nova Scotia and British Columbia since 1874, and the imports of anthracite and bituminous coal in the last two years by provinces:—

EXPORTS OF COAL (FOREIGN & CANADIAN) BY PROVINCES IN THE YEARS 1886 & 1887.

TABLE 1.

1886.				
PROVINCE.	CANADIAN.		FOREIGN.	
	Tons.	Value.	Tons.	Value.
Ontario	367	$ 1,299	49,469	$119,853
Quebec	5,126	21,432	20,342	38,092
Nova Scotia	240,459	441,693	5	25
New Brunswick	17	162	8,610	33,038
Manitoba	.....	.....	.....	.....
British Columbia	274,466	960,649	.....	.....
P. E. Island	268	601	17	51
Totals	520,703	$1,425,836	78,443	191,059

1887.				
PROVINCE.	CANADIAN.		FOREIGN.	
	Tons.	Value.	Tons.	Value.
Ontario	.....	.....	67,837	$170,754
Quebec	14,737	$ 37,772	15,188	23,413
Nova Scotia	207,941	390,738	3,803	9,297
New Brunswick	1,341	4,025	2,270	7,486
Manitoba	15	60	.....	.....
British Columbia	356,657	1,262,552	.....	.....
P. E. Island	274	636	.....	.....
Totals	580,965	$1,595,783	89,098	$210,950

EXPORTS OF COAL FROM NOVA SCOTIA AND BRITISH COLUMBIA (THE PRODUCE OF CANADA) FROM 1874 to 1887, INCLUSIVE.

TABLE 2.

Year.	NOVA SCOTIA		BRITISH COLUMBIA.	
	Tons.	Value.	Tons.	Value.
1874	252,124	$647,539	51,001	$ 278,180
1875	179,626	404,351	65,842	356,018
1876	126,520	263,543	116,910	627,754
1877	173,389	352,453	118,252	590,263
1878	154,114	293,795	165,734	698,870
1879	113,742	203,407	186,094	608,845
1880	199,552	344,148	219,878	775,008
1881	193,081	311,721	187,791	622,965
1882	216,954	390,121	179,552	628,437
1883	192,795	336,088	271,214	946,271
1884	222,709	430,330	245,478	901,440
1885	176,287	349,650	250,191	1,000,764
1886	240,459	441,693	274,466	960,649
1887	207,941	390,738	356,657	1,262,552
Totals..	2,649,293	$5,159,577	2,689,060	$10,258,016

IMPORTS OF ANTHRACITE AND BITUMINOUS COAL BY PROVINCES IN 1886 AND 1887.

TABLE 3.

PROVINCE.	1886.				1887.			
	ANTHRACITE.		BITUMINOUS COAL.		ANTHRACITE.		BITUMINOUS COAL.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	649,384	$2,755,294	937,988	$2,541,140	1,042,077	$4,456,827	1,138,279	$3,226,524
Quebec.....	267,286	957,740	75,864	136,468	340,046	1,315,390	75,324	147,890
Nova Scotia.....	18,803	59,550	1,243	5,963	21,909	79,104	1,131	7,135
New Brunswick..	34,845	111,260	8,922	17,525	33,333	126,449	3,102	7,607
Manitoba.....	3,437	15.800	69	289	2	25	1,832	4,345
British Columbia.	26	407	589	3,838	112	1,737	665	5,259
P. E. Island.....	1,747	4,975	36	71	2,673	9,950	.....	.....
Totals....	975,528	$3,905,026	1,024,702	$2,705,304	1,440,152	$5,990,283	1,218,333	$3,398,760

Coke.

Returns received from the Londonderry Iron Works and from the Albion Mines, Nova Scotia, show the quantity manufactured by these two companies to have been 40,428 tons, valued at the ovens at $135,951. 162 ovens were in fire, and the number of men employed was about 60. Coke ovens were built in December, 1887, at Cow Bay, Cape Breton, and have been in fire since, but had not produced during the year to which these statistics refer.

The following table gives the imports of coke for the last three years:—

IMPORTS OF COKE DURING THE YEARS 1885, 1886 AND 1887.

PROVINCE.	1885		1886		1887	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	9,860	$33,681	11,140	$38,406	15,981	$67,797
Quebec	1,682	5,118	2,132	7,510	3,696	13,849
New Brunswick..	.....	.....	2	11	.....	.....
Manitoba	34	237	163	1,150	43	260
British Columbia.	253	1,041	105	364	85	429
Totals....	11,829	$40,077	13,542	$47,441	19,805	$82,335

Charcoal.

The production of charcoal is estimated to have been in 1887, about 1,610,900 bushels, worth at the kilns about $88,823. Of this 940,400 bushels were used in the manufacture of pig iron at the Radnor and Drummondville Blast Furnaces, and about 670,500 bushels were manufactured in the County of Essex for exportation to iron works in the United States.

COPPER.

Summary.

The total marketed production of copper in 1887 in Canada was, according to the returns received, 40,800 tons of ore containing 3,260,424 lbs* of fine copper, valued, at the average market price for the year of 10½ cts., at $342,345.

This, compared with the 1886 production, shows a decrease of 344,576 lbs., principally due to the fact that the largest of the producers, Messrs. G. H. Nichols & Co., were extensively engaged during the year in constructing a new mining plant and sulphuric acid works.

* Quantity of fine copper manufactured from the ore of Capelton plus copper contents calculated from assay value in the other returns.

The 1887 production was mined:—at Capelton, in Quebec; at the Sudbury mines, in Ontario; and at the Goodfellow mine, in Albert Co., New Brunswick. The larger part, viz.:—38,773 tons, with a copper content of 2,937,900 lbs., was from the Albert and Crown mines of Capelton. At Coxheath mines, in Nova Scotia, a little exploratory level driving was done, but no returns of ore shipment were made to the Inspector of Mines at Halifax. Production by districts.

There being no copper works in Canada, the whole of the production was exported principally to the United States, and as follows, according to the returns of the Customs Department:— Exports and Imports.

Province.	Quantity.	Declared Value.	Destination.
Ontario	567 tons of ore.	$ 3,416	U. S.
Quebec	1,015¾ " " ore.	13,550	G. B.
	1,210 " " fine copper.	121,000	U. S.
Nova Scotia	6 " probably matte.	270	G. B.
New Brunswick...	2 " " "	200	G. B.

The following Table 1 gives the exports from Quebec and Ontario for the last four years as per corrected Customs Department returns, and Table 2 shows that the export returns at Stanstead, our principal port of export for copper ore, are constantly lower than what is really exported, and consequently is a proof that in Table 1 the figures in Quebec should be greater.

Exports of Copper from Ontario and Quebec.
(From details furnished by Customs Department).

Table 1.

Year.	Quebec.		Ontario.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1884	2,714,400	$273,422			2,714,400	$273,422
1885	2,626,000	262,600			2,626,000	262,600
1886	2,736,630	232,855	164,040	$16,404	2,900,670	249,259
1887	2,555,500	134,550	34,160	3,416	2,589,660	137,966

COMPARATIVE STATEMENT OF COPPER CONTENTS OF SAME QUANTITIES OF CANADIAN ORES EXPORTED TO THE UNITED STATES.

TABLE 2.

Fiscal Years.	Imported to Vermont as per U. S. Treasury Department Returns.		Exported from Stanstead as per Canadian Customs Department Returns.		Difference.	
	Pounds of Copper.	Value,	Pounds of Copper.	Value.	Pounds of Copper.	Value.
1884	2,234,642	$223,405	1,676,000	$171,700	558,642	$51,705
1885	2,943,736	294,413	2,452,000	245,200	491,736	49,213
1886	3,318,723	332,033	2,590,000	267,340	728,723	64,693
1887	3,064,337	170,523	2,770,000	161,200	294,337	9,323

The imports in 1886 and 1887 were as below :—

IMPORTS OF COPPER.

(From Customs Department Books).

PROVINCE.	1886.			1887.		
	Pigs, bars, ingots, old, &c.		Manufactured.	Pigs, bars, ingots, old, &c.		Manufactured.
	Pounds.	Value.	Value.	Pounds.	Value.	Value.
Ontario.....	1,159,200	$121,994	$29,162	1,121,400	$120,204	$35,768
Quebec	1,146,100	64,349	16,623	794,600	67,855	56,700
Nova Scotia...	64,100	4,823	3,483	37,500	3,054	11,231
N. Brunswick.	66,200	4,547	4,123	54,200	5,153	6,644
P. E. Island ..	3,800	480	112	1,000	119	82
Manitoba.....	.....	.....	4,763	2,100	242	2,642
B. Columbia..	4,400	653	4,503	16,200	1,900	4,365
Totals....	2,443,800	$196,846	$62,769	2,027,000	$198,527	$117,432

GOLD.

The total production in 1887 was 66,271 ozs., valued at $1,178,637. About 3250 men were employed in gold washing or gold mining during the year. This production compared with that of 1886 shows a decrease of 10,608 ozs. and of $151,805 or a decrease in the value of 11 per cent, which is principally due to a falling off in British Columbia of about 23 per cent. Production by provinces.

By provinces the above total quantity would be divided as follows :—

Province.	Oz. dwt. grs.	Value.	No. of men employed.
		$	
British Columbia.....	40,856—— 8—— 5	694,559*a*	2,379
Nova Scotia.....	21,211——17——18	413,614	578
Ontario.....	450—— 7—— 0	6,760	15
North West Terr..... (includ. Yukon dist).	3,660—— 5—— 0	62,100	256
Quebec	90——18——10	1,604	22
Total.....	66,270——16—— 9	$1,178,637	3,250

(a) A small amount of bullion obtained at one of the quartz mines is added to the total $693,709 given in the Minister of Mines' annual report.

The statistics for British Columbia are from the annual report of the Minister of Mines of that province, and are as follows :— British Columbia.

Table A is the statement of the gold exported by the banks at Victoria during the year.

Table B gives the gold returns as estimated by the Gold Commissioners of the different district.

Table C shows the yearly yield of gold in the province since 1858.

VALUE OF GOLD REPORTED AT THE BANKS AT VICTORIA DURING THE YEAR 1887.

TABLE A.

Bank of British Columbia.....	$320,794
Bank of British North America.....	58,774
Garesche, Green & Co.....	199,356
	$578,924

PRODUCTION OF GOLD AND NUMBER OF MINERS EMPLOYED IN BRITISH COLUMBIA DURING 1887, AS ESTIMATED BY THE GOLD COMMISSIONERS.

TABLE B.

Districts.	Divisions.	Whites.	Chinese	Yield of gold by divisions.	Total yield by districts.
Cariboo	Barkerville	89	201	$ 79,373	
	Lightning Creek	28	163	30,700	
	Quesnel Mouth	10	127	51,000	
	Keithley Creek	27	211	66,600	
		154	702		$227,673
Cassiar	Laketon	24	53	31,430	
	McDame Creek	8	52	23,775	
	Skeena	17	4	5,280	
		49	109		60,485
Kootenay	Northern	100	20	8,550	
	Southern	13	62	29,350	
		113	82		37,900
Lillooet		50	400	106,000	106,000
Omineca		12	18	13,000	13,000
Yale	Hope, Yale and Lytton	.....	200	20,000	
	Kamloops	6	16	5,200	
	Okanagan	9	30	5,000	
	Similkameen	102	325	128,000	
		117	571		158,200
					$603,258
	Total Whites	495	.....		
	" Chinese	.....	1882		
	Total employed	2,377			

ANNUAL PRODUCTION OF GOLD IN BRITISH COLUMBIA SINCE 1858.

TABLE C.

Year.	Amount actually known to have been exported by banks, &c.	Addone-third more, estimate of gold carried away in private hands.	Total.	Number of miners employed.	Average yearly earnings per man.
1858 (6 months.)	$ 390,265	$ 130,088	$ 520,353	3,000	$ 173
1859	1,211,304	403,768	1,615,072	4,000	403
1860	1,671,410	557,133	2,228,543	4,400	506
1861	1,999,589	666,529	2,666,118	4,200	634
1862	3,184,700	1,061,566	4,246,266	4,100	517
1863				4,400	482
1864	2,801,888	933,962	3,735,850	4,400	849
1865	2,618,404	872,801	3,491,205	4,294	813
1866	1,996,580	665,526	2,662,106	2,982	893
1867	1,860,651	620,217	2,480,868	3,044	814
1868	1,779,729	593,243	2,372,972	2,390	992
1869	1,331,234	443,744	1,774,978	2,369	749
1870	1,002,717	334,239	1,336,956	2,348	569
1871	1,349,580	449,860	1,799,440	2,450	734
1872	1,208,229	402,743	1,610,972	2,400	671
1873	979,312	326,439	1,305,749	2,300	567
1874	1,383,464	461,154	1,844,618	2,868	643
1875	1,856,178	618,726	2,474,904	2,024	1,222
1876	1,339,986	446,662	1,786,648	2,282	783
1877	1,206,136	402,045	1,608,182	1,960	820
1878	1,062,670	1-5th 212,534	1,275,204	1,883	677
1879	1,075,049	" 215,009	1,290,058	2,124	607
1880	844,856	" 168,971	1,013,827	1,955	518
1881	872,281	" 174,456	1,046,737	1,898	551
1882	795,071	" 159,014	954,085	1,738	548
1883	661,877	" 132,375	794,252	1,965	404
1884	613,304	" 122,861	736,165	1,858	396
1885	594,782	" 118,956	713,738	2,902	246
1886	753,043	" 150,608	903,651	3,147	287
1887	578,924	" 115,785	693,709	2,342	296
			$50,983,226		

The statistics of the gold production of Nova Scotia in 1887 according to the report of Mr. Gilpin, Inspector of Mines of that province, will be found, by districts, in the following table A. Nova Scotia.

Tables B and C, compiled from the annual reports of the Inspector of Mines, give the production by districts as well as the yearly output for the whole of Nova Scotia since the beginning of the year 1862:—

GENERAL STATEMENT OF GOLD PRODUCTION IN NOVA SCOTIA FOR THE YEAR 1887.

TABLE A.

DISTRICTS.	No. of mines.	Days labor.	Mills.	Steam power.	Water power	Quartz, &c., crushed.	Yield per ton.			Total yield of gold.			Max. yield per ton.		
						tons.	oz.	dwt.	grs.	oz.	dwt.	grs.	oz.	dwt.	grs.
Caribou	3	7,832	1	1	0	2,689	0	13	20	1,861	9	22	0	18	5
Oldham	2	11,606	1	0	1	2,357	1	2	1	2,599	7	9	2	10	4
Renfrew	1	5,098	2	0	2	1,234	0	12	3	750	4	14	0	17	16
Sherbrooke	4	9,575	0	0	0	2,413	0	4	20	585	3	5	0	18	7
Stormont	2	2,964	1	1	0	663	0	8	20.7	293	15	22	1	5	6
Tangier	2	6,319	2	2	0	738	0	8	10	311	10	13	1	10	0
Uniacke	1	10,503	3	3	0	689	0	3	2	107	3	1	0	4	6
Salmon River	1	33,774	1	0	1	10,602	0	6	3	3,258	0	0	0	9	1
Brookfield	1	13,075	1	0	1	1,691	0	16	18	1,418	1	15	1	3	9
Whiteburn	2	7,599	3	3	0	1,094	2	2	3	2,305	12	13	6	2	8
Lake Catcha	2	12,116	2	2	0	601	4	18	18	2,959	4	0	7	5	4
Rawdon	2	31,560	1	1	0	5,302	0	13	5.5	3,507	13	8	1	7	2
Fifteen Mile Stream	1	4,920	1	1	0	829	0	9	15	398	5	0	1	5	4
Unproclaimed, &c.	4	16,437	5	2	3	1,378	0	12	10	856	6	16	1	9	0
Totals	28	173,428	24	16	8	32,280	Av. 0-19-11			21,211	17	18	7	5	4

GOLD PRODUCTION OF THE DIFFERENT DISTRICTS IN NOVA SCOTIA FROM 1862 TO 1887 INCLUSIVE.

TABLE B.

District.	Total quantity of quartz crushed.	Total Yields.				Average yield per ton of 2,000 lbs.
		Quantity.			Value at $19.50 per oz.	
	Tons.	Oz.	dwt.	grs.		
Caribou	23,647	17,606	0	4	$343,317	$14.56
Montague	13,828	28,417	0	10	554,133	40.07
Oldham	33,528	34,059	1	18	664,153	19.80
Renfrew	43,096	30,220	8	13	589,299	13.67
Sherbrooke	161,355	118,868	17	15	2,317,943	14.36
Stormont	16,355	18,656	6	17	363,797	22.24
Tangier	28,156	18,751	10	6	365,653	12.80
Uniacke	31,920	18,215	16	5	355,209	11.12
Waverly	88,953	53,158	18	4	1,036,598	11.65
Salmon River	10,602	3,258	0	0	63,531	5.99
Brookfield	1,691	1,418	1	15	27,652	16.31
Whiteburn	1,094	2,305	12	13	44,960	41.09
Lake Catcha	601	2,959	4	0	57,705	96.00
Rawdon	5,302	3,507	13	8	68,399	12.90
Wine Harbor	38,944	27,287	16	19	532,112	13.66
Darr's Hill	39,909	18,715	19	19	364,962	9.14
15 Mile Stream	1,917	958	11	23	18,693	9.75
Unproclaimed	44,171	35,262	10	15	687,620	15.56
Total	585,069	433,627	10	12	$8,455,736	$14.45

YEARLY PRODUCTION OF GOLD IN NOVA SCOTIA SINCE 1862.

TABLE C.

YEAR.	Tons of quartz crushed.	Total yields.		Average yield per ton of 2,000 lbs.
		Quantity.	Value @ $19.50.	
		Oz Dwt. Grs.		
1862	6,473	7,275 8 0	$141,871	$21.91
1863	17,000	13,971 13 17	272,448	16.02
1864	21,431	20,017 18 13	390,349	18.11
1865	24,421	25,454 3 22	496,357	20.32
1866	32,157	25,204 13 2	491,491	15.28
1867	31,384	27,310 18 11	532,563	16.96
1868	32,259	20,541 6 10	400,555	12.41
1869	35,144	17,868 0 19	348,427	9.91
1870	30,824	19,866 5 5	387,392	12.56
1871	30,787	19,229 7 4	374,972	12.17
1872	17,089	13,094 17 6	255,349	14.81
1873	17,708	11,852 7 18	231,122	13.05
1874	13,844	9,140 13 10	178,244	12.87
1875	14,810	11,211 14 19	218,629	14.89
1876	15,490	11,978 13 18	233,585	15.08
1877	17,369	16,882 6 1	329,205	19.01
1878	17,989	12,577 1 22	245,253	13.63
1879	15,936	13,760 8 21	268,328	16.83
1880	13,997	13,221 13 22	257,823	18.42
1881	16,556	10,756 13 2	209,755	12.66
1882	21,081	14,107 3 20	275,090	13.04
1883	25,954	15,446 9 23	301,207	11.60
1884	25,186	16,079 14 10	313,554	12.44
1885	28,890	22,203 12 20	432,971	14.98
1886	29,010	23,362 5 15	455,564	15.70
1887	32,280	21,211 17 18	413,631	12.81
Totals	585,069	433,627 10 12	$8,455,736	$14.45

Ontario.

Very little work was done in the Ontario gold mines in 1887; only small shipments of ore for test purposes were made from three or four of the mines. A new find was made late in the fall near Sudbury, in the township of Denison, from which very good specimens were obtained.

North West Territory and Yukon district.

A small amount of gold is obtained every year from the Saskatchewan river alluvions near Edmonton.

Dr. G. M. Dawson, from conversation with the miners, estimates the production of the Yukon district to have been about $60,000.

Quebec.

A little gold was obtained on the Mill river and the Gilbert river, in Beauce county, and also a small quantity at Ditton, Compton county. Some promising exploratory work was done on the Cumberland and Des Plantes rivers.

In the report for last year the available statistics of the production of the Chaudière division in previous years was given. So far we have been unable to improve this imperfect record.

Exports.

The following table shows the exports of gold-bearing quartz, dust, nuggets, &c., as per Customs Department returns:—

Ontario	$ 6,650
Nova Scotia	321,379
British Columbia	592,300
Total	$920,329

Imports.

It is impossible to give the imports of gold coin and bullion, and of the manufactures of gold, as these articles are not entered separately in the returns of the Customs Department, but are grouped with the same articles of silver and also with copper coins.

GRAPHITE (PLUMBAGO.)

Summary.

The total production of graphite in 1887 has been 300 tons, valued at $2,400 at the mine, which is situated near St. John, New Brunswick; another locality was being prospected near St. John, and there was also some prospecting work done for graphite in Waltham township, Pontiac county, Quebec. The mines near Buckingham, Ottawa county, Quebec, were not worked during the year.

Exports and imports.

EXPORTS OF GRAPHITE (PLUMBAGO) FROM NEW BRUNSWICK DURING THE YEARS 1885, 1886 AND 1887.

Year.	Cwts.	Value.
1885	2,043	$ 917
1886	8,142	3,586
1887	6,294	3,017

The above table gives all the exports of graphite during the last three years, except 6 cwts. from Quebec in 1885.

In the following tables 1 and 2, will be found the imports of raw and manufactured plumbago, and of pencils and blacklead:—

IMPORTS OF RAW AND MANUFACTURED PLUMBAGO AND OF PENCILS FOR THE YEAR 1887.

TABLE 1.

PROVINCE.	Plumbago.	Manufactures of Plumbago.	Pencils, lead, in wood or otherwise.
Ontario.....	$1,473	$5,140	$33,458
Quebec	534	4,033	21,263
Nova Scotia.....	61	1,739	2,769
New Brunswick	.....	657	3,028
Prince Edward Island..	.....	44	.....
Manitoba	.....	96	833
British Columbia	35	232	987
Totals.....	$2,103	11,941	$62,338

IMPORTS OF BLACK LEAD.

TABLE 2.

PROVINCE.	1886.	1887.
Ontario.....	$11,322	$7,001
Quebec	4,825	2,683
Nova Scotia.....	4,333	2,121
New Brunswick	4,049	3,559
Prince Edward Island..	640	745
Manitoba	94	165
British Columbia	550	602
Totals.....	$25,813	$16,876

GYPSUM.

Crude.

Taking the shipments from Nova Scotia as representing very nearly the total production of that province, the total quantity of crude gypsum produced in 1887 was about 154,008 tons, valued in the raw state at the quarries at $157,277.

Comparison with 1886.

Compared with the preceding year the returns show a decrease in the quantity of 7,992 tons, and in the value of $21,465.

Ground or Land plaster.

The total quantity of ground gypsum manufactured in the country and used for land plaster, is calculated to have been about 12,000 tons. Most of the Ontario production is milled and used as such; on the contrary almost the whole of the quantity produced in Nova Scotia is shipped in the crude state, and in New Brunswick most of it is either shipped in the crude state or calcined into Plaster of Paris.

Calcined or Plaster of Paris.

From direct returns it was ascertained that 49,308 bbls. of Plaster of Paris, made in the country from Canadian gypsum, were sold during the year for $50,058 at the works; this does not include about 5,000 or 6,000 bbls. made in Ontario, of which returns were not received; if this was added, the statistics of this manufacture would probably be very nearly complete.

The Albert Manufacturing Co. of New Brunswick is by far the largest producer, and besides what is made in Ontario there are also small quantities made at Windsor, Nova Scotia, and at Quebec, from Nova Scotia gypsum.

Production by provinces of crude gypsum.

The following table A gives the production of crude gypsum for each province, the value at the mines, the number of producers, and the number of men employed:—

TABLE A.

PROVINCE.	Tons.	Value.	No. of producers.	No. of men employed.
Nova Scotia....	116,346	$116,346	?	?
New Brunswick	29,102	29,216		179
Ontario	8,560	11,715	5	42
Totals.....	154,008	$157,277	....	....

In Nova Scotia the different districts produced as follows, according to the report of the Inspector of Mines :— Nova Scotia.

District.	Tons.	Value.
Windsor (a)	87,175	$86,595
Cheverie (a)	23,870	17,840
Walton (a)	545	382
Halifax (a)	316	1,543
Arichat, C.B.	340	275
St. Ann's, C.B	4,100	4,000
Total	116,346	$110,635

(a) Amount exported.

The two districts of Albert and Victoria counties in New Brunswick show the following returns :— New Brunswick.

	Tons.	Value.
Albert County	27,805 (a)	$27,805
Victoria "	1,297	1,411
	29,102	$29,216

(a) A certain proportion of this was suitable for "terra alba" and sold as such, but the exact quantity could not be ascertained.

The producing district of Ontario is along the Grand River, principally in the county of Haldimand, but there are also some quarries in Brant county near Paris. The statistics are given in the above table A. Ontario.

The tables of the exports and imports of gypsum are given below and show how much greater the exports are than the imports :— Exports and imports.

EXPORTS OF CRUDE GYPSUM, BY PROVINCES IN 1886 AND 1887.

TABLE 1.

Provinces.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	350	$538	225	$337
Nova Scotia	118,985	114,116	112,557	106,910
New Brunswick	23,498	40,559	19,942	39,295
Total	142,833	$155,213	132,724	$146,542

EXPORTS OF GYPSUM (GROUND) (a) FROM NOVA SCOTIA AND NEW BRUNSWICK IN 1885, 1886 AND 1887.

TABLE 2.

Provinces.	1885.	1886.	1887.
Nova Scotia.....	$ 294	$ 265	$ 662
New Brunswick....	15,404	24,670	13,291
Total.....	$15,698	$24,935	$13,953

(a) Probably all plaster of Paris. This heading is the one in the Customs Dept. returns.

There were no imports of crude gypsum into Canada during 1887, whereas during 1886, 1,557 tons valued at $2,492 were imported into Ontario.

IMPORTS OF GROUND GYPSUM AND PLASTER OF PARIS DURING THE YEARS 1886 AND 1887.

TABLE 3.

PROVINCES.	Ground Gypsum.				Plaster of Paris.			
	1886.		1887.		1886.		1887.	
	Pounds.	Value	Pounds.	Value	Pounds.	Value.	Pounds.	Value.
Ontario	26,872	$129	5,506	$ 73	247,906	$1,338	243,350	$1,282
Quebec.....	11,210	36	14,476	157	33,000	165	2,458	13
Nova Scotia	.....	.....	.....	.....	2,056	68	650	6
New Brunswick.	150,800	395	1,900	7	56,900	261	52,800	225
Manitoba.....	.....	.....	.....	.....	242,700	1,297	146,300	733
British Columbia.	.....	.....	15,000	138	254,895	2,473	363,607	3,363
Totals	188,882	$560	36,882	$375	837,457	$5,602	809,165	$5,622

IRON.

The total production of iron ore in Canada in 1887 was 76,330 tons, valued at the mines at $146,197. Iron ore.

This includes the quantities used in the blast furnaces at Drummondville which had not been obtained for the 1886 report, so that a comparison of the 1886 and 1887 figures is not possible.

By provinces, the iron ore statistics for 1887 are as follows:— Production by provinces.

Provinces.	Tons.	Value.	No. of men employed.	No. of Producers.	No. of Mines Producing.
Nova Scotia.....	43,532	$76,181	About 160	2	3
Ontario.....	16,598	36,218	129	2	7
Quebec.....	13,404	26,808	?	2	2
British Columbia.	2,796	6,990	20	1	1
Totals.....	76,330	$146,197		7	13

In Nova Scotia, according to the report of the Department of Mines, the East and West mines of Londonderry continued to be worked, and produced in 1887 43,360 tons and 80 tons of ankerite. There were also 172 tons of limonite mined at Bridgeville, Pictou county, and some prospecting work was done on the George river and on the East Bay deposits in the county of Cape Breton. Nova Scotia.

The following table compiled from the annual reports of the Department of Mines gives the yearly production since 1876:—

	Tons.
1876.....	15,274
1877.....	16,879
1878.....	36,600
1879.....	29,889
1880.....	51,193
1881.....	39,843
1882.....	42,135
1883.....	52,410
1884.....	54,885
1885.....	48,129
1886.....	44,388
1887.....	43,532

During the year 1887, iron mining in Ontario was almost entirely confined to the mines of the Kingston and Pembroke Iron Mining Ontario

Company, along the Kingston and Pembroke Railway line. Shipments were made from six of these mines, and amounted to 15,478 tons of a value at the mines of about $33,418. There were also about 1120 tons shipped from the district of Hastings; the other districts did not produce in 1887.

As shown in the tables of our 1886 statistical report, all the iron ore shipped from the provinces of Ontario and Quebec in the last 30 years amounted to about 600,000 tons only. In comparison we give the statistics published by the United States Survey, of the shipments of iron ore from the Vermillion Lake district of Minnesota, since 1884, when it first began to produce:—

	Long Tons.
1884 from August 1st to November 1st.....	62,124
1885 " May to November.....	225,484
1886 " " "	304,396
1887 (*a*) " "	390,467
	982,471 (*b*)

The Vermillion Lake district not being one of the most productive districts of the United States, the above comparative statement shows how little the iron mines of Ontario and Quebec have yet been developed, though rich deposits exist in those provinces in many places. Similar ores to those of Vermillion Lake and in the same geological conditions are known on the Canadian side of the boundary on Hunter's Island, and along Gun Flint Lake, and it is hoped they will prove equally rich and extensive.

Quebec.

There were 13,404 tons of soft iron ores charged in the blast furnaces of Drummondville, and at the Radnor furnace, near Three Rivers, during the year. A good deal of work was also done at the Bristol mine, Pontiac county, where several thousand tons of iron ore were taken out, but no shipment was made, it being contemplated to previously roast the ore, and for this operation two Taylor Langdon gas kilns were erected.

Operations were suspended in March 1887 at the Texada Island mine and during the rest of the year it was not worked.

There were, nevertheless, 2,796 tons of ore shipped from that mine to Irondale, Washington Territory, and operations at the mine have now been resumed again.

(a) From the Marquette Mining Journal.
(b) This is more than one million short tons.

The following table gives the exports for the last three years. No iron ore is imported. Exports. Imports.

Province.	1885.		1886.		1887.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario.....	15,426	$45,433	16,032	$51,175	12,244	$38,990
Quebec.....			2	10	38	119
New Brunswick..	12	449				
British Columbia.	190	425	3,130	7,225	1,410	3,525
Totals.....	15,628	$46,307	19,164	$58,410	13,692	$42,634

There were only four furnaces in blast during the year, one at Londonderry, N.S., two at Drummondville, Quebec, and the Radnor furnace, near Three Rivers. The first-mentioned was run with coke and a little raw coal, and the other three with charcoal. The statistics of their total production and consumption have been grouped in the following table A:— Pig Iron.

Pig Iron Production, and Consumption of Ore, Charcoal, Coke, Coal and Flux, in 1887.

Table A.

Number of furnaces in blast—4.

Production and Consumption.	Quantity.	Value at furnaces.
Pig Iron made.....	24,827 tons.	$366,192
Iron ore consumed.....	60,434 "	130,808
Fuel consumed { Charcoal.....	940,400 bush.	48,593
Fuel consumed { Coke.....	30,248 tons.	89,123
Fuel consumed { Raw coal....	3,333 "	5,877
Flux consumed.....	17,171 "	17,500

About 250 men were employed.

No pig iron is exported.

The imports for the last three years with the values are given by provinces in the following table 1 which shows, by comparison with Exports and Imports.

the above table, that the importation of pig iron in 1887 was about twice the production in the country, and also that the pig iron manufactured in Canada is of a superior quality and commands a higher price.

IMPORTS OF PIG IRON BY PROVINCES IN 1885, 1886 AND 1887.

TABLE 1.

PROVINCE.	1885.		1886.		1887.		
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Duty.
Ontario	17,149	$248,430	20,490	$296,290	19,451	$298,083	$ 61,291
Quebec	21,306	243,997	22,477	233,182	25,317	263,098	77,903
Nova Scotia	1,532	19,044	860	13,927	1,197	16,171	3,613
New Brunswick	2 684	40,513	2,824	51,352	1,729	36,771	5,362
Prince Edward Island	67	767	78	814	.....	.....	.....
British Columbia	1,021	13,662	631	8,819	557	5,981	1,211
Totals	43,759	$566,413	47,360	$604,384	48,259	$620,104	$149,380

As exhibited in the above tables, the total quantity of pig iron consumed (imported and manufactured) in 1887 was about 73,000 tons, having a value of about one million dollars; this was nearly all used as cast iron in the foundries, as the Londonderry Iron Works and the Nova Scotia Steel Works—which alone made iron or steel from pig iron —used only 3,799 tons of pig iron for that purpose. It must be well understood, however, that the above stated consumption of pig iron does not represent at all the quantity of pig iron that might be annually manufactured for the market of Canada, as besides the pig iron that is imported there is also imported a great quantity of manufactures of cast iron, as well as a very great weight of iron and steel made from pig iron in the iron and steel works of foreign countries. We have calculated from the tables given in the 1886 annual report, pages 42, 43 and 44, and from tables Nos. 2 to 9, inclusive, given below, that the imports of all articles of iron and steel, in the price of which the principal item is the weight of the metal, (not including cutlery, edge-tools, machinery of all sorts, engines and other hardware and manufactures) amounted in 1886 and 1887, respectively, to about 287,798 tons, and 235,792 tons made up as follows:—

1886.		1887.	
Iron.....	110,428 tons.	Iron.....	90,850 tons.
Steel.....	18,723 "	Steel.....	16,630 "
Castings and Forgings...	8,544 "	Iron and Steel.....	48,636 "
Railroad (iron and steel).	142,761 "	Castings and Forgings...	7,076 "
Hardware and mfrs.....	7,342 "	Railroad (iron and steel).	72,600 "
Total.....	287,798 tons.	Total.....	235,792 tons.

The equivalents in pig iron of these quantities of iron and steel, which are only a part of what was entered for consumption in 1886 and 1887, would be respectively about 345,000 tons and 283,000 tons. If to this is added the amount of pig iron consumed as such, it will be seen that—excluding all the iron and steel entering into such highly manufactured articles as cutlery, surgical instruments, edge tools, machinery of all kinds, engines and many other hardwares and manufactures—there was a total consumption equivalent in pig iron, in 1886 and 1887 respectively, to about 415,000 tons and 356,000 tons. If made in the country, this quantity of pig iron would represent to our makers at actual prices a value of about $5,000,000; it would necessitate a yearly supply from Canadian iron mines of 1,000,000 tons of ore, and, before this ore could be melted into pig iron and further made into the different merchantable articles of iron and steel which are now imported, it would also require about 3,000,000 tons of coal.

Iron and Steel.

The above statistical statement of our needs in iron will be a guide as to what can be done towards developing iron and steel industries in Canada; it also gives an insight into the splendid future of these industries; let us see now what is actually being done.

Returns where received from the Nova Scotia Steel Co., the Nova Scotia Forge Co., the Londonderry Iron Works and from six rolling mills. We regret very much that notwithstanding repeated efforts, returns could not be obtained from Messrs. J. A. & W. A. Chesley of St. John, N.B., The Montreal Rolling Mills Co., Messrs. Pillow, Hersey & Co., Messrs. Peck, Benny & Co., and the Metropolitan Rolling Mills of Montreal.

As far as received, the returns show :—

Description of articles made or consumed.	Quantity.	Value.
	Tons.	
Iron, all sorts, made	31,527	$1,087,728
Puddled iron bars consumed	2,312	58,700
Scrap iron and all other, consumed	36,448	579,497
Steel, all sorts, made	7,326	331,199
Steel consumed (almost all scrap steel)	8,407	149,177
Pig iron consumed in the manufacture of iron and steel.	3,799	56,990
Fuel consumed in the manufacture of iron and steel..	58,112	146,986
Men employed—about 850.		

This statement is estimated to represent about $\frac{2}{3}$ of the total production of iron and about $\frac{3}{4}$ of the total production of steel. If the manufacturers named above had not met our repeated requests for returns with a spirit of suspicion or indifference these statistics could have been made more complete ; fortunately, only a minority of the iron makers adopted the course, and it is hoped that even this minority will in the future be convinced of the necessity and advantages of having complete returns.

Exports and Imports.

The following tables give the exports and imports of iron and steel goods :—

EXPORTS OF IRON AND STEEL GOODS MANUFACTURED IN CANADA. YEAR 1887.

TABLE 1.

PROVINCE.	Iron, Scrap.	Iron Castings.	Iron, Stoves.	Iron, all other, and Hardware.	Steel, and Manufactures of.	Total.
Ontario	$62,108	$10,240	$796	$17,558	$5,228	$95,930
Quebec	7,148	2,851	684	52,201	19,307	82,191
Nova Scotia	2,005	1,880	750	18,601	41,030	64,276
New Brunswick	114	72	....	6,847	434	7,467
Prince Edward Is'd.	....	40	....	7	14	61
Manitoba	....	1	143	293	859	1,296
Totals	$71,375	$15,084	$2,383	$95,507	$66,872	$251,221

IMPORTS OF IRON IN SLABS, BLOOMS, LOOPS, PUDDLED BARS, ETC., FOR 1886 AND 1887.

TABLE 2.

PROVINCE.	1886.		1887.		
	Cwts.	Value.	Cwts.	Value.	Duty.
Ontario	291	$ 812	11,332	$ 8,995	$ 899
Quebec.....	354,130	289,702	348.557	285,233	50,520
Nova Scotia	438	369	1,116	8,552	855
New Brunswick	5,493	4,583	6,548	3,948	395
British Columbia.....	.....	8	.....	.....	.....
Totals	360,352	$295,474	367,553	$306,728	$52,669

IMPORTS OF SCRAP IRON AND SCRAP STEEL FOR 1886 AND 1887.

TABLE 3.

PROVINCE.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	5,616	$ 6,788	19,775	$81,091
Quebec	137,985	87,360	252,042	161,167
Nova Scotia	67,803	54,673	84,349	43,904
New Brunswick.....	36,440	23,115	54,718	40,169
British Columbia.....	40	15	440	262
Totals	247,884	$171,951	411,324	$326,593

This Table 3 forcibly exhibits the immediate good results of the new protective tariff which, having very wisely been made to bear more heavily on the manufactured products, has at once given rise to an increase of 66 per cent. in the imports of the raw material for our iron mills, proving a very marked greater activity in those mills since last May.

IMPORTS OF IRON.

IMPORTS OF FERRO-MANGANESE, FERRO-SILICON, SPIEGEL, STEEL BLOOM ENDS AND CROP ENDS OF STEEL RAILS FOR THE YEAR 1887.

TABLE 4.

PROVINCE.	TONS.	VALUE.	DUTY.
Quebec	1,121	$16,772	$2,242
Nova Scotia	274	3,531	549
New Brunswick	277	4,385	553
Totals	1,672	$24,688	$3,344

In the following tables the headings of the articles have been epitomized from the classification used by the Customs Department; this was rendered necessary by the change in the tariff on the 13th May, 1887.

TABLE 5.

ARTICLES.		QUANTITY.	VALUE.	DUTY.
Bar iron, rolled or hammered	cwt.	534,972	$654,918	$196,384
Boiler or other plate iron, inch nail plate	"	83,787	132,254	28,594
Tacks, brads and sprigs			6,552	1,910
Band and hoop iron	"	82,623	113,028	28,455
Iron in slabs, blooms, loops, puddle bars, &c	"	367,553	306,728	52,669
Iron bridges and structural iron work	lbs.	3,212,220	104,214	19,867
Nails, spikes and sheathing nails compressed	"	24,378	3,161	623
Nails and spikes	"	357,275	14,521	5,417
" " cut	"	264,235	9,594	2,692
" " incl. R. R. spikes	"	133,358	4,588	1,583
Nail and spike rods	cwt.	2,192	4,744	829
Iron, N. O. P. F	"	2,427	2,509	454
Ornamental iron work			368	90
Rolled round wire rods in coils	"	187	286	28
Swedish rolled iron nail rods	"	22,710	33,320	6,663
Tubing of every description			436,162	119,296
Wire work, other			54,570	13,444
Manufactures of iron, N.O.P.F.			8,845	2,069
Hoop iron for tubular rivets	"	73	805	Free
Total			$1,891,257	$491,007

IMPORTS OF STEEL.

TABLE 6.

ARTICLES.	Quantity.	Value.	Duty.
Wire, spring steel, coppered ..... cwt.	1,872	$6,270	$1,150
Locomotive tires ..... "	9,967	40,572	(a) 1,636
Steel Ingots, blooms, slabs, billets, bars, sheets, &c... "	272,920	516,471	117,337
Axes		11,828	4,313
Saws		63,113	18,945
Steel for manufacture of files ..... "	1,348	5,899	Free
" " skates ..... "	1,636	6,506	"
" " saws and straw cutters..... "	8,216	67,291	"
" " mower and reaper knives... "	2,002	8,498	"
" " knobs, locks and cutlery.... "	4,708	6,547	"
" " corsets, shoes, & clock springs "	3,097	11,407	"
" " spades and shovels..... "	2,367	9,022	"
Homo spring steel, for mattrasses ..... lbs.	569,523	20,397	"
Total		$773,821	$143,381

(a) This duty was collected previous to 13th May, 1887, when this article was placed on the free list.

IMPORTS OF IRON AND STEEL.

TABLE 7.

ARTICLES.	Quantity.	Value.	Duty.
Axles and springs of iron or steel ..... cwt.	14,460	$ 29,742	$ 10,275
Chains over 9-16 inch. diam ..... "	16,752	32,471	2,138
Chain cables, all other to 13th May, 1887..... "	9,966	30,136	6,049
Iron or steel bolts, nuts, rivets, etc..... lbs.	748,708	45,286	17,689
Rolled iron or steel angles, beams, girders, and all structural shapes..... cwt.	154,251	222,210	30,228
Screws, iron and steel "Wood screws"..... "	...	25,750	8,710
Sheet iron ..... "	312,601	615,074	79 026
Wire fencing, barbed, of iron or steel..... lbs.	55,310	2,317	816
" " Buckthorn, etc., iron or steel..... "	44,934	1,458	531
" of iron or steel, 15 guage and coarser, N.E.S... cwt.	91,973	194,555	42,205
" rope of iron or steel, N.E.S..... "	2,323	30,055	7,510
Mfrs. of iron or steel, N.E.S.....	....	286,503	82,386
Iron or steel rolled round wire rods..... "	57 991	74,482	Free
Iron or steel beams, etc., for composite ships..... "	7,128	14,420	"
Wire iron or steel, 16 gauge or smaller..... lbs.	1,622,994	89,286	"
Wire rigging for ships..... cwt.	2,849	11,033	"
Total.....	.....	$1,704,778	$287,563

IMPORTS OF CASTINGS AND FORGINGS.

TABLE 8.

ARTICLES.	Quantity.	Value.	Duty.
Castings of every description and forgings	.....	$230,344	$ 65,423
Cast iron pipe of every description.....	.....	186,573	81,949
Malleable iron castings and steel castings.....	.....	57,473	16,493
Anvils, to 13th May, 1887..... cwt.	553	3,299	988
Stoves	... .	15,914	4,426
Anchors ..... "	2,863	9,715	Free
Total.....	.....	$503,318	$169,279

IMPORTS OF RAILROAD IRON AND STEEL.

TABLE 9.

ARTICLES.	Quantity.	Value.	Duty.
Car Wheels ..... cwt.	7,955	$ 25,278	$ 6,319
Railway bars, iron or steel ..... "	13,685	21,948	4,186
" fish plates ..... "	47,950	62,469	29 733
Steel rails ..... "	900,051	905,072	Free.
" " for C. P Ry ..... lbs.	48,225 640	473,994	"
" " " E. & N. Ry ..... "	10,824	555	"
Totals ..... tons.	72,600	$1,580,316	$30,233

SUMMARY TABLE OF THE IMPORTS OF PIG IRON, IRON AND STEEL, FOR THE YEAR 1887 (ARTICLES NOT HIGHLY MANUFACTURED).

TABLE 10.

ARTICLES.	Value.	Duty.
Pig iron	$620,104	$149,380
Ferro manganese, etc	24,688	3,344
Scrap iron and steel	326,593	33,694
Blooms, etc.	306,728	52,669
"Iron"	1,891,257	491,007
"Steel"	773,821	143,381
"Iron and steel"	1,704,778	287,563
Castings and forgings	503,318	169,279
Railroad iron and steel ...	1,580,316	30,238
Totals	$7,731,603	$1,360,555

IMPORTS OF IRON AND STEEL HIGHLY MANUFACTURED ARTICLES NOT INCLUDED IN PREVIOUS TABLES, FOR FISCAL YEARS 1886 AND 1887.

TABLE 11.

COUNTRIES FROM WHENCE IMPORTED.	1886.		1887.	
	Value.	Duty.	Value.	Duty.
Great Britain	$688,028	$182,299	$889,590	$235,693
United States	2,500,946	692,764	2,369,321	671,810
France	6,469	1,593	8,436	2,353
Germany	41,137	10,847	89,094	24,086
Belgium	14,156	2,950	49,509	11,597
Switzerland	1,399	428	2,029	566
Other countries	1,514	398	947	242
Totals	$3,253,649	$891,279	$3,408,926	$946,347

Assuming that the imports shown in the above table 11 for the fiscal years are very nearly the same on the average as those for the calendar years, we see that the total imports of all pig iron, iron and steel articles and goods, were in 1887 of a declared value of a little more than $11,000,000, and that the duty paid was a trifle over $2,300,000.

LITHOGRAPHIC STONE.

It is very much to be regretted that the Canadian lithographic stone quarries have not been worked in 1887, and that nothing further has been done to develop them. It is a well-known fact that the Bavarian quarries do not produce now a sufficient quantity of the best quality stones for the requirements of the American market, and it should lead to the development of our own supply. The lithographic stones of the townships of Madoc and Marmora, and of the counties of Peterboro and Bruce have been examined and practically tested by lithographers, and in several cases, pronounced to be of good quality; they have also obtained medals at various exhibitions. They were obtained from the surface in small quarries and possibly, when the quarries are more developed, better stones free from "specks" of quartz or calcite will be available in large slabs.

The following table shows our imports for the last three years Imports.

IMPORTS OF LITHOGRAPHIC STONES.

TABLE 1.

PROVINCE.	1885.	1886.	1887.
Ontario	$1,033	$4,037	$3,756
Quebec	926	1,715	2,613
New Brunswick.....	2	8	....
British Columbia.....	27	2	....
Total.....	$1,988	$5,762	$6,369

MANGANESE.

Total production and comparison with 1886.

The total production of Manganese ore in 1887 was 1,245½ tons, valued at the mines at $43,658.

This compared with 1886 shows a decrease in the quantity of 544 tons, but an increase in value of $2,159, indicating that a higher grade ore was obtained.

Production by provinces.

Nova Scotia and New Brunswick are the only provinces of the Dominion where manganese mines are in active operation, and the production of each of these provinces was as follows:—

	Tons.	Value at mines.
New Brunswick	939½	$22,398
Nova Scotia (a)	306	21,260
Total	1,245½	$43,658

(a) The 385 tons from Cornwallis of a value of $2,233 is classed as an ochre.

New Brunswick.

In New Brunswick, the Markham mine which has now been working continuously for 25 years, provides the greater part of the production. Twenty men were employed at the mines and thirty at the works; two classes of ore were produced:—the "metallic" ore worth about $15.00 a ton at the mine and shipped to England, and the "chemical" ore worth from $50.00 to $60.00 and shipped to Boston; these two names sufficiently indicate the uses of these ores

Two other mines in King's county produced also small quantities in 1887, and development work was being proceeded with on an extensive bog manganese deposit at Hillsboro', Albert county.

Nova Scotia.

The following table, taken from the report of the Department of Mines, exhibits the production by districts in Nova Scotia:—

	Tons.	Value.
Onslow mine	40	$2,800
Pembroke	25	1,750
Tenny Cape	235	16,450
Cornwallis (a)	385	2,233
Cheverie	5	200
Maitland	1	60
Total	691	$23,493

(a) Classed as ochre in the above table of the summary production.

Statistics of the production in Nova Scotia, since 1877, according to the annual reports of the Department of Mines, may be found in the report for 1886.

The tables of exports were also given since 1868 in the last report; a table of the exports for the last three years only is now given, and one of the imports of oxide of manganese. Exports and Imports.

EXPORTS OF MANGANESE ORE.

TABLE 1.

Year.	Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1885.....	77	$5,054	1,607	$29,595	1,684	$34,649
1886.....	441(a)	30,854	1,377	27,484	1,818	58,338
1887 (b)...	578(a)	14,240	837	20,562	1,415	34,802

(a) A certain amount from Cornwallis included in these quantities more properly comes under the heading mineral pigment.

(b) 7-10ths of a ton valued at $53.00 exported from Quebec this year.

IMPORTS OF OXIDE OF MANGANESE.

TABLE 2.

Provinces.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario.....	16,464	$ 824	18,733	$903
Quebec	29,413	1,530	48,977	2,171
Nova Scotia.....	1,075	75	1,173	79
Manitoba.....	609	26	.....	.....
British Columbia.....	.....	.....	1,010	16
Total.....	47,561	$2,455	69,893	$3,169

MICA.

Total production.

The returns received show 22,083 lbs. of cut mica marketed in 1887, valued at the works at $29,816; the average price therefore is $1.35. The quantity mined and cut during the year was $39,500 lbs., and there was also marketed 18 tons of ground mica sold for $700; these returns are believed to include the whole of the production in Canada; they represent the production of four different mines: three in the province of Ontario and one in Quebec, employing altogether about 55 men.

In comparison with 1886, there is an increase of 1,722 lbs., in the amount of cut mica marketed with an increase of price of $808; this indicates a decrease, in the average price, of 7 cts. a pound due to the fact that a market was found for a second class quality mica from one of the mines.

Exports and imports.

There were 1000 lbs. of cut mica exported to the United States from Kingston during the year, according to the returns of the Customs Department.

We regret being unable to give the imports, there being no special entry for mica in the books of the Customs Department.

MINERAL PIGMENTS.

In the following table is given the returned production of some mineral pigments:—

Product.	Tons.	Value.	Prov. where produced.
Baryta.....	400	$2,400	N.S.
Ochre.....	385	2,233	N.S.
Mineral Paint.....	100	1,500	Ont.
Whiting.....	75	600	Ont.
Total.....	960	$6,733	

The baryta was all produced in Nova Scotia, no shipments having been made from McKellar's Island, Lake Superior, in 1887.

Imports.

Tables of the imports of these products and other mineral pigments are given below:—

IMPORTS OF UNMANUFACTURED BARYTA.

TABLE 1.

Province.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	45	$291	2	$ 24
Quebec	127	80	.....	.....
Nova Scotia	238	54	.....	.....
New Brunswick	6	47	200	252
Total	416	$472	202	$276

IMPORTS OF PAINTS.

TABLE 2.

VARIETY.	Lbs.	Value.
Fire-proof paint, dry	216,174	$3,112
Paint, ground in oil or any other liquid	.....	112,807
White and red lead and orange mineral, dry	6,876,910	286,589
White lead in pulp, not mixed with oil	.....	276
Ochres, dry, ground or unground, washed or unwashed, not calcined	1,676,434	16,371
Zinc, dry white	.....	28,227
Other paints and colors, N. O. P. F.	.....	87,069

IMPORTS OF WHITING.

TABLE 3.

PROVINCE.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	10,272	$3,577	8,868	$3,325
Quebec	24,839	8,698	52,949	13,659
Nova Scotia	8,654	1,823	2,689	1,027
New Brunswick	2,773	1,166	2,494	1,038
Prince Edward Island	109	61	464	190
British Columbia	739	857	274	121
Total	47,386	$16,182	67,738	$19,360

IMPORTS OF CHALK.

TABLE 4.

PROVINCE.	1885.	1886.	1887.
Ontario	$4,882	$3,053	$2,483
Quebec	1,322	1,657	1,864
Nova Scotia	230	167	213
New Brunswick	66	191	441
Prince Edward Island	23	20	37
Manitoba	71	208	164
British Columbia	13	28	21
Total	$6,607	$5,334	$5.223

IMPORTS OF LITHARGE.

TABLE 5.

PROVINCE.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	3,843	$13,001	6,354	$21,034
Quebec	1,891	6,289	2,353	7,440
Nova Scotia	2	8	2	9
New Brunswick	13	85	11	74
Manitoba	10	41	33	122
British Columbia	6	35	3	26
Total	5,765	$19,459	8,756	$28,705

MISCELLANEOUS.

Returns of a small production of certain miscellaneous minerals were received and are given in the following table:—

Product.	Quantity.	Value.	Province where produced.
Chromic Iron	38 tons.	$ 570	Que.
Lead.. Fine contained in ore.	204,800 lbs.	9,216	B.C.
Moulding sand	160 tons.	800	N.S.
Platinum	1,400 ozs.	5,600	B.C.
Soapstone	100 tons.	800	Que.

The lead ore was obtained at the mine of The Selkirk Mining and Smelting Co., in the Illecillewaet district, B.C.; preparatory work was also continued at the Lake Temiscamingue mine, Quebec. Lead.

The platinum was derived from the placer mines of Granite Creek, Similkameen division, B.C., and was sold in Portland, Oregon. In the report of the Minister of Mines of British Columbia, the total production of platinum of the Similkameen division is estimated at 2,000 ozs., by Mr. Tunstall, the gold commissioner of that division. Platinum.

As shown in the report for 1886, the exports of lead ore from Canada were always very small and of no importance; it is still so in 1887. Exports and Imports.

The imports of lead and platinum are tabulated below, as well as the imports of zinc, tin and mercury, of which there was no production. Zinc, Tin and Mercury.

The imports of glass and manufactures of, are also given in table 7. The exports of glass and glassware amounted only to $1,030. Glass.

IMPORTS OF LEAD.

TABLE 1.

ARTICLES.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Lead, old, scrap and pig.....	68,794	$142,667	69,866	$182,059
" bars, blocks and sheets.	10,488	32,450	20,048	58,283
" pipe.....	613	2,016	1,783	6,322
" shot.....	2,907	9,661	1,260	4,204
" mfrs. of, N.O.P.F.....	.....	9,884	.....	6,772
Total.....	.....	$196,678	.....	$257,640

IMPORTS OF PLATIUUM WIRE.

TABLE 2.

PROVINCE.	Ozs.	Value.
Ontario.....	207	$1,555
Quebec.....	4	68
New Brunswick (a).....	64	13
Total.....	275	$1,636

(a) Returns for New Brunswick incorrect.

IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

TABLE 3.

PROVINCES.	1886.		1887.	
	Cwt.	Value.	Cwt.	Value.
Ontario	5,307	$19,667	5,981	$25,947
Quebec	15,457	56,905	10,731	38,981
Nova Scotia	1,456	5,973	2,221	6,668
New Brunswick	1,457	7,387	2,022	7,890
Prince Edward Island	102	371	154	578
Manitoba	50	199	825	2,820
British Columbia	209	785	67	379
Totals	24,038	$91,287	22,001	$83,263

IMPORTS OF TIN.

TABLE 4.

PROVINCES.	1886.				1887.			
	Blocks, pigs and bars.		Tin-foil.		Blocks, pigs and bars.		Tin-foil.	
	Cwt.	Value.	Pounds	Value.	Cwt.	Value.	Pounds	Va ue.
Ontario	4,017	$73,661	30,929	$ 5,480	4,858	$78,908	49,232	$ 8,774
Quebec	7,822	104,717	57,602	11,226	3,441	83,562	65,760	13,289
Nova Scotia	2,423	39,937	1,083	255	984	21,260	4,683	832
New Brunswick	587	11,333	184	45	1,171	12,744	350	113
Prince Edward Island	451	10,047	.....	.....	182	4,114	10	2
Manitoba	42	939	655	230	.....	.....	408	119
British Columbia	1,639	36,301	50	14	847	21,092	37	16
Totals	16,981	$276,935	90,503	$17,250	11,483	$221,680	120,480	$23,145
Total Tin-foil.—Cwts.	905	17,250	.....	.....	1,204	23,145	.....	.....
Total Tin	17,886	$294,185	.....	.....	12,687	$244,825	.....	.....

IMPORTS OF TIN PLATES AND SHEETS.

TABLE 5.

PROVINCES.	1886.		1887.	
	Cwt.	Value.	Cwt.	Value.
Ontario	67,200	$248,899	81,225	$245,100
Quebec	75,302	251,240	80,375	286,670
Nova Scotia	29,546	96,101	11,764	74,879
New Brunswick	7,769	29,316	5,485	21,076
Prince Edward Island	9,106	27,006	2,030	6,731
Manitoba	1,415	4,380	1,714	5,246
British Columbia	35,933	145,413	16,156	54,210
Totals	226,071	$802.355	198,749	$693,912

IMPORTS OF MERCURY.

TABLE 6.

PROVINCES.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	8,742	$5,020	25,062	$12,778
Quebec	1,422	684	2,307	1,210
Nova Scotia	1,648	1,052	1,851	1,222
New Brunswick	20	11	.....	.....
Manitoba	80	44	3	2
British Columbia	4,210	1,981	1,866	1,174
Totals	16,122	$8,792	31,089	$16,386

IMPORTS OF GLASS.

TABLE 7.

DESCRIPTION.	Quantity. Square feet.	Value.
Carboys, demijohns, bottles and decanters, flasks and phials, telegraph and lightning rod insulators, jars and glass balls, and cut, pressed, or moulded table ware	.....	$259,389
Carboys and demijohns, bottles and decanters, flasks and phials of less capacity than eight ounces	.....	43,613
Flasks and phials of eight ounces capacity and over, telegraph and lightning rod insulators jars and glass balls, and cut, pressed, and moulded table ware	.....	99,099
Lamp and gas-light shades, lamps and lamp-chimneys, side-lights and head-lights, globes for lanterns, lamps, and gas-lights	.....	214,691
Ornamental, figured, and enamelled stained glass	.....	4,446
Stained, tinted, painted, and vitrified glass and stained glass windows, figured enamelled, and obscured white glass	.....	13,419
Common and colourless window glass	14,750,961	302,122
Coloured glass, not figured, painted, enamelled, or engraved	36,403	3,426
Photographic dry plates	17,416	4,221
Plate glass, not coloured, in panes not over 30 sq. ft.	169,148	56,456
" " " over 30 & not over 70 "	157,363	55,136
" " " over 70 sq. ft.	206,808	69,703
Silvered plate glass	.....	8,366
Porcelain shades, imitation	.....	12,488
All other mfrs. of glass, N. O. P. F.	.....	87,947
Total		$1,234,522

PETROLEUM.

Summary of the production. Inspection returns.

The Petroleum Inspection returns as entered in the books of the Inland Revenue Department show that the number of packages of Canadian refined oil (refined petroleum and naphtha) inspected during the year 1887 were:—

(1) 221,684 packages at 10c. inspection fee.
(2) 619 " 5c. "
(3) 35,134 " 2½c. "

Refined oil.

Rating the different packages, (1) (2) and (3) as containing respectively 35, 10, and 4 imperial gallons, we have a total of Canadian refined oils during the year of 7,905,666 imperial gallons, or 225,876 barrels of 35 imperial gallons. This at the yield of 100 crude oil for 38 refined, corresponds to 20,804,384 imperial gallons, or to 594,411 barrels of 35 imperial gallons, of crude oil. Taking the average price for the year on the Petrolea Oil Exchange of 78c. per barrel of crude oil, the value would be $463,641.

Crude oil.

Comparison with 1886.

Compared with our Inspection returns of 1886, which were made up as above from the number of packages inspected entered in the books of the Inland Revenue Department, the above statement shows an increase in 1887 of 107,970 barrels, or of 22 per cent in the quantity, but of only $25,844 in the total value.

In the following table will be found the quantities of Canadian oil inspected, and the corresponding equivalents in crude oil since 1881, obtained for each year by a similar calculation based on the number of packages entered in the Inland Revenue Department books.

CANADIAN PETROLEUM AND NAPHTHA INSPECTED AND CORRESPONDING QUANTITIES OF CRUDE OIL.

TABLE A.

Year.	Refined Oils Inspected.	Crude Equivalent Calculated.	Ratio of Crude to Refined.
1881	5,380,081	10,760,162	100 : 50
1882	5,111,893	11,359,762	100 : 45
1883	6,204,544	13,787,875	100 : 45
1884	6,730,068	16,825,170	100 : 40
1885	5,853,290	14,633,225	100 : 40
1886	6,469,667	17,025,439	100 : 38
1887	7,905,666	20,804,384	100 : 38

Direct returns. Summary of the production.

Direct returns were kindly sent from 13 refineries, 9 of which are situated in Petrolea, 2 in London, 1 in Hamilton, and 1 in Sarnia; it is believed that the whole of the refining operations in Canada is nearly covered by these returns, and that there were only two other small refiners, one in Petrolea and one in Montreal, both of whom went out of business during the year, so that it has been impossible to ascertain the statistics of their production and consumption. The three tanking companies of Petrolea have also very willingly forwarded to us the statistics of their operations.

These returns are summarised in the following tables:—

MAIN PRODUCTION of CANADIAN REFINERIES IN 1887.

TABLE B.

Products.	Imp. gals.	Value at refinery.
Illuminating oils.....	10,387,825	$991,290
Benzine and Naphtha.....	344,570	31,447
Black and Paraffine oils, (including fuel, gas, and lubricating oils.....	6,793,461	240,851
Paraffine Wax.....	lbs. 400,036	24,521
Total value.....	.....	$1,288,109

MAIN CONSUMPTION OF THE CANADIAN REFINERIES IN 1887.

TABLE C.

Crude Petroleum.....	26,737,668 Imp. gals.
Sulphuric Acid (*a*).....	3,215,410 lbs.
Soda (*a*).....	331,898 "
Litharge (*a*).....	496,163 "
Sulphur (*a*).....	96,816 "

(*a*) The quantities consumed by the Sarnia refinery could not be ascertained, but they were small and do not much materially affect the result.

The above tables B and C exhibit:—

1st. That the percentage of the different oils per 100 crude petroleum was as follows:—

Illuminating Oils	38.00
Benzine and Naphtha	1.30
Black and Paraffine Oils (including fuel, gas and lubricating oils, and paraffine wax)	25.70
Heavy tar and Residuum, Coke and waste (not returned.)	35.00
	100.00

2nd. That, there were 763,933 bbls. of 35 imp. gals. of crude oil consumed during the year in the manufacture of illuminating oils.

3rd. That, besides and above the 7,905,666 imp. gals. of refined petroleum and naphtha inspected during the year, there were also 2,836,729 imp. gals. produced in the refineries and not yet inspected at the close of the year. As this would indicate a stock, carried over from year to year in the country, of some 5,000,000 gals. of refined oils which is much more than the real stock carried, it shows that the calculations based on the number of packages of refined oils inspected give an incorrect and too low a result. The figures in table A above are consequently believed to be about one third too low. It is to be regretted that the Inland Revenue Department does not keep a record of the number of gallons inspected instead of the number of packages.

The returns of the tanking companies give the following results:—

CRUDE OIL.

Stocks on 1st January, 1887	388,192$\frac{3}{35}$ bbls.
Quantity of Oil delivered to tanking Co's. from wells, in 1887	414,273$\frac{31}{35}$ "
Quantity of Oil delivered by tanking Co's., in 1887	584,672$\frac{23}{35}$ "
Stocks on 1st January, 1888	217,793$\frac{8}{35}$ "

Compared with the direct returns of the refiners, the above statement shows that the refiners themselves must have received directly from the wells, about 180,000 bbls. of crude petroleum during the year, making the total production from the wells in 1887 to be:—

414,273$\frac{31}{35}$ bbls. received by tanking Co's.
180,000 " " refiners.

Total..594,273$\frac{31}{35}$ bbls.

This total production from the wells in 1887 of 594,274 bbls., added to the balance in the stocks on 1st January 1887 and on 1st January 1888, which was one of 170,399 bbls., gives 764,673 bbls. as the quantity of oil available for consumption during the year, and proves that the direct returns from the refiners of their crude consumption are correct. The returns of the tanking companies exhibit also a decrease in the stocks at the end of 1887 of nearly 44 per cent.

Petrolia Oil Exchange business in 1887.

We are also indebted to James Kerr, Esq., Secretary of the Petrolia Oil Exchange, for the following tables of the business during the year 1887 on that exchange, and of the average closing prices per month for the years 1885, 1886 and 1887:—

PETROLIA OIL EXCHANGE, CRUDE PETROLEUM BUSINESS FOR THE YEAR 1887.

Month.	Opening price.	Highest price.	Lowest price.	Closing price.	Average closing price.	Average price.	Total Sales Barrels of 35 imp. galls each.
January	92	92	80	83¼	84.78	84.71	41,549
February	83½	84½	79¾	79¾	81.63	82.38	37,969
March	79½	79½	75	77¼	76.72	78.26	44,703
April	77	77	74	74½	75.04	75.61	36,153
May	74	74	76	67½	69.29	75.89	34,462
June	67½	68½	66	68½	67.26	73.42	35,937
July	68½	68½	66¼	66½	67.50	72.34	18,127
August	66½	83½	66½	82½	71.36	78.55	31,011
September	83	84	78½	79	81.03	83.78	32,639
October	79⅝	79¾	75	75¾	77.12	77⅛	25,338
November	75½	75½	76	73¾	72.21	72½	20,479
December	73¾	80	72½	76	76.30	77⅔	47,836
Year 1887	92	92	66	76	78.02	78	406,203
Puts and Calls							45,000
							451,203

"The above is a resumé of sales and resales of crude oil warehouse certificates on the Petrolia Oil Exchange during the year 1887, and indicates the market price of Petroleum Oil (crude) as stated in warehouse. The further charge of 3 cents per barrel is made when the oil is delivered for pipeage to refiners in each case."

AVERAGE CLOSING PRICE OF CRUDE OIL ON PETROLEA OIL EXCHANGE.

Month.	1885	1886	1887
January	75¼	88¼	84¾
February	85¾	88¼	81¾
March	83¾	89½	76¾
April	80¼	90	75
May	78	90	69¼
June	79	90	67¼
July	83	80	67½
August	91¾	75½	71¼
September	89½	75	81
October	79½	84¼	77¼
November	79½	93¾	72¼
December	83½	97	76¼
Year	82¼	86¾	78

Tables of the exports of Canadian petroleum since the beginning of the operations in the Ontario oil fields in 1861 are given in the report for 1886, and show how fluctuating the exportations always were: varying from 9,000,000 to nothing; in 1887 they were as follows:— Exports.

EXPORTS OF CANADIAN PETROLEUM IN 1887.

TABLE 1.

PROVINCES.	Gallons.	Value.
Ontario	472,362	$13,616
Quebec	916	147
Nova Scotia	281	68
Totals	473,559	$13,831

Imports.

The following Table 2 is from the inspection returns of the Inland Revenue Department, and Table 3 is from the returns of the Customs Department. Table 4 shows the imports of crude oil, calculated by taking the difference between the totals of Tables 2 and 3.

REFINED PETROLEUM AND NAPTHA, IMPORTED AND INSPECTED.

TABLE 2.

Years.	Imperial Gallons.
1881	$1,111,338
1882	1,226,918
1883	1,110,580
1884	1,231,984
1885	1,211,152
1886	1,584,422
1887	1,511,433

IMPORTS OF CRUDE AND REFINED PETROLEUM.

TABLE 3.

PROVINCE.	1886.		1887.	
	Gallons.	Value.	Gallons.	Value.
Ontario	1,563,864	$179,756	1,688,611	$174,768
Quebec	759,312	69,526	805,197	69,527
Nova Scotia	699,480	66,690	762,346	63,096
New Brunswick	804,911	82,636	820,639	61,697
Prince Edward Island	170,736	18,818	173,852	13,793
Manitoba	7,627	871	15,486	1,905
British Columbia	173,921	50,934	198,913	44,826
Total	4,179,851	$469,231	4,465,044	$429,612

CRUDE PETROLEUM IMPORTED.

TABLE 4.

Years.	Imperial Gallons.
1885	2,599,064
1886	2,595,429
1887	2,953,611

PHOSPHATE AND MANUFACTURED FERTILIZERS.

Summary.

The total quantity of phosphate (apatite) shipped from the Canadian mines in 1887 is shown by direct returns received to have been 23,690 tons, the total value of which at the mines may be estimated to have been about $319,815, if $13.50 is admitted for the average spot value of a ton.

Compared with 1886, it is an increase in the marketed production of 3,195 tons; the increase in the value cannot be fairly ascertained, the average price given for 1886 being probably too high.

The production may be divided as follows:—

Quebec mines, Ottawa county	19,589 tons.
Ontario mines	4,101 "

Returns were received from eleven producers in Ottawa county, employing about 456 men; and from five producers in Ontario, employing about 130 men; it must be understood that in some cases the men were not employed all the year.

Exports.

The exports of apatite since 1877 were given in the report for 1886. The following table 1 shows the exports for 1887 by provinces and the destination of the product, but it must be remembered that the great bulk of what is produced in the Ontario district is first shipped to Montreal, and that Quebec is thus credited with more than the production of the mines from the county of Ottawa. Table 2 from the mining and mineral statistics of Great Britain supplements the information as to the destination of our apatite exports, and as to the proportion the Canadian phosphate bears on the English market to the total phosphate imported each year in Great Britain:—

EXPORTS OF PHOSPHATES. YEAR 1887.

TABLE 1.

PROVINCE.	TONS.	VALUE.	DESTINATION.
Ontario	705	$8,277	All to United States.
Quebec	22,447	424,940	All to Great Britain and Germany.
Total	23,152	$433,217	

EXPORTS OF CANADIAN PHOSPHATE TO GREAT BRITAIN COMPARED WITH THE TOTAL IMPORTS OF PHOSPHATES THERE.

TABLE 2.

Year.	Canadian Apatite.		Total Phosphates.		Proportion of value of Canadian Apatite to the value of Total Phosphates Imported into Great Britain.
	Long Tons.	£ stg.	Long Tons.	£ stg.	
1882	8,187	39,851	199,428	613,198	6.5 per cent.
1883	16,531	66,714	246,945	813,825	8.2 "
1884	15,716	52,370	219,225	643,851	8.1 "
1885	21,484	76,179	238,572	628,027	12.1 "
1886	18,069	63,490	223,111	526,885	12.0 "

This table shows that the proportion of the value of Canadian apatite imports to that of the total imports of all phosphates of lime in Great Britain is steadily increasing; in 1886 it had reached 12 per cent., or double what it was in 1882.

Manufactured Fertilizers.

The following statistics though not quite completed may prove of interest in connection with the manufacture of fertilizers in this country. The industry is merely in its infancy in Canada, but will probably before long attain large proportions, thanks to the great resources of this country in many of the raw or other materials used in this manufacture such as phosphate, gypsum, marls, pyrites (for making the acid), bones, fish and other manures, &c.

Production.

Returns of three producers show a total quantity of fertilizers manufactured and marketed during the year of 498 tons, of a value at the works of $25,943. The return of Messrs. Jack & Bell of Halifax has not been received. There were 221 tons ef Canadian apatite consumed in that manufacture, and also small quantities of the following minerals:—sulphate of ammonia, nitrate of potash, kainite and calcic sulphate which were imported.

Land plaster used in the country.

As stated on page 30 it is estimated that about 12,000 tons of ground gypsum were used in the country as a fertilizer during the year.

Exports and imports.

Table 3 below shows that considerable quantities of bones are exported for use in the manufacture of fertilizers, and table 4 exhibits the imports of fertilizers and of the raw minerals used in that manufacture.

EXPORTS OF BONES FOR THE LAST THREE FISCAL YEARS BY PROVINCES.

TABLE 3.

PROVINCE.	1885.		1886.		1887.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
Ontario	35,694	$35,222	39,805	$35,148	30,084	$24,169
Quebec	19,212	15,311	60,782	44,451	21,922	12,797
Nova Scotia	5	5	130	150	1,483	1,066
New Brunswick	850	1,398	2,793	2,485	2,575	1,944
P. E. Island	.....	.....	405	540	.....	.....
Manitoba	2,940	1,169	37,379	12,001	26,160	7,844
British Columbia	502	240	214	120	346	344
Totals	59,203	$53,345	141,508	$94,895	82,570	$48,164

IMPORTS OF FERTILIZERS AND OF THE RAW MINERALS USED IN THAT MANUFACTURE IN 1887.

TABLE 4.

ARTICLES.	Quantity.	Value.
Ground Gypsum ..... lbs.	36,882	$ 375
Potash, German mineral ..... "	15,313	935
" muriate and bichromate of (crude). "	573,773	31,641
Kainite ..... "	2,700	112
Sulphate of Ammonia ..... "	53,555	1,526
Fertilizers	.....	7,749
Bones (crude and dust) ..... "	11,760	677
Total	.....	$43,015

THE IRON ORES AND PHOSPHATE DEPOSITS IN THE ARCHÆAN ROCKS OF CANADA.

Object of paper

The object of this paper is to present in a concise form the conclusions arrived at by the writer as to the mode of occurrence of the iron ores and phosphate deposits in the Archæan rocks of Canada after a careful and minute study of many of these deposits in the iron and phosphate districts of Ontario,* and in the counties of Ottawa and Pontiac in Quebec. It is here presented on account of the practical bearing that it may have on the future developments of these important deposits, as it is hoped that it will be found to be a strong encouragement for the working of many of these deposits in depth as well as a guide in the following of their irregular structure and a help in the further discovery of new deposits of these minerals.

Origin of deposits.

We think we may say that our conclusions will be found to be greatly at variance with the views generally admitted here in Canada, expressions of which have been published principally in the different reports of the Geological Survey, and especially in the "Geology of Canada," 1863, and in the well-known subsequent reports of Dr. Hunt, Dr. Harrington, and H. G. Vennor. For indeed we believe that we have gathered year after year strong and clear evidence to show that not only our deposits of iron ores in the Archæan rocks are of an eruptive or igneous origin, but also that our deposits of phosphate are exactly similar and have also the same origin. This is why we are treating here of the deposits of these two minerals together as we believe that they are exactly analogous, and that which can be said for one is applicable to the other. As far as the iron ores are concerned, the view of their deposits in the Archæan rocks being of an eruptive origin is far from being a new one, and has been held by a great many eminent geologists in many countries, principally, I believe, in France, Norway, and Sweden, and also by some of the English and American geologists. In the case of the phosphate (apatite), the eruptive or igneous origin has also been advanced in Norway and in France, but by a smaller number of observers, probably on account of the fact that the apatite deposits are not so numerous as those of iron ores, and thus the opportunities for examination and report were less frequent. Here in Canada, this eruptive origin of the apatite as well as of the iron ores has always been denied so far: and if my conclusions were not backed by so many facts, some of which were only brought to light in the workings of the mines in the last few years, I would feel somewhat reluctant to go thus entirely

* Counties of Haliburton, Victoria, Peterboro, Hastings, Frontenac, Leeds, Lanark and Renfrew.

against the views already arrived at in this country by several very able men, but these facts were repeatedly observed and have been very carefully ascertained.

The principal among these observed points are the following:— Observations.

1. About 30 different deposits of iron ores (principally magnetite, though sometimes hematite) have been geologically surveyed by us * in the Madoc and Marmora region of Ontario, and were found to occur in the form of irregular veins around and always in close proximity to a large granite mass or to dykes and bosses of granite derived from it. The granite intrusions clearly cut across the Archæan crystalline limestone and schists and the deposits of iron ores are also manifestly veins cutting in a like manner across the Archæan rocks.

2. Away from the main granitic bodies, in the region covered by the map above referred to, there are no large deposits of iron ore, and when small quantities occur there can be seen almost in every case a small dyke of granite along the iron ore; so that the intimate connection of the two cannot be doubted.

3. An exactly similar connection was also observed between the iron ore deposits and intrusive igneous masses in a more extended region of several thousand square miles, also geologically surveyed by us,† and comprising parts of the counties of Hastings, Peterboro, and Victoria, in Ontario. There the iron ore deposits such as those forming the Blairton Mine, Orton Mine, Baker Mine, Emily Mine, Coe Hill Mine, Jenkins Mine, the Snowdon Mines, etc., were always found to be intimately connected in the manner described above with many varied kinds of igneous rock such as granite, granulite, pegmatite, mica syenite, hornblende syenite, diorites and diabases.

4. In the region north of Kingston, in the Counties of Frontenac, Leeds, Lanark, Renfrew, Pontiac and Ottawa, many deposits of iron ores and many deposits of phosphate were observed also in the same association with igneous rocks, and both cutting through the Archæan rocks. In the case of the phosphate the igneous rock was often the rock termed by Dr. Hunt "pyroxenite," but at other times it was a pegmatite or a mica syenite or a pyroxene syenite. In that region the iron ore and the phosphate have been found in the same deposits as witnessed by the evidence at the Foley Mine, the Forsyth Mine, and especially at the Blessington Mines where the writer observed the apatite and the magnetite together in the workings of nine different pits, and where at the time of his examination last summer there were

* This map on the scale of 40 chains to one inch, and comprising an area of 125 square miles, is now in the hands of the engraver and is expected to be ready shortly. It will be accompanied by a report in which the details of our observations will be given at length.

† A map of about 3,500 square miles covering this region, has been prepared and is expected to be published at the scale of 4 miles to the inch in the course of a year or so.

between 500 and 600 tons of iron ore and about 1500 tons of phosphate on the dumps, the two minerals having been taken out from the same pits.

5. In the two regions mentioned above the apatite and magnetite were often seen to be amongst the component elements of these masses or dykes of igneous rocks, which rocks were observed to accompany these minerals in their deposits as a veinstone of quartz or calcite carries other minerals in other veins.

Conclusion. Considering all this and knowing that similar facts have also been observed in other countries especially in the States of New York and New Jersey, and in Norway and Sweden, it is only natural that we should conclude, like many other geologists have done before in those countries, that the iron ore and phosphate to be found in our Archæan rocks are the result of emanations which have accompanied or immediately followed the intrusions through these rocks of many varied kinds of igneous rocks which are no doubt the equivalent of the volcanic rocks of to-day. These deposits then are of a deep-seated origin and consequently the fears entertained, principally by our phosphate miners, that their deposits are mere surface pockets, are not well founded. These fears are no doubt partly the result of the belief which has been somewhat prevalent that the apatite in them was the metamorphic equivalent of the phosphate nodules of younger formations, and it may be also that they have resulted from the fact that the apatite is irregularly distributed in these deposits and is often suddenly replaced by rock; this is not so often the case in the iron ore deposits which are on a larger scale. But notwithstanding this, when the deposits are properly understood to be, as we hold they are, igneous dykes and veins accompanying the igneous rocks, it will be easily seen why in the deposit itself the economic minerals can be suddenly replaced by rocks which may be said to be nothing else but the gangue. If this origin is understood it will besides facilitate and encourage the working of these deposits in depth, because the accompanying igneous rock, forming a mass or a dyke alongside of the deposit will be easy to follow and, because if it is apatite or iron-bearing at the surface, it will always be a guarantee that it will also be in depth, as each separate mass of igneous rock is generally quite constant in composition.

PRECIOUS STONES.*

By GEORGE F. KUNZ.

Although no mining for precious stones is carried on in Canada, and it can scarcely be called a gem-producing country, yet it furnishes a number of stones that are of more than passing interest to the mineralogist, and of some value in jewellery and the arts. A number of gem minerals, not of gem quality, are found here in examples of such stupendous size and wonderful perfection that they have found prominent places in the cabinets of the world, and are even more prized as such than cut stones from other localities. Their mineralogical value gives them no small commercial importance. For instance, the magnificent zircon crystals, occurring as individuals up to 15 lbs. in weight, many fine ones weighing nearly a pound, and the beautiful twin crystals of the same mineral; the black titanite in simple and twinned crystals up to 70 lbs. each; the vast quantities of amethyst from Lake Superior; the ouvarovite or green chrome garnet from Orford, and the white garnet crystals from near Wakefield, are some of the most notable of Canadian occurrences. Not the least wonderful are the apatite crystals, one weighing over 500 lbs., which are found of such size and beauty that the rich green variety, especially, would do to work into ornaments similar to those made from fluorite, which it exceeds in hardness.

What Canada has produced in precious and ornamental stones was well shown at the Centennial Exhibition, Philadelphia, 1876, and at the Colonial and Indian Exhibiton, at London, in 1886. The finer minerals have found their way into the well-arranged collection of the Geological Snrvey of Canada, at Ottawa, the British Museum, the Mineralogical collection of McGill College, which contains the cabinet of the late John G. Miller, and the Provincial Museum of Nova Scotia. Many of the finest specimens, in full series, grace the cabinets of Mr. Clarence S. Bement, at Philadelphia, King's College, Windsor, N. S., School of Mines, New York, which contains the collection of the late Dr. Henry How, Walter G. Ferrier, Montreal, Colonel W. J. Wilcox (deposited at the United States National Museum), Amherst College, at Amherst, Mass., Prof. O. C. Marsh, New Haven, Conn., and the New York State Museum, at Albany, N. Y.

The field in Canada is so vast that although much has been done in the way of prospecting of late years, only a small part of the territory has been thoroughly gone over. With the great resources developed by the opening of the Canadian Pacific Railway many new localities

* Specimens from the localities marked with an asterisk are in the Geological Survey Museum, Ottawa.

will doubtless be brought to light in the next ten years, and important additions made to the foregoing list.

DIAMONDS—have not been found at any locality in British North America.

SAPPHIRE.—Corundum, in red and blue crystals has been found in the limestone near Burgess, also in grains disseminated through a rock made up of felspar, quartz, calcite and titanite, in contact with the crystalline limestone. These grains are of a light rose-red to sapphire blue color, and are of no gem value, nor in quantity sufficient for commercial use. Chrysoberyl, alexandrite or chrysoberyl cat's eye has not been observed in Canada. Chrysoberyl has been found in Maine, however.

SPINEL.—In the seigniory of Daillebout small translucent octahedrons of blue spinel are found in a bed of micaceous limestone, and from Wakefield* come pink and dark bluish spinels in rounded cubic crystals and opaque light blue cubes nearly an inch in diameter.

Very interesting black spinels in brilliant crystals, one to two inches in diameter, occur in Burgess and Bathurst* townships, Ont., where a vein of them has been traced for a mile in one direction. They are also associated with fluorite in the township of Ross, Ont. None of these possess any gem value, however.

TOPAZ (?).—At the London Exposition, 1862, Mr. McDonald exhibited two topazes (?) from Cape Breton, one in the rough, and the other which had been cut at Pictou, half an inch in length and of a yellow color, the variety of this mineral peculiar to Brazil, which leads to the inference that these stones may have been citrine or artificially decolorized smoky quartz, and not the true mineralogical topaz.

EMERALD.—Emeralds have not been observed in Canada. Although very fine aquamarines have been found in Maine, adjacent to the province of Quebec. Little if any beryl of value for gems has been discovered in Canada. Pale green, well defined crystals have been reported by Dr. Bigsby at Rainy Lake, 230 miles west of Lake Superior. And in Berthier* and Saguenay* Cos., Que., some crystals over an inch in diameter have been found.

ZIRCON.—The zircons of Ontario, especially those from Lake Clear* and Sebastopol* and Brudenell* townships, in Renfrew County, are the most remarkable known for beauty, size, perfection and richness of color. An occasional crystal top or a small fragment will afford a gem of the hyacinth variety, but they rarely exceed a carat in weight.

Some of these individual crystals weigh about 15 lbs., and are more than four inches in diameter. One was observed three inches in diameter and nearly a foot in length. On the land of E. J. Gallagher, 25 miles west of Eganville, Ont., in Brudenell township* fine crystals are obtained. The twin zircons from Lake Clear are especially beautiful and interesting, one of them measuring nearly four inches in length, and many thousand dollars worth have been sold as specimens. Short's Claim,* on the north shore of Lake Clear, yields the finest twin zircons. Perhaps the finest twin crystals ever found and one of the best single crystals are in the British Museum Collection, while perhaps the finest series of this mineral is in the collection of Mr. Clarence S. Bement, of Philadelphia. An enormous single crystal is in the cabinet of the Academy of Natural Sciences at Philadelphia. In Burgess and adjoining townships occur some fine crystals, not so large as those from Renfrew, it is true, but of exquisite polish and highly modified forms; in Templeton* and, near Grenville, Que.,* especially four miles north, are found smaller crystals, often cherry red and transparent, that would make small gems. Highly modified crystals, associated with wollastonite and graphite are also found at this place.

Zircon is now mined by the ton in the United States and about $150 per ton is paid for it, because of the earth it contains (zirconia) which is used in the hoods for the new incandescent gas burners. The zircons are obtained by washing out the soil resulting from the decomposition of felspathic rocks.

TOURMALINE.—Tourmaline in green crystals is found in Chatham township,* Que., and the green and red (rubellite) varieties in Villeneuve township,* Que. Brown tourmalines are frequently met with in the Laurentian limestone. Fine crystals, rich yellowish or translucent brown in color, often occur imbedded in a flesh-red limestone at Calumet Falls, Que.,* and also in the townships of Ross, Ont.,* Clarendon and Hunterstown, Que. These furnish an occasional gem. Slender crystals in white quartz occur at Fitzroy, Island Portage and Lac des Chats, and of inferior color at McGregor's Quarry in Lachute,* Ont. Black tourmaline of no gem value is found at a number of localities, principally at Yeo's Island, near the upper end of Tar Island, one of the Thousand Islands. It occurs in large crystals at Murray Bay, Cap Tourmente, Que., and in white quartz on the 18th lot, 4th range of Bathurst,* Ont.; in the granitic veins in the township of Ross,* Ont.; on Roche Fendue channel, on Camping Place Bay, on Charleston Lake in Lansdowne, Ont., and on the west side of the North River at St. Jerome, Que.; in Blythfield, on the Madawaska, and at N. Elmsley, and Lachute,* Ont., St. Felix and Calumet Falls,* Que. The velvet black, fibrous tourma-

line found at Madoc* and Elzevir gives a blue powder and is evidently an indicolite, like the variety from Paris, Maine.

PHENACITE.—Phenacite has not yet been observed in Canada, but was recently identified by the writer at Stow, Maine.

GARNETS.—Almandite garnets occur plentifully in magnificent crystals in mica schist along the Stickeen River* in British Columbia. Owing to their perfect form and polish the faces of these crystals are the most beautiful in the world. Although they are not transparent enough to be of value to cut into gems, if obtained in sufficient quantity they would be useful for watch jewels.

Beds of nearly pure red garnet rock, from five to twenty-five feet thick, are sometimes met with in the gneiss at St. Jerome, Que., and in quartzite in Rawdon, and Marmora townships, Ont., and at Baie St. Paul,* Que. Some small pieces would afford gems of little value, but the stone is of considerable use in the arts as a grinding material and for sand paper. The large red garnet, disseminated through a white oligoclase gneiss, at Lake Simon, would not afford gems but if polished with the rock would afford an ornamental stone.

Andradite garnet is found on Texada Island, B. C.,* in fair crystals, not of gem value, however.

Essonite, cinnamon-colored garnet, the so-called hyacinth of the jewellers, is found in small crystals in Grenville, Que., but not of gem value, and in fine crystals, associated with idocrase, in Wakefield,* Que. But few of these would furnish even small gems.

Grossularite, white lime-alumina garnet, is found in Wakefield* and in Hull in considerable quantity, in veins lining the crystalline limestone, and assosiated with essonite, idocrase and pyroxene. This is the most remarkable locality for this mineral, superb crystals two inches across having been found there, as well as groups of crystals a foot across. In color the crystals vary from colorless to light yellow and light brown, and some of them are transparent enough to afford colorless gems of from one to two carats in weight.

Melanite, black garnet, is found in Marmora,* Ont., but this variety has no use in jewellery.

Ouvarovite, or green chrome garnet, found in Orford,* is one of the most beautiful known occurrences of this rare mineral. The crystals, which are transparent dodecahedrons, rarely over one-eighth of an inch in diameter, and of the deepest emerald green color, are found lining druses in cavities of crystalline limestone, often on the chrome pyroxene and associated with millerite. If it were not for the small size of the crystals, this would be a gem of the highest rank. A few crystals of this mineral have been found in Wakefield, some of which

rival in size any that have been discovered, the largest measuring nearly one-half inch in diameter. They are of a fine green, but opaque, and are sometimes filled with a yellow centre.

IOLITE has not been observed at any Canadian locality.

QUARTZ.—Rock crystal is found in many localities of Canada, especially in veins with amethyst in the Lake Superior region, but it has not been observed of sufficient size to afford crystal balls or other art objects.

The small doubly terminated crystals found in the limestone of the Levis and Hudson River formation, and familiarly called "Quebec diamonds," are sold as souvenirs to tourists, as the Lake George diamonds are in the United States.

Fine crystals are found in the soil in Lacolle, Que., and in the cavities of the calciferous formation in many places in beautiful limpid crystals.

Larger crystals have been found with smoky quartz near Paradise Bay, N. S., (see Smoky Quartz), also in the geodes on agate throughout the entire Bay of Fundy district, and on the Musquash River, N.B., at Cape Blomidon, N. S., etc.

Milky quartz is found all through Canada, but it is never of any value in the arts except for porcelain. Rose quartz is also found at many localities, especially at Shelburne, N. S. It is of little value in the arts, but has been made into various ornaments and charms. Smoky quartz in fine groups occurs in the same veins with amethyst on both Lake Superior and the Bay of Fundy, so uneven in color, however, as to afford gems of little value. It has been found in immense crystals in the vicinity of Paradise River, also near Bridgetown and Lawrencetown, Annapolis County, N.S., from a light yellow color to the dark, smoky "cairn-gorm." Dr. How mentions a crystal 13 inches high and 6 inches in diameter. Single crystals weighing 100 lbs. each have often been obtained from the decomposing granite and have been piled up with the stones from the fields, near Paradise River, and loose in the soil. It occurs in crystals about two inches in length at Mill Village, Lunenburg Co., N. S., and at Margaret's Bay, Halifax Co., N. S. In King's College cabinet there is a specimen of the dark, almost black variety known as "Morion," with crystals one-half inch across. When transparent, smoky quartz has considerable sale for jewellery under the name of cairngorm, Scotch or smoked topaz; when partly decolorized to a yellow and yellowish brown, as Spanish or Saxon topaz.

Amethyst is found in some form in nearly every vein cutting the cherty and argillaceous slates around Thunder Bay,* on the north shore of Lake Superior. At Amethyst Harbor* this mineral consti-

tutes almost the entire vein, and numerous openings have been made to obtain it for tourists who visit the spot. Thousands of dollars worth are annually sold here, and as much more is sent to Niagara Falls, Pike's Peak, Hot Springs, and other tourists' resorts, as well as to the mineral dealers. Surfaces several feet across are often covered with crystals from ¼ inch to 5 inches long, rich in color, and having a high polish. Sometimes, especially when large, the crystals have a coating of a rusty brown color, owing to the oxidation of the included goethite. This is one of the most famous occurrences of this mineral, regarded as mineral specimens, but the purple color is very unevenly distributed, resembling the Siberian not the Brazilian in this respect, and as the crystals are not transparent like those from Siberia, they afford very few gem stones of value.

In Nova Scotia, however, fine amethysts occur in bands, veins and geodes at Partridge Island, Cumberland County, N. S., surfaces a foot square being covered with splendid purple crystals an inch across. Dr. Gesner mentions a geode that would hold about two gallons, found at Cape Sharp, nearly opposite Blomidon, N. S. Another, lining walls of chalcedony with concentric bandings, was found at Sandy Cove, Digby County, N. S., and weighed 40 lbs. De Monts is said to have taken crystals from Partridge Island to Henry IV. of France whom they greatly pleased, and a crystal from Blomidon was among the French Crown Jewels twenty years ago. A bushel of crystals were obtained by the late Dr. Webster, of Kentville, N. S., in digging a single well. Dr. Gesner also states that he had seen a band of amethyst some feet in length and perhaps two inches thick, about a mile east of Hall's Harbor, N. S. Other localities are the south side of Nichols Mountain, Cape D'Or, Mink Cove, Scot's Bay, in Nova Scotia, and Little Dipper Harbor and Nerapis in New Brunswick, and other localities along the Bay of Fundy.

The beautiful masses of straight, concentric and irregular banded amethyst (banded with quartz and agates) (see above) found in Nova Scotia on the Bay of Fundy, are somewhat similar to a variety found abroad, and used for ornamental purposes, principally for clock cases and jewel caskets. The material is slit into plates so thin that they are often strengthened by cementing them on plates of glass, and the colors are enhanced by setting the plates so that the light can pass through. Dr. How mentions prase, green quartz, as occurring at Kail's Point, N. S. A beautiful hyaline quartz is found at Scot's Bay, N.S.

Sagenite (Flesche D'Amour, or Venus' hair stone) is reported by Dr. How from Scot's Bay, N. S. It is transparent quartz penetrated with needles of rutile.

AGATE, CHALCEDONY AND CARNELIAN.—Agates are found along the entire coast of Lake Superior in great abundance and often of considerable size and beauty. The finest in this region, however, are derived from the trap of Michipicoten Island,* Ont. They also occur on St. Ignace and Simpson's islands, Ont., on the former only as nodules in the trap. Both chalcedony and agate occur also as veins filling dislocations and cracks which penetrate the trap in several directions. In the Thunder Bay district they are associated with amethysts, occuring also as pebbles. Although these agates are often of rich color, and are beautifully veined, they are rarely over two inches across. Many are sold to tourists for ornaments, and many others could probably be disposed of if a little more attention were given to cutting and polishing them. As natural agates their color is exceptionally fine. Nearly all the large agates sold in this region are foreign material as well as of foreign coloring and cutting. Agate pebbles, known to the collectors as Gaspé Pebbles,* are found in the conglomerate of the Bonaventure formation, on the Baie des Chaleurs, Que., and along the shore of Lake Superior, in the vicinity of Goulais Bay, and especially on the St. Mary's River. Handsome agate and chalcedony in nodules and veins are of frequent occurrence on the south shore of the Bay of Fundy,* between Digby and Scot's Bay, N. S. Large masses of agate have frequently been found on this coast. Gesner mentions a mass of 40 lbs. weight made up of curved layers of white, semi-transparent chalcedony and red carnelian, forming a fine sardonyx. A mass showing distinct parallel zones of cacholong, white chalcedony and red carnelian, was found a few miles east of Cape Split, N.S.* When polished it resembles an aggregation of circular eyes, and hence the name eye-stone, or eye agate is applied to it.

At Scot's Bay, N. S., large surfaces of rocks are studded with these minerals. Fine specimens are also found at Blomidon, and at Partridge Island, N. S. Fine agates and carnelians occur at Digby Neck, six miles east of Sandy Cove, Woodworth's Cove, west of Scot's Bay, and at Cape Blomidon, N.S. Fine agates, chalcedony and carnelians are also found in New Brunswick, at Darling Lake, at Hampton, near the mouth of the Washdemoak River, at Dalhousie and on the Tobique River, in Victoria County.

An unique blue chalcedony, rich brownish green by transmitted light, is mentioned by How, from Cape Blomidon, N. S. Agate often occurs in layers forming an onyx in the Bay of Fundy and Lake Superior regions. Beautiful ones are found at Two Islands, Cumberland County, near Cape Split, at Scot's Bay and at Parrsboro, N. S. At the Queen Charlotte Islands, B. C., they occur abundantly at some localities, being derived from the miocene-tertiary rock.

Beautiful moss agates are found at Two Islands, Cumberland County, and near Cape Split, Partridge Island, also at Scot's Bay, King's County, N. S., exceptionally fine at the latter locality. Chrysoprase of fair color has been found in the Hudson's Bay district, on Belanger's Island.*

Silicified woods are found to some extent in the north-west territories* and in British Columbia. This is a beautiful ornamental stone, when the colors are fine, and it is highly polished.

Jasper conglomerate exists in mountain masses, along with the quartzite masses of the Huronian series, for miles in the country north of the Bruce Mines,* on Lake Superior north of Goulais Bay,* on the St. Mary's river about four miles west of Campment d'Our's, and at two places on the east shore of Lake George, and on Lake Huron, Ont. It is a rock consisting of a matrix of white quartzite, in which are pebbles often several inches across, of a rich red, yellow, green or black jasper, and smoky or other colored chalcedony, which form a remarkably striking contrast with the pure white matrix. It is susceptible of a very high polish, and has been made into a great variety of ornamental objects, such as vases, paper weights, etc. Some very beautiful mosaics have been produced by using the rock and included pebbles. The stone occurs in thick bands which extend for miles, and large boulders of it are scattered along the shores of the lake and rivers. Within half a mile of the northern extremity of Goulais Bay, Ont., there is a ridge containing several varieties of it.

Large quantities of rich, red jasper are found in Hull,* Que. Yellow and red occur at Handley Mountains, Annapolis, Pictou, Gulliver's Hope, Blomidon*, N.S.; at Belleisle Bay, King's County, Grand Manan, Darling's Lake and Hampton, near the mouth of the Washdemoak River; at Red Head and at the Tobique River, Victoria Co., N. B.; Woodworth's Cove, west of Scot's Bay, and all along the shore of the Bay of Fundy from Sandy Cove,* N. S. Near the head of St. Mary's Bay lie large blocks of red, yellow† and yellowish red jasper, often banded, but generally impure, however.

Considering the abundance of this jasper it seems strange that so beautiful an ornamental stone should have been so long neglected, but the recent improvements in sawing and polishing hard stones for ornamental purposes will doubtless bring it into extensive use in the near future.

Heliotrope (bloodstone) in good specimens is of rare occurrence in the North Mountain. Bay of Fundy, N. S.*

† Specimens of a rich yellow jasper from Pt. La Lime, Restigouche County, N. B., are in the Survey Museum, Ottawa.

Dr. Gesner mentions finding two small nodules of opal, resembling pieces of wax, at Partridge Island, N. S.

Semi-opal has been found at Partridge Island in fine specimens, at Grand Manan, N. B., and other localities in that vicinity.

Cacholong has been found associated with chalcedony in Nova Scotia on the Bay of Fundy.* The hornstone found at Partridge Island admits of a fine polish and is of some use as an ornamental stone.

JADE.—Jade (nephrite) in the form of archæological implements, has been found from the straits of Fuca northward along the entire cost of British Columbia and the northern end of Alaska. At the latter place it is closely allied with other minerals, such as the new form of pectolite, and is found with other relics of various kinds about shell heaps and old village sites, in graves, or still preserved, although seldom used, by the natives. It is also found as far inland as the second mountain system of the Cordillera belts, represented by the Gold, Cariboo and other ranges, principally among remains from Indian graves, and along the lower portions of the Fraser and Thomson rivers, within the territory of the Selish people. In the interior it is of rare occurrence, the coast Indians having used the tools in the construction of their houses and canoes, which are much superior to those of the interior. Dr. Geo. M. Dawson procured about sixty specimens for the Survey Museum, and at McGill College there is a fine series together consisting of 44 adzes, 6 drills, 2 boulders and 9 other objects. Dr. Dawson says: "It is among the highly altered and decomposed rocks of the Carboniferous and Triassic that silicates of the jade class might be expected to occur, and I feel little doubt that when these rocks are carefully investigated they will be found to be the sources of the jade." The Indians of the region, however, have usually if not invariably obtained their supply from loose fragments and boulders.

Jade is also reported from the Rae River and from the Hudson's Bay district by Mr. Rae.

This stone is highly esteemed in China and India, where it is carved into fine art objects and sold in large quantities,—a single object requiring the work of a lifetime, and selling for thousands of dollars. In New Zealand it is made into charms, trinkets, paper cutters, and in copies of native aboriginal objects.

PECTOLITE.†—Among the minerals sent to the United States National Museum from Point Barrow, Alaska, was a substance which Professor F. W. Clarke identified as pectolite. It had s specific gravity of 2.873, was white, grey and pale green in color, and about as

† A specimen of this mineral from Cathcart Point, Lake Superior, is in the Geological Survey Museum, Ottawa.

hard as jade. Almost simultaneously it was described abroad. Mr. F. Mercier has in the Geological Survey Museum several interesting objects of this material from northern Alaska, and a number of Indian implements are in the museum of McGill College. During the past year Professor W. P. Blake handed the State Mining Bureau of California, a description of a vein of this mineral which occurs in Tehama County, California, where it can be broken out in pieces four inches thick and larger. When freshly broken the color is sea green, but on weathering it becomes white. This material would also make a valuable ornamental stone, and Professor Blake's discovery leads to the inference that it may be found at many other places on the Pacific coast, since objects made of it have been discovered both in Alaska and in California.

AXINITE.—Axinite in fine crystals was reported by Dr. Bigsby from a boulder of primitive rock at Hawkesbury, near Ottawa.

EPIDOTE.—Epidote is found at many localities, though not in gem form, except when with flesh colored felspar in the amygdaloidal trap on Lake Superior. This has been polished to form an odd ornamental stone. At the falls of the Mingam river, Que., and in Ramsay township, Ont., is found a peculiar, fine-grained, reddish gneiss, traversed by veins of a pea-green epidote. It is very beautiful when polished. Pale-green epidote with quartz is found on the Matane river. That which forms mountain masses in the Shickshock Mountains, Que.,* is hard, susceptible of a high polish, and would be of value as an ornamental stone.

MICROCLINE.—Amazon stone (microcline) has been found in Sebastopol,* Ont., and in Hull,* Que., in cleavages of good color.

MOONSTONE.—The Adularia variety of moonstone, similar to the Ceylonese, has not been observed in Canada.

LABRADORITE.—Labradorite, the most beautiful of all the chatoyant felspars, exists in great quantities on the coast of Labrador,* especially at Nain and on St. Paul's Island adjacent to it, where the finest known occurs in veins of some size, whence for over a century it has been brought by the ton for use in the arts. It occurs on Lake Huron, Ont., at Cape Mahul, and the 10th range of Abercombie, Que.,* in fine cleavages several inches in diameter and of rich color, shewing beautiful blue opalescence, at Morin, Que.* In Lewis County, New York, it is extensively quarried for building purposes, and polished into columns and other objects for interior decorations.

PERISTERITE.—This beautiful variety of albite exhibits a peculiar bluish chatoyancy or opalescence, sometimes mingled with pale green and yellow, and called "moonstone." It is found in crystals and by the ton in large cleavable masses, containing disseminated grains of quartz, in veins cutting the Laurentian strata at Bathurst,* Ont., also in crystals on the north side of Stony Lake, near the mouth of Eel Creek, in Burleigh, Ont. in large opalescent cleavable masses of reddish albite, and on the 9th line or concession north of Perth, Ont., on the land of Robert McEwen. This beautiful material is especially adapted for use in the arts.

It is also reported by Mr. Hoffmann in specimens, showing beautiful blue color from Villeneuve,* Ottawa Co., Que.

PERTHITE.—Perthite occurs in large cleavable masses in thick pegmatite veins, cutting the Laurentian strata, and is often made up of flesh-red and reddish-brown bands of orthoclase and albite, interlaminated. When cut in certain directions it shows beautiful golden reflections like avanturine, and being susceptible of a high polish, is adapted for an ornamental stone or for use in jewellery. It is also found in considerable quantity at Burgess,* Ont., about seven miles southwest of the town of Perth, and near Little Adams Lake on what was formerly called Dobey Farm.

SUNSTONE.—Sunstone, avanturine felspar, has been described by Dr. Bigsby in the form of a largely crystallized flesh-red felspar, constituting part of a granitic vein traversing gneiss, 20 miles east of the French river, on the northeast shore of Lake Huron, and occurs in fine specimens at Sebastopol,* Ont.

OBSIDIAN.—Obsidian has been found in British Columbia,* but it has little value except for the cheaper jewellery, and is rarely used for that purpose.

PORPHYRY.—The porphyries which cut the Laurentian limestones in the townships of Grenville* and Chatham,* Que., form a dike running east and west 20 feet in breadth. They have a dark green or brownish black base, homogeneous and compact, containing crystals of red orthoclase, and admitting of a high polish, which strongly recommends it for use as an ornamental stone.

GRAPHIC GRANITE.—The pegmatite at Montgomery's clearing on Allumette Lake, five miles above Pembroke, Ont, consisting of a brownish-red orthoclase with white quartz is a beautiful ornamental stone, and admits of a good polish.

IDOCRASE.—Idocrase in wax-yellow crystals imbedded in limestone is found in Grenville, Que., in crystals of remarkable perfection and rich brown color, in a white calcite near Wakefield,* Que., on Frye's Island,* N.B., and in large brown crystals at Calumet Falls, Que. Some of these would cut small gems, for which there is slight demand to represent the initial "I" in sentimental jewellery.

PYRITE.—Pyrite is found at many localities, but nowhere in great perfection. It was extensively cut and polished for jewellery a century ago, but was superseded by the introduction of steel jewellery.

HEMATITE.—Hematite (specular iron) occurs finely crystallized at Cape Spencer, and exceptionally perfect and brilliant at Digby Neck, N. S., Sussex, King's County, and Black River, St. John Co., N. B. This fibrous form of red oxide of iron is extensively worked into jewellery in England and Germany; but it has not been found of sufficient value in Canada to warrant working, as it can be cut so much more cheaply abroad. All the hematite jewellery of the Lake Superior region is believed to be not only of foreign workmanship but foreign material.

OLIVINE.—Although olivine, chrysolite or peridot, as it is variously known, is found at a number of localities as a rock constituent, and often in the form of imperfect olive and amber-colored crystals one-half inch in diameter, at Mount Royal, Montarville,* Mount Albert and Rougemont, Que.; it has not yet been observed of sufficient clearness and perfection to afford gems.

ANDALUSITE.—The andalusite, found on Lake St. Francis in small flesh-red prisms not exceeding one-tenth of an inch in diameter, and also in black crystals and the variety known as *chiastolite macle*, or cross stone, is sold abroad for use in jewellery. It also occurs at Guysboro,* N. S., in fair macles.

PYROXENE.—The deep chrome-green pyroxene found at Orford,* Que., is of special interest. Many fine crystals have been found. Occasionally they are transparent and would afford gems. The lilac-colored variety from Grenville,* Que., does not admit of a fine polish.

STAUROLITE.—Staurolite has been found at several localities in Nova Scotia, more especially at Guysboro.* This mineral when in perfect crosses finds some sale for charms in Switzerland. A legend, believed by many inhabitants of Brittany, attaches a symbolic meaning to them representing that they have been dropped from the sky.

DIOPSIDE.—Diopside is found as a rock constituent at many localities in the Laurentian area. At Calumet Falls, Que., it occurs in crystals six inches long though not of gem value.

SCAPOLITE.—Scapolite, wernerite, occurs in large cleavable masses in a limestone at Grenville,* Que., and Bathurst, Ont. When free from the lilac-colored crystals of pyroxene with which it is associated it admits of a good polish, but is of little value in the arts.

ILVAITE.—Ilvaite was found in a boulder nearly a foot in diameter in the vicinity of Ottawa, Ont.,* and is believed to form a bed in the Laurentian series. It has little value as a gem, but is occasionally used for the letter "I" in sentimenal jewellery.

SODALITE.—Sodalite in fine blue grains has been found in the granite of Brome, Que., and at Kicking Horse Pass,* B. C., in seams at Montreal,* Que., and in veins several inches wide on the line of the Canadian Pacific Railway, by Dr. B. J. Harrington. It is occasionally used in the arts.

LAZULITE.—Lazulite is reported from the Hudson's Bay district, but of little gem value even when it is of fine color.

KYANITE.—Kyanite has been found in Vermont adjacent, but has not been observed in Canada.

PREHNITE.—Prehnite is associated with native copper and calcite in the Lake Superior region,* where it is often of a rich green color in spherical masses of crystals an inch across, or in aggregations even larger affording a curious but pleasing green stone resembling a chrysoprase. Prehnite in fine specimens occurs at Clifton, Clark's Head and Black Rock, King's County, N. S.

TITANITE (Sphene).†—The titanites of Canada have a world wide reputation, not only for their color, polish and the perfection of the crystals but also for their great size. A twin crystal of this mineral has been found on Turner's Island, in Lake Clear, weighing 80 lbs. They are found abundantly in this region, associated with apatite. The crystals are generally of such deep brown color as to appear black, and it is rare that even a small transparent gem could be cut from them. As crystals, however, they are unexcelled, and many thousand dollars worth have been sold as specimens. The finest are found in Renfrew County, especially in Sebastopol* and Brudenell* townships, Ont. Yellow crystals have not been observed as yet.

ZONOCHLORITE.—Zonochlorite, said by Hawes to be a chemically impure variety of prehnite, is yet distinctive enough as a gem stone to

† Fine specimens from Grenville and Hull, Que.; S. Sherbrooke, Ont.; and of a variety almost white from Brome, Que., are in the Geological Survey Museum, Ottawa.

entitle it to its name. It occurs in small rolled masses and in the rock at Nepigon Bay, Ont., and was described by Dr. A. E. Foote. It is a dark opaque green stone, beautifully marked and veined, and admitting of a high polish, and ought to find some sale as a local or tourists' gem.

CHLORASTROLITE.—Chlorastrolite, while not occurring on the north shore of Lake Superior, is found at Isle Royale, and Michipicoten Island.* This beautiful, stellated gem stone, which is sold to a considerable extent as an ornamental stone on all sides of the lake, is of purely American occurreuce.

THOMSONITE.—Thomsonite of a red color, compact and fibrous, often banded with green in a number of concentric rings, is found on the northern shore of Lake Superior, Ont., and Cape Split,* N.S. The pebbles vary in size from one-eight of an inch up to one inch across, and are quite extensively sold on all sides of the lake as an ornamental stone. The pebbles when polished find a ready sale among the tourists who frequent that region. The green which Peckham and Hall described as lintonite, an uncrystalline green variety of thomsonite, often forms the centre or band, making an effective gem stone, and is sold for the same purposes.

ILMENITE.—The ilmenite in the parish of St. Urbain,* at Baie St. Paul, sometimes contains grains of a greenish triclinic felspar, and would furnish an ornamental stone similar to the porphyritic menaccanite found at Cumberland, Rhode Island. It also contains rutile crystals, too small, however, to have value as gems, though adding to the beauty of the material when polished.

LAPIS LAZULI.—Lapis Lazuli is specially mentioned in nearly all the early government grants as one of the gem stones reserved for the Crown, but as yet it has not been observed at any North American locality.

NATROLITE.—Natrolite is found in stout crystals with other zeolites at Peter's Point and other localities on the Bay of Fundy,* and at Swan's Creek, Cape Blomidon, and Partridge Island, N. S. When transparent, and of sufficient size, it is occasionally used as a gem to represent the initial N in sentimental jewelry.

APOPHYLLITE.—Apophyllite is often found along the coast of Nova Scotia on the Bay of Fundy,* principally at Cape d'Or, Isle of Haute, Partridge Island, and Swan's Creek just above Cape Blomidon, in magnificent crystals sometimes one inch or more across. It occasionally occurs on agate and amethyst in the trap rock, and would afford a minera-

logical gem, as the pearly lustre produces a curious effect like that of a fish's eye, hence the name ichthyophthalmite, or fish eye stone. The color is generally white, but occasionally the crystals have a rich green tinge.

MONAZITE: Hoffmann has described a part of a crystal from Villeneuve,*Ottawa Co., making this one of the most remarkable occurrences known. If transparent it would afford a hyacinth yellow gem, rather low in hardness.

APATITE.—This mineral, which has added so much to the mining industry of the Dominion, is found in greater quantity and in finer crystals than in any other country. The crystals are often of great size and perfection, one famous crystal from the Emerald Mine, at Buckingham,* Que., weighing 550 lbs. Magnificent crystals are found throughout Eastern Ontario, on the shores of Lake Clear,* several feet in length and of fine color; at Sebastopol* and elsewhere throughout Renfrew County,* and at Wakefield,* Templeton,* Portland* and Buckingham Townships,* Ottawa County, Que. The crystals are often partly transparent, and are of all shades of red brown, brick-red, and often rich, deep green, especially in Ottawa County, in which case they ought to have some of the uses of fluor spars as ornamental stones.

WILSONITE.—Wilsonite is found at Bathurst* and Burgess,* Ont., and Ottawa County,* Que., in masses of some size, associated with scapolite. The specimens are beautiful, the minerals often passing into each other. The rich, purplish-red color of this mineral, and the fact that it admits of a good polish, make it one of the most interesting of gem minerals.

FLUORITE.—Fluorite is occasionally found in purple crystals measuring several inches on a face, associated with and on the Lake Superior amethyst. Green and purple fluor often fills mineral veins in the Lake Superior region,* and veins in syenite opposite Pic Island, on the mainland. On an island near Gravelly Point, in a porphyry, it occurs in green octahedral crystals, with barite; in green cubes associated with calcite and quartz, at Prince's Mine, Ont., and in small, beautiful crystals near Hull,* Que. Fluor spar of a beautiful blue color is found at Plaster Cove, Richmond County, N.S., and also on the west side of the harbor of Great St. Lawrence, Nfld. Small purple crystals of great beauty are occasionally found on pearl-spar in the geodes at Niagara Falls, Ont., and elsewhere in the Niagara formation.* A green, compact variety occurs in white calcite associated with galena, in veins cutting the Potsdam sandstone at Baie St. Paul and Murray Bay, Que. This would work into an ornamental stone. It is frequently found all through the Laurentian rocks. When transparent, the various colors

are called purple (false amethyst), yellow (false topaz) and green (false emerald). It is rarely cut into mineralogical gems, but when compact, of good color, or beautifully veined, it is worked into vases, cups and other ornamental objects, known as Blue John, Derbyshire Spar, etc.

MALACHITE.—Malachite of gem value has not been found to any extent in Canada, although it occurs in nearly every locality where copper and its ores are obtained. It has been observed at Sutton,* Que.

AGALMATOLITE.—The agalmatolite found in Canada is not of such quality as to fit it for the uses of the Chinese figure stone.

JET.—Jet is found at Pictou, Pictou County, N.S., in fine pieces. It has been pretty much superseded in jewellery by black onyx, and the little now used is mined at Whitby, Eng., owing to its superior hardness, and the perfect facilities for working it there.

Further reference to this subject can be found in the following works:—"Remarks on the Mineralogy and Geology of the Peninsula of Nova Scotia, by Charles T. Jackson and Francis Alger, Cambridge, 1832, 4to., page 116; "Geology and Mineralogy of Nova Scotia," Abraham Gesner, Halifax, 1836, 8vo., page 272; "Catalogue of the Mineral Localities of New Brunswick, Nova Scotia and Newfoundland," from the American Journal of Science and Arts, II. Series, Vol. XXXV., 1863, page 8; "Mineralogy of Nova Scotia," by Henry How, Halifax, N.S., 1868, 8vo., page 217; "Geology of Canada—Report of the Geological Survey from its Commencement to 1863," Montreal, 1863, 8vo., page XXVII., 983; "The Mineral Resources of the Dominion of Canada," Ottawa, 12mo., page 72; "Descriptive Catalogue of a Collection of Economic Minerals of Canada at the Philadelphia International Exhibition," Montreal, 1876, 8vo., page 152; "The Woods and Minerals of New Brunswick at the Centennial Exhibition at Philadelphia," Fredericton, N.B., 1876, by L. W. Bailey and Edward Jack, 12mo., page 51; "Dana's Mineralogy," 5th Edition, 8vo., New York, page 827; "Descriptive Catalogue of a Collection of the Economic Minerals of Canada at the Colonial and Indian Exhibition, London, 1886," by the Geological Corps, Alfred R. C. Selwyn, Director, London, 8vo., 1886, page 172.

The writer is indebted for information to Messrs. E. Coste and H. P. Brumell, of the Canadian Geological Survey, Rev. Dr. Honeyman, of Windsor, N.S., and Mr. C. D. Nimms, the indefatigable mineral collector, of Philadelphia.

PYRITES AND SULPHURIC ACID.

The total production of pyrites for use in acid making in 1887 was 38,043 tons, valued at the mines at $171,194 at the average price of $4.50 a ton. Pyrites.

Compared with 1886, it is a decrease of 4863 tons, due to the fact that the force of Messrs. G. H. Nichols & Co. of the Albert Mines was not directed exclusively to extracting the ore, as they were extensively engaged during the year in building sulphuric acid works as well as a new crushing and concentrating plant, new shaft houses, new skip roads, etc.

The whole of the pyrites produced in 1887, which was as in the previous years mined at Capelton, Que., was exported to the United States. The following table (A) shews that the growth of this export from 1881 to 1886 was very rapid, and that Canadian pyrites have always been in great favor in the United States, where they form nearly 43 per cent. of all that is used; it also shows that the great industry of acid making from pyrites, which in Great Britain now consumes about 600,000 tons of pyrites yearly, is rapidly increasing in the United States, and it is evident that the result cannot fail to be a great development of Canadian pyrites mines, as there are many other deposits of the same class of ore, as at Capelton, known in the Eastern Townships. Exports.

EXPORTS OF CANADIAN PYRITES TO THE UNITED STATES, AND CONSUMPTION OF PYRITES IN THE UNITED STATES, FROM 1881 TO 1886.

TABLE A.

YEAR.	Exports from Canada to United States. Fiscal Years.	Consumed in United States. Calendar Years.
	Tons.	Tons.
1881	10,812	7,840
1882	23,980	32,368
1883	25,211	50,400
1884	26,000	72,800
1885	34,123	102,368
1886	47,410	125,440
Total	167,536	391,216

Proportion of Canadian Exports to total consumption in the United States for the six years, 43 per cent.

Imports. About 2000 tons of pyrites were imported in 1887 for acid making from the United States.

Sulphuric acid. The total quantity of sulphuric acid manufactured in Canada in 1887 was about 5,477,950 lbs., valued at theworks at about $70,609.

The quantity made in 1886 has not been ascertained exactly, but it it estimated that there was an increase in 1887 of about 50 per cent. This increase is likely to become larger this year on acconnt of the new Capelton chemical works started at the close of 1887.

Imports.

IMPORTS OF SULPHURIC ACID.

TABLE 1.

PROVINCE.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	55,743	$733	1,658,860	$26,233
Quebec	82,754	951	725,749	8,914
Nova Scotia	68,373	857	186,451	1,941
New Brunswick.....	139,644	1,589	138,264	1,484
Prince Edward Island..	2,045	24	.....	.....
Manitoba.....	194	4	197	4
British Columbia.....	15,678	531	21,402	634
Total.....	364,431	$4,689	2,730,923	$39,210

Great increase in consumption. The above table shows the imports in 1887 to have been between eight and nine times greater than in 1886 and, as above stated, the increase in the home production of acid was about 50 per cent. These facts prove a very much larger consumption of sulphuric acid in 1887 in Canada; and, as this acid is the basis of all chemical industries, it may be taken as a sure sign of a very brisk start in the development of these industries.

IMPORTS OF BRIMSTONE OR CRUDE SULPHUR.

TABLE 2.

PROVINCE.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	2,225,598	$24,046	1,097,882	$13,279
Quebec	626,005	9,797	776,237	11,698
Nova Scotia	170,571	2,641	371,625	5,566
New Brunswick	34,513	702	58,287	936
Prince Edward Island	929	20	1,752	36
Manitoba	370	11	941	27
British Columbia	5,393	179	1,818	74
Total	3,063,379	$37,396	2,308,542	$31,616

PYRITES DEPOSITS IN CANADA.

Quantity of Canadian pyrites used in the United States.

We have in Canada very important deposits of cupreous pyrites, in the Eastern Townships of Quebec. As shown by the statistical Table A. of page 81, these pyrites, from Capelton, P.Q., supplied, from 1881 to 1886 inclusive, 43 per cent of all that was used in the United States, notwithstanding that the transportation and duty charges from Canada to Brooklyn and New Jersey, where they are first treated, amounts to about $5.00 per ton. This shows what industrial standing Canadian pyrites has acquired in the United States, the reason being that, besides 40 per cent. of sulphur, there is also extracted from it from 3 per cent. to 4 per cent. of copper and from $3.00 to $4.00 of silver per ton. None of the American pyrites contain as much copper or silver, as may be seen by referring to the reports on the mineral resources of the United States published by the United States Geological Survey.

Comparison of the yield of Spanish and Canadian pyrites.

Comparing Canadian cupreous pyrites with those used in England, we find, according to the official "Mining and Mineral Statistics of Great Britain," that there were, during the three years, 1884, 1885 and 1886, 1,774,582 long tons of cupreous pyrites imported into Great Britain, principally from the famous Huelva district in Spain and Portugal, of a total value of £3,527,333 sterling; these, after roasting,

gave 1,217,811 long tons of burnt cupreous pyrites, which were treated for copper, silver and gold, and furnished 54,450 long tons of metallic copper and about $1,100,000 of gold and silver. This shows that there was saved from these pyrites a copper content of about 2·5 per cent. and a value of gold and silver of less than one dollar a ton, or very much less copper and silver than what is saved from Canadian pyrites.

A similar advantageous comparison could be made between Canadian pyrites and the pyrites used in France and Germany, so that it may be said that Canadian pyrites stand to-day the best in the world.

Capelton Mines

Canada can also provide very large quantities, as absolutely proved by the continuous production for the last ten years of many thousands of tons a year from one single vein on which are located the Hartford, Crown and Albert mines of Capelton. This vein is a strong one, and outcrops on the summit of a high flat hill for a length of about 3,000 feet in a north-east and south-west direction; it dips to the south-east with an angle varying from 50° to 60°. On it seven shafts have been sunk: one of these (the No. 5 Hartford Mine shaft continued by the Crown Mine shaft) is now about 1,600 feet deep, and another one (the Albert shaft), about 2,000 feet more to the north-east, is now about 850 feet deep. In both of these shafts, and in the adjoining workings, the vein has varied in width from two and three feet to fifty and sixty feet of massive pyrites, and immense stopes of great height can be seen there. The vein in shape is a succession of large, lenticular bodies of pyrites dipping in the vein to the north-east; it follows very nearly the direction of the Archæan hydro-mica schists in which it is found and with which it was contorted, disturbed and faulted after its formation. Its character as a vein is nevertheless well established by the way it often splits up into several branches across the schists, from the seams running in the walls from the main vein and by the gangues and minerals it contains, viz., quartz, iron pyrites, copper pyrites, mispickel and tetrahedrite. Dykes of diorite, with which eruptions the deposition of the pyrites may have been connected, are to be seen in several places along the outcrop of the vein on the top of the hill, and also all through the hill; this diorite has often been encountered in the workings forming the walls or right in the vein, as in No. 5 Hartford shaft between the 40 and 50 fathoms levels to the east of the shaft, and also in other places. Several slides or faults, with an east and west direction and a north-westerly dip, have been encountered in the shafts, throwing the downward portion of the vein up. Several dykes of columnar trap, of about the same direction as the vein and nearly vertical, have also been found to cut it, but not to throw it.

This vein is now actively worked by the owners of the Crown and Albert mines, who employ there about 300 men. As already mentioned, page 81, sulphuric acid works and a new large mining, crushing, concentrating and transportation plant have been put up during the year 1887 by Messrs. G. H. Nichols & Co., of Brooklyn, N.Y. now the owners of the Albert, Hartford and Capel mines.

Many other deposits of pyrites, very similar to the one just described, are known to exist in the Eastern Townships of Quebec, principally in the Townships of Ascot, Orford, Bolton, Sutton and Acton, and in the Counties of Megantic, Wolfe, Arthabaska and Shefford. Some of these deposits were worked extensively many years ago, but only for their copper, and the work was suspended at most of them on account of the great decline in price of that metal; but, from many of these deposits pyrites are obtainable that could be utilized also for acid-making and for the silver and gold they contain. Like those of Capelton we have no doubt that they would find a ready market not only in the United States but also in Great Britain, France or Germany where we are sure they could be made to supersede in a great measure the famous Spanish or Portuguese pyrites on account of their greater copper and precious metal contents, and of their easy burning for acid. Other deposits.

Other large deposits of pyrites are known in Canada, especially in Leeds, Lanark and Hastings Counties, and at Sudbury, Ont., and often contain nickel and cobalt. One of them, at Elizabethtown near Brockville, Ont., was worked for several years and furnished the sulphur to the Brockville Chemical Works. The pyrites in the Sudbury deposits, now being worked for the last two years, are unfortunately cupreous pyrrhotite or a mixture of magnetic iron pyrites and of copper pyrites, and are of very little use for acid-making, but they may be for their nickel and copper contents. The other Ontario deposits of the counties mentioned above are not cupreous, and their value, being thus consequently reduced to a minimum, is too small to permit of their being transported to the large manufacturing centres.

SALT.

The total marketed production of salt in 1887, according to direct returns very willingly sent to this office by the producers, was 60,173 tons, or 429,807 bbls. of 280 lbs., the value of which at the works was $166,394; this is the value of the salt alone; the value of the salt plus the packages used was about $241,605. The average price for the salt alone is thus shown to have been $2.76 per ton, or 38c. per barrel of 280 lbs.; this high average price is due to the fact that three or four of the producers obtain much higher prices than the other manufacturers, the average price of whose production varies between $2.00 and 2.50 per ton.

There were in 1887 seventeen producers in Ontario and one in New Brunswick, and they employed about 273 men. Compared with the preceding year the marketed production shows a decrease in 1887 of 2,186 tons, but an increase in the value of $6,012 for the salt alone exclusive of packages.

The following table of the yearly shipments of salt by the Grand Trunk Railway shows that they have not varied much since 1883:—

SALT SHIPPED BY RAIL—LAKE HURON DISTRICT—G.T.RY.

TABLE A.

Year.	Tons.
1883	35,961
1884	34,850
1885	39,600
1886	41,577
1887	36,311

Exports and Imports.

Tables 1, 2, 3 and 4, give the exports and imports of salt, and compared with the above statement of the production, indicate the total consumption of salt in Canada in 1887 to have been about 148,000 tons.

EXPORTS OF SALT.

TABLE 1.

PROVINCE.	1886.		1887.	
	Bushels.	Value.	Bushels.	Value.
Ontario	224,595	$16,816	153,475	$11,425
Nova Scotia	240	40	.....	.....
New Brunswick	90	25	570	101
Prince Edward Island	18	5	.....	.....
Total	224,943	$16,886	154,045	$11,526

IMPORTS OF COARSE SALT PAYING DUTY.

TABLE 2.

PROVINCE.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	855,000	$2,177	683,270	$2,110
Quebec	.....	.....	7,240	32
Nova Scotia	600	4	.....	.....
New Brunswick	.....	.....	2,260	9
British Columbia	10,336	38	72,000	368
Total	865,936	$2,219	764,770	$2,519

IMPORTS OF FINE SALT PAYING DUTY.

TABLE 3.

PROVINCE.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	688,211	$2,431	1,000,842	$ 3,349
Quebec	6,564,801	24,994	4,989,918	14,748
Nova Scotia	302,688	1,093	841,782	1,981
New Brunswick	1,800,890	6,177	1,662,300	5,110
Prince Edward Island	29,698	76	27,138	75
Manitoba	50,300	230	5,900	33
British Columbia	1,311,040	5,606	561,100	3,468
Total	10,747,628	$40,607	9,088,980	$28,764

IMPORTS OF SALT (DUTY FREE) FOR FISHERIES.

TABLE 4.

PROVINCE.	1886.		1887.	
	Pounds.	Value.	Pounds.	Value.
Ontario	6,230,657	$ 10,159	1,668,942	$ 2,765
Quebec	60,465,880	79,687	69,118,737	92,194
Nova Scotia	103,153,827	140,458	81,982,510	112,031
New Brunswick	30,679,640	49,519	28,207,140	42,300
Prince Edward Island	7,199,160	8,165	4,578,787	2,626
Manitoba	133,168	935	252,100	998
British Columbia	672,000	1,458	1,038,452	2,479
Totals	208,534,332	$290,381	186,846,668	$255,393

SILVER.

Summary. The total production of silver in 1887 is estimated to have been $349,330; that is to say, there were about 349,330 ozs. of silver contained in the silver ores and bullion shipped from Canada during the year.

Comparison. Compared with 1886, it is an increase of $140,240, due principally to the rich bodies of silver ore struck at the Beaver Mine, Port Arthur District, in the month of March, 1887. Three of the other mines in the

By districts. Port Arthur District—the Silver Mountain, Rabbit Mountain, and Porcupine Mines—also shipped small quantities of ore during the year, and the total shipments from the district amounted to $190,495. In British Columbia, the Lanark Mine of Illecillewaet made it first shipment in 1887; and it is estimated that about 146,898 ozs. of silver were extracted from the copper pyrites shipped to the United States from the mines of Capelton, Eastern Townships, Quebec.

Exports. The following table, taken from the books of the Customs Department, gives the exports of silver ore in 1887 from the provinces where the outward shipments were made at the Customs offices:—

EXPORTS OF SILVER ORE.

TABLE I.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	29¼	$16,505	234	$184,763
Quebec	17½	8,000	?	450
Manitoba	11	1,452	⅛	3,741
British Columbia	...	.....	237	17 331
Totals	.....	$25,957	.....	$206,284

THE MOST IMPORTANT NEW DEVELOPMENTS IN THE PORT ARTHUR SILVER DISTRICT IN 1887.

The year 1887 was a very successful year for the silver district south-west of Port Arthur, and, as shown by the statistics, the production of silver in that district has been very much greater than that of the last eight or nine years. The strike of a large body of very rich ore at the Beaver Mine, in the month of March of that year, proved that the famous Silver Islet was not the only rich mine in that district; a fact already known to many but which was none the less more forcibly established and more widely recognized when the wonderful reports of richness from the Beaver Mine were duly authenticated. The interest prospectors and capitalists took already in that region, not only on account of the old mines but also of the more recent discoveries in the Rabbit Mountain and Silver Mountain districts, was at once very much increased; very great activity was soon noticed at Port Arthur and throughout the whole district and lasted during the remainder of the year. The last steps were also taken in 1887 to provide for the construction of a railway through these new silver districts: the surveys were completed, and all financial and other arrangements concluded, so as to start the work early in the following year.

Date of examination and mines working.

Our examinations in the district were made at the end of July and the beginning of August. The mines† then in active work were the Jarvis Island Mine, the Beaver Mine, the Rabbit Mountain Mine, the Badger Mine, and the Silver Mountain Mine; there was besides a

† See map accompanying Mr. Ingall's report—Part II, annual report 1886—for location of these mines.

great deal of exploratory work being done all through the region and openings were being made at some of the new locations showing very encouraging and good veins containing rich ores. After examining all the working mines, except the Jarvis Island Mine, we had witnessed very promising developments at some of them, and were convinced of the truth of the reports of the very rich strike at the Beaver Mine. In the following notes the most important facts observed at the principal mines are summarised.

Beaver Mine underground developments.

Beaver Mine.—At the Beaver Mine the underground development work was found to consist of:—†two shafts Nos. 1 and 2, respectively 135 and 108 feet deep, and of three levels drifted in the vein and opening a total length on the vein of about 770 feet. There were, besides, other developments made in search of the veins consisting of:—a gallery about 400 feet long drifted in the foot wall of the vein, a cross-cut about 330 feet long, and a winze about 125 feet deep sunk from the cross-cut.

Bodies of ore and value of the ore.

The large ore body ‡ was first struck between No. 1 and No. 2 on the three levels, and was found to extend in the adit level as far S.E. (the vein is about N.W.—S.E. and dips to the S.W.) as No. 2 shaft; but the richest ore was towards its western limits, where, in the adit and No. 2 levels and in stope D, there had been obtained at the time of our visit, besides the mill rock, about 100 tons of selected ore, of an average assay value of $1,500, some assays going as high as $15,000 to the ton. The mill rock so far had averaged about $40 to the ton, and during our stay in the district its average assay value varied between $50 and $80. Besides this large body of rich ore, several smaller ones had been encountered at other places in the mine, in stopes A, B, and C shown on the vertical section referred to in note on page 89. As will be noticed by studying the plan and section above referred to, the adit level enters the hill in the hanging wall of the vein, and only reaches the vein a little before the stope C, where good ore was found, and where there was a good massive vein of about 3 feet; the vein then suddenly pinched out and entirely disappeared it may be said for a distance of about 240 feet from the stope C to the south east; the black slates composing the walls are locally disturbed there and have evidently filled that part of the fissure; the vein suddenly opened again and remained well open with a varying width of vein matter of from 2′ to 4′ 6″ as far as shaft No. 2 on that level; there, as stated above, the richest ore was found especially in the first 90 feet nearest

Thickness of the vein and description. Adit level.

† See plate VIII. of plans and sections—Part H. annual report, 1886.

‡ The line showing its western limit on the vertical section referred to in note on page 89 is a little too near shaft No. 1, especially at the No. 2 level, where it should be brought back to the right or south-east about 40 feet.

to shaft No. 1. The following is a section taken across the vein in the "Bonanza" at about 200 feet north-west from shaft No. 2.

Hanging Wall—Black Shales.

1′ to 1′ 6″ of very rich ore.	Composed of a first streak on the hanging wall of amethyst quartz, then another of white calcite with dark blende and galena, then another of white calcite with native silver and argentite.
About 2′	Of a decomposed soft slate with little stringers of white calcite through it.
3′ 6″ of mill rock.	Composed of quartz, calcite, blende, pyrites, argentite, and native silver.

Foot Wall—Black Shales.

To the south-east of shaft No. 2 in the adit level, the vein is split into two small veins of about 1 foot each by a "horse" of shales 4′ or 5′ wide.

No. 2 level. In No. 2 level a corresponding dead ground to the one in the adit level below exists between stopes B and D; the shales there dip strongly to the south-west, filling the old fissure of the vein; after that the vein opens in good ore and at the S.E. face was 2′ 6″ massive with quartz on both walls and calcite in the middle, the minerals being distributed in both gangue stones.

No. 1 level. In No. 1 level the vein was strong and well defined in the whole ground opened, varying between 2′ and 4′ 6″ massive veinstone and ore; in the part of the level through the rich ore body there was always also some soft decomposed slates sometimes in the vein and other times either on the foot or the hanging wall; outside of the ore bodies and in the poor ground the veinstones, calcite and quartz, are coarsely crystallised.

Other veinstones and minerals in vein. Apart from the gangues already mentioned in the section given above, there was often to be found all through the ore, and principally where it was the richest, a great deal of a very white, soft, unctuous silicate of magnesia, and often some fluor-spar; besides the native silver, argentite, dark colored blende, galena and yellow pyrites already mentioned, there was also noticed in the vein some other minerals such as brittle silver and pyrrhotite. The argentite was often noticed as a pseudomorph of crystals of quartz or calcite, indicating for the silver a subsequent deposition to the gangues in the solid state.

Mill and outside developments. The mill was not quite completed, but was already a substantial one, capable of crushing between 30 and 45 tons a day. It is situated at the end of a tramway at a little more than 2,000 feet from the mine, and on the banks of Silver Creek. The principal machinery was:—

CRUSHING PLANT:—

One large Blake crusher (capacity 10 tons per hour) for the mill rock.

One small Dodge crusher (capacity 1½ tons per hour) for sampling and crushing the selected ore.

One double Worthington pump 10 x 12 (capacity 12,000 galls. per hour.)

Two batteries of 5 stamps, fed automatically, 850 lbs. head, 100 strokes per minute, 6 in. drop.

CONCENTRATING PLANT:—

Four Frue vanners.

One Goldengate concentrator, with a Sturtevart aspirator No. 3.

One Krauss concentrator.

AMALGAMATING PLANT:—

Two 5 feet pans.

One 7 feet settler with a canvas filter, an amalgam safe and a small settler to clean the amalgam.

STEAM PLANT:—

One cylinder engine 22 x 24 of 150 horse-power, with a 7 ton fly-wheel 12 feet in diameter, and a Northey feed pump.

Two 66 inches boilers 16' long with a 30 inches mud drum, a 30 inches water drum 15 feet feet long, 1 steam dome 9 feet x 30 inches, 1 copper flue heater 9 feet x 36 inches, and a 4 feet smoke stack 75 feet high.

The putting up of ten more stamps, four more pans and two more settlers was being proceeded with, as well as the construction of another assay office and of a furnace to evaporate the mercury from the amalgam.

The mining machinery consisted of a two-flue boiler 20 feet by 4, furnishing steam to a Burleigh air compressor No. 4, of a capacity of seven No. 2 Rand drills, with an air receiver of 20 feet x 4 feet, and a 6 inches air pipe; this gave the compressed air to the drills, and to a Copeland and Bacon hoisting engine, 6-in. cylinder, on No. 2 shaft. Other necessary surface plant and houses such as saw-mill, machine repair shop, blacksmith shop, boarding-houses, office, store, etc., were also partially built or being completed; when the mine was first worked in 1885, the place was a perfect wilderness in the woods, and everything had been provided for and built since.

Rabbit Mountain underground developments.

Rabbit Mountain Mine.—The developments at this mine during the year 1887, were small and brought about nothing new. One shaft only, No. 2*, had been sunk below the first level (the 80-feet level) and was, at the end of July 1887, about 270 feet deep, and from that shaft 3 levels, below the 80-feet level, had opened only about 180 feet of

* See Plate VII. part H. annual report, 1886.

ground on the vein, viz.: about 115 feet to the N.E. of the shaft on the second level and about 65 feet to the S. W. of the shaft on the third level; so that it will be seen that the explorations below the 80-feet level are very small yet and cannot consequently prove or indicate much. No. 1 level or the 80 feet level was about 370 feet long. There was besides some work done on what appears to be a branch of the main vein outcropping about 100 feet to the N. W.; the extent of that work can be seen by reference to Plate VII. above mentioned.

Situation of bodies of ore.

Good ore containing a good deal of argentite was found:—in stopes C. D. and E., in shaft No. 2 just below the No. 2 level, in the sump of that level, also in No. 4 level southwest and in the bottom of the shaft just below that level.

Size and description of vein. No. 4 level.

The section at the face of No. 4 level was:—

Hanging wall—black shales.
About 1′ 6″ of quartz and calcite.
About 2′ of slickensided slates often impregnated with argentite.
About 1′ of good ore composed of galena, light colored blende and argentite in calcite.
Foot wall—black shales, smooth, well separated from vein matter.

No. 3 and No. 2 levels.

The northeast face of that level was entering a dead ground in the vein already met in No. 3 and No. 2 levels, about 70 feet N.E. from the shaft, and there was only at that face 6″ of vein matter along a good foot wall. At the faces S.W. of No. 3 and No. 2 level the vein was about 4 feet wide, massive, composed of a poor ore almost wholly made up of large crystals of calcite and quartz.

Shaft. No. 1 level. Outcrop.

Between No. 2 and No. 1 level in the shaft the vein pinches out and is very small, when it re-opens again to from 2 to 4 feet of a well banded vein of coarse calcite and quartz in No. 1 level. In stopes C. D. and E. very rich nuggets of argentite were obtained. Some 500 feet S. W. of No. 2 shaft an opening shows the vein to be about 5 feet, strong and massive and to be composed of calcite with a little fluor spar, blende and galena.

The vein, apart from the gangues and minerals mentioned above, was also noticed to contain some fluor spar, baryta and iron pyrites.

Mill and hoisting machinery.

The mill consisted of a small Blake crusher, 5 stamps, 2 Frue vanners, 4 settling tanks, 2 pans, one settler, one small settler for cleaning the amalgam, one amalgam safe and one engine and boiler.

At the time of our visit a new large two cylinder hoisting engine had just been received from the Iron Bay Manufacturing Co., Marquette, Mich., and preparations were being made to replace by it the old small hoisting engine in use so far.

Badger Mine.—The developments at this mine were very small but very promising indeed, showing, as they did, rich ore and a good vein.

They consisted of a cut through about 120 feet of boulder clay, and of a tunnel at the end of that cut running in the vein through the black slates just under a trap hill. This tunnel, at the time of our visit, was only about 25 or 30 feet long, and showed at the face a vein about 2 feet wide: 1′ 6″ of calcite on the foot and about 6″ of quartz on the hanging wall. In the trap just above the tunnel the quartz and calcite were separated into two well defined small veins. The direction of the vein in the tunnel is 36° east of north magnetic, and its dip appears to be S. E., but it was nearly vertical as far down as the tunnel and could not be clearly detected. The minerals and gangues observed in the vein were native silver, argentite, galena, dark colored blende, fluor spar, quartz and calcite; native silver and argentite were only seen in the quartz, the galena and blende were observed in both gangues. The slates at the hanging-wall at the entrance of the tunnel were impregnated with blende, galena and argentite.

There were no surface developments of any account, but we understand that a mill has since been built.

Porcupine Mine.—Work had been suspended at this mine but was, I understand, soon to be started again.

The underground work consisted of 4 short levels and one stope on the west side of the hill and of a small shaft, 60 feet deep, on the east side of the hill, some 600 feet from the centre of the other workings.†

The mean direction of the vein is about 70° east of magnetic north, and it dips a little to the south, but is almost vertical; its width varies between one foot and three feet, and considerable argentite or silver glance has been obtained, and can be seen in the roof and faces of the four levels driven in the slate. The slates are often impregnated with it. Through the trap in the shaft there was no silver in the vein, but there was a little galena and blende. A little native silver has also been obtained, and the gangues are exactly the same as at the other mines, viz., calcite, quartz and fluor spar; argentite has also been observed there as pseudomorphs after quartz. As the shaft was full of water, I could not ascertain if silver was found at the bottom where it enters the slates, but I believe some was found, as I was informed.

No machinery or outside developments of any consequence as yet.

Silver Mountain Mine.—Work had been pushed with vigor at this mine, and quite a little underground development done at the end of July 1887, consisting of three shafts, each about 120 feet deep, two

† See Plate VII, Part H., annual report, 1886.

levels each about 600 feet long, two winzes and several pits; the adit level is about 200 feet below the mouth of the shafts, and No. 3 shaft is about 820 feet west of No. 2 shaft.†

The vein cuts across Silver Mountain in an east and west direction (or, more properly, about 72° east of magnetic north is the mean direction of the vein between No. 1 shaft and No. 3 shaft, but it curves to the north between No. 1 shaft and No. 3 pit), dips north, and occupies a well-marked line of fault, with a downthrow of the hanging wall of about seventy feet, as evidenced by the junction of the trap and slates being found on the hanging wall of the vein in No. 1 and No. 2 shafts at ninety feet from the surface instead of twenty feet as on the foot wall.

Bodies of rich ore.

Rich ore was found in several small bunches at different places in the eastern part of the mine and generally along the foot wall:—in No. 4 pit and in the drift below from that pit, in the two stopes above No. 2 level, and in No. 2 shaft at about sixty-five feet down. Good ore (pieces of which assayed $90 to the ton) was also found in No. 3 shaft at the depth of about seventy feet.

Size of the vein.

The vein is a long one, and of good width as a rule, notwithstanding that the thickness is very variable and almost nothing in some places.

No. 2 level.

In No. 2 level, in nearly the whole of the ground opened, there is a total width of about five or six feet of veinstone, generally separated into several seams as at the west face of that level where the following section was obtained from the hanging to the foot wall:—

1′ 6″ of quartz, calcite and fluor-spar.
2′ of slates.
2′ of quartz, calcite and fluor-spar.
1′ 6″ of slates.
3′ of fractured slates, all impregnated with vein matter.

No. 2 shaft. No. 3 shaft.

In No. 2 shaft, the width all the way down varied between three and six feet; and in No. 3 shaft it was seven feet wide at the start, a few inches only at sixty-five or seventy feet down, and about two feet six inches again at the bottom, 120 feet.

No. 1 level or adit level.

No. 1 drift is in dead ground all the way, that is to say, the fissure is almost completely filled up with slates, except about sixty feet around the first winze sunk below the adit, where there is a very brecciated vein of about two feet, and except the last fifteen feet near the face where there was about one foot of brecciated vein.

Composition of the vein.

The gangues forming the vein are calcite, quartz (white and amethystine) and fluor spar. The following minerals are disseminated through these veinstones:—light-colored blende, galena, iron pyrites, argentite and native silver.

† See Plate IX., Part H., Annual Report, 1886.

Mining plant.

No mill had yet been put up at the Silver Mountain Mine, and the mining plant consisted of the following machinery, viz. :—one small air compressor, capable of running three No. 1, Rand drills, and fed by a tubular boiler of thirty horse-power, and one hoisting engine of two 12-inch cylinders, with a 4 feet drum, fed by a twenty horse-power tubular boiler, on No. 3 shaft.

Other veins discovered and worked a few years ago.

A great many other veins of precisely the same nature were discovered all through that district; they contain exactly the same minerals and veinstones, and are exactly in the same geological conditions, that is :—they cut through the cherts, black slates and traps of an horizontal series, the Animikie, resting unconformably on the Archæan rocks. Some of these veins were a little worked, and at many places rich ores were obtained, as we had occasion to ascertain ourselves at some of them. It is unnecessary here to mention them all as their progress will be followed when they become more developed.

New discoveries last year.

Numerous and important new discoveries were made also during the summer of 1887, and have further extended the area of Animikie rocks in which silver-bearing veins were already actually known to occur. We have ascertained this to be a fact by going ourselves to Atik Lake (five or six miles west of Whitefish Lake, and about two miles north of the east end of Arrow Lake) and there we saw that good ores, containing rich black blende and some argentite, had been found in four different veins, and also that some native silver had been obtained in one of them; the veins were several feet wide and in exactly similar geological and other conditions as those described above.

Conclusion.

We think that every one will now admit what we have said in the beginning of this article, viz :—that the year 1887 was a very successful one for the Port Arthur Silver district; and, to conclude briefly, we will say that the recent developments in that region, principally those of 1887, have again brought it forward before the eyes of the public, as it was at the time of the discovery and of the working of the Silver Islet and the other old mines, as a region containing a great number of very well-defined veins containing very rich silver ores; and everybody understands now that it only needs, no doubt in many cases, active work and the help of capital to develop these veins into rich mines. We know also now that these veins will be found all through the area occupied by the Animikie rocks, which the researches of Messrs. Ingall and Lawson, of the Geological Survey, have proved to extend as far west as Gun-Flint Lake, and to occupy about 1,500 square miles, the greater part of which is still unexplored.

STRUCTURAL MATERIALS.

Granite.—The total production in 1887 as reported directly to this office, was 21,217 tons, valued in the rough state at the quarries at $142,506. It is an enormous increase over 1886 of 145 per cent. in the three provinces of Ontario, Quebec, and New Brunswick; we cannot say as to Nova Scotia as we had not the figures for that province last year; this increase speaks for itself, and demonstrates how much the granites from Kingston and from St. George, N.B., which are worth from $10.00 to $18.00 per ton at the quarries, are becoming appreciated. Granite.

The production by provinces was as follows:— Production by provinces.

Ontario	7,663 tons.	$ 73,800
New Brunswick	6,681 "	48,281
Nova Scotia	6,289 "	15,125
Quebec	584 "	5,300
Total	21,217 tons.	$142,506

In New Brunswick, besides the very valuable granite from St. George, (worth about $1.00 per cubic foot in the rough state) there was also a large quantity of gray granite quarried at Hampstead, Queen's Co., for structural purposes, and of less value.

A good deal of Canadian granite is polished and manufactured for ornamental and monumental purposes in the country. The exact quantity thus manufactured and marketed during the year could not be ascertained but is estimated to have been about 3,500 tons, sold for about $350,000. Manufactured article.

Marble and Serpentine.—The production, as far as returned from three quarries, was 242 tons valued, in the rough state but quarried to sizes, at about $6,224. This is not a complete statement of the total production. Marble and serpentine.

The value of the imports of marble, and manufactures of stone or granite N.E.S. (as classified in the returns of the Customs Department) will be found in the following tables 1 and 2:— Imports.

VALUE OF IMPORTS OF MARBLE.

TABLE 1.

Provinces.	1886.		1887.	
	Blocks.	Slabs.	Blocks.	Slabs.
Ontario	$1,879	$44,330	$2,205	$37,468
Quebec	414	21,073	1,581	21,259
Nova Scotia	736	5,637	2,060	7,520
New Brunswick	737	6,420	306	6,376
Prince Edward Island	.....	2,683	106	1,891
Manitoba	12	78	.....	110
British Columbia	.....	1,147	226	1,850
Total	$3,778	$81,368	$6,484	$76,474
	Blocks.	3,778	.....	6,484
Totals	.....	$85,146	.....	$82,958

VALUE OF IMPORTS OF OTHER ORNAMENTAL STONES.

TABLE 2.

Manufactures of Stone or Granite, N.E.S.	1886	1887
Ontario	$28,695	$15,253
Quebec	8,425	3,286
Nova Scotia	1,037	491
New Brunswick	1,058	465
Prince Edward Island	443	117
Manitoba	373	1,059
British Columbia	1,052	940
Total	$41,083	$21,611

Slate.

Slate.—The production of slate in 1887 was 7,357 tons which where valued manufactured at the quarries at $89,000 ; it is an increase over 1886 of a little more than 2,000 tons and was also all quarried in the province of Quebec.

Flagstone.—The returns of flagstone received amount to a production of 116,000 square feet with a value at the quarries of about $11,600; the great bulk of this is from Dudswell, Quebec. Flagstone.

The tables of exports and imports of slate and flagstone are appended. Exports and imports.

EXPORTS OF SLATE FOR LAST FOUR YEARS.

TABLE 3.

Year.	Quebec.		Nova Scotia.	
	Tons.	Value.	Tons.	Value.
1884.....	539	$6,845	.....	.....
1885.....	346	5,274	.....	.....
1886.....	34	495	.....	.....
1887.....	27	373	22	$880

IMPORTS OF SLATE.

TABLE 4.

Province.	1886	1887
Ontario	$16,253	$17,299
Quebec.....	8,071	2,211
Nova Scotia.....	1,438	927
New Brunswick.....	3,130	3,909
Prince Edward Island	182	88
Manitoba	329	191
British Columbia	289	589
Total.....	$29,692	$25,214

IMPORTS OF DRESSED FLAGSTONES.

TABLE 5.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	1,494	$11,513	2,531	$20,233
New Brunswick.....	.....	.....	1	36
	1,494	$11,513	2,532	$20,269

Building stone.

Building Stone.—We have received many more returns this year, their number being 129 instead of 94 received last year; and the recorded production of 1887 is nearly 100,000 cubic yards more than what was returned in 1886. This simply demonstrates that the 1886 returns of building stones were unfortunately very incomplete owing to the short time then available for collecting addresses of the producers; the value also was over-stated in the returns, and included probably a great deal of freight costs. Though the returns for 1887 are much improved, they are still incomplete, and every producer is earnestly requested to send in his address before the end of the year, and thus render possible a complete record for 1888.

PRODUCTION OF BUILDING STONE IN 1887.

As returned to this office, and estimated to be three to four-fifths of the total production.

TABLE 6.

PROVINCE.	No. of Returns.	Cubic Yards.	Value.
Ontario	70	184,426	$343,046
Quebec	16	41,251	72,958
Nova Scotia.....	About 25	22,328	68,682
New Brunswick.....	8	6,871	52,901
Prince Edward Island....	4	1,536	2,700
Manitoba.....	3	3,052	5,050
British Columbia.....	1	1,000	1,500
North-West Territories..	2	2,128	5,430
Total	About 129	262,592	$552,267

The following exports and imports tables of stone are given as classified by the Customs Department; the marble could not be separated from other stones. Exports and imports.

VALUE OF EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

TABLE 7.

PROVINCE.	1886.		1887.	
	Wrought.	Unwrought.	Wrought.	Unwrought.
Ontario	$ 103	$27,922	$ 17	$ 4,490
Quebec.....	1,206	.....	670	.....
Nova Scotia.....	121	18,377	425	24,476
New Brunswick..	18,596	26,954	12,827	24,925
British Columbia.	.....	.....	70	95
Total	$20,026	$73,253	$14,049	$53 986

IMPORTS OF DRESSED FREESTONE AND ALL OTHER BUILDING STONE.

TABLE 8.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	777	$5,108	?	$3,189
Quebec	5	185	11	74
New Brunswick.....	2	10	.....	.....
Prince Edward Island	.....	.....	.....	2
British Columbia ...	.....	.....	240	148
Totals	784	$5,303	.....	$3,413

IMPORTS OF ROUGH FREESTONE, SANDSTONE AND BUILDING STONE.

TABLE 9.

PROVINCES.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	7,499	$39,282	6,384	$47,610
Quebec	202	1,909	2,649	22,014
New Brunswick.....	25	453	25	254
Totals.....	7,726	$41,644	9,058	$69,878

Lime

Lime.—The same remarks that were made for the building stone apply to the lime returns; 133 returns were received instead of 87 last year, and the value is $100,000 more than the total value arrived at last year. About four-fifths of the total production is now estimated to have been returned.

Cement.

Cement.—The compilation of seven returns received from cement works gives the following result which is believed to be very nearly a complete record :— 69,843 bbls., valued at the works at $81,909.

PRODUCTION OF LIME IN 1887, AS RETURNED TO THIS OFFICE.

TABLE 10.

PROVINCES.	No. of returns.	Bushels.	Value.
Ontario	78	1,239,451	$178,153
Quebec.....	21	424,316	79,137
Nova Scotia	10	49,400	11,442
New Brunswick	13	478,410	103,463
Prince Edward Island.	3	30,280	8,214
Manitoba	5	32,800	8,500
British Columbia.....	1	10,080	2,688
North-West Territories	2	4,350	3,262
Totals.....	133	2,269,087	$394,859

EXPORTS OF LIME AND CEMENT.

TABLE 11.

PROVINCES.	Value.
Ontario	$4,269
Quebec	83
Nova Scotia	142
New Brunswick	77,518
Manitoba	4
British Columbia	241
Prince Edward Island	4
Total	$82,261

IMPORTS OF LIME AND CEMENT FOR THE YEAR 1887.

TABLE 12.

PROVINCE.	Bbls.	Value.
Ontario	4,379	$3,487
Quebec	3,441	2,501
Nova Scotia	450	407
New Brunswick	46	44
Manitoba	904	791
British Columbia	700	860
Total	9,920	$8,090

IMPORTS OF HYDRAULIC CEMENT.

TABLE 13.

PROVINCE.	1886.		1887.	
	Bbls.	Value.	Bbls.	Value.
Ontario.....	3,553	$3,408	3,505	$3,705
Quebec	1,414	2,119	46	163
Nova Scotia	9	15	31	70
New Brunswick.....	1,576	1,840	1,476	2,054
Prince Edward Island	25	31	.....	.....
British Columbia....	564	1,896	35	136
Total.....	7,141	$9,309	5,093	$6,128

IMPORTS OF CEMENT IN BULK OR IN BAGS.

TABLE 14.

PROVINCE.	1886.		1887.	
	Bushels.	Value.	Bushels.	Value.
Ontario	4,520	$1,134	6,029	$1,554
Quebec	918	470	.....	.....
Nova Scotia	.....	.....	18,666	4,456
Total.....	5,438	$1,604	24,695	$6,010

IMPORTS OF PORTLAND CEMENT.

TABLE 15.

PROVINCE.	1886.		1887.	
	Bbls.	Value.	Bbls.	Value.
Ontario	.....	$ 5,049	5,705	$ 7,761
Quebec	.....	131,238	98,760	139,409
Nova Scotia	.....	5,900	6,911	11,124
New Brunswick	.....	2,999	2,846	4,307
Prince Edward Island	.....	290	123	186
Manitoba	.....	3	.....	.....
British Columbia	.....	3,358	2,515	6,682
Total	.....	$148,837	116,860	$169,469

Sand and Gravel.—The exports and imports alone have been ascertained through the Customs returns. Sand and Gravel.

EXPORTS OF SAND AND GRAVEL.

TABLE 15.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	124,662	$23,902	180,699	$29,470
Quebec	.....	.....	.....	22
Nova Scotia	200	200	161	815
New Brunswick	3	124	.....	.....
Total	124,865	$24,226	180,860	$30,307

IMPORTS OF SAND AND GRAVEL.

TABLE 16.

PROVINCE.	1886.		1887.	
	Tons.	Value.	Tons.	Value.
Ontario	11,298	$15,002	10,361	$16,956
Quebec	5,794	6,191	6,586	7,931
Nova Scotia	1,307	4,015	1,264	4,271
New Brunswick	906	1,120	1,014	1,300
Manitoba	30	83	15	40
British Columbia	27	45	1	10
Total	19,362	$26,456	19,241	$30,508

Bricks and Tiles.

Bricks and Tiles.—The same remarks as above for building stone and lime apply here also; 26 more returns were received this year for bricks and 13 for tiles, and the proportion of the returns to the total production is now believed to be about three-fourths.

Miscellaneous clay products.

Fifteen returns were also received of $182,150 worth of miscellaneous clay products manufactured in 1887, such as glazed sewer pipes, pottery, ornamental bricks, fire bricks, bath bricks, pressed artificial stone and carbonized drain tiles.

PRODUCTION OF BRICKS DURING 1887, AS RETURNED TO THIS OFFICE.

TABLE 17.

PROVINCE.	No. of Returns.	Thousands.	Value.
Ontario	222	149,821	$778,757
Quebec	25	13,820	80,117
Nova Scotia	15	6,981	43,311
New Brunswick	11	6,476	43,454
Prince Edward Island	6	1,328	9,145
Manitoba	4	835	8,125
British Columbia	2	2,020	19,480
North-West Territories	2	300	4,300
Total	287	181,581	$986,689

PRODUCTION OF TILES DURING 1887, AS RETURNED TO THIS OFFICE.

TABLE 18.

PROVINCE.	No. of Returns.	Thousands.	Value.
Ontario	88	14,456	$226,546
Nova Scotia	2	45	435
New Brunswick	5	157	3,087
Total	95	14,658	$230,068

IMPORTS OF BUILDING BRICK. Imports.

TABLE 19.

PROVINCE.	1886.		1887.	
	Thousands.	Value.	Thousands.	Value.
Ontario	213	$1,269	173	$1,861
Quebec	119	1,133	1,620	13,444
Nova Scotia	2	11	.....	82
New Brunswick	13	59	21	64
Prince Edward Island	3	57	.....	.....
Manitoba	.....	.....	1	18
British Columbia	.....	.....	165	33
Total	350	$2,529	1,980	$15,502

IMPORTS OF DRAIN TILE AND SEWER PIPE, GLAZED.

TABLE 20.

PROVINCE.	1886.	1887.
Ontario	$45,706	$71,424
Quebec	8,510	16,041
Nova Scotia	.....	554
New Brunswick	979	914
Prince Edward Island	16	.....
Manitoba	506	809
British Columbia	654	638
Total	$56,371	$90,380

IMPORTS OF FIRE-CLAY.

TABLE 21.

PROVINCE.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	20,750	$5,033	23,822	$7,285
Quebec	78,863	10,273	130,959	17,861
Nova Scotia	2,152	704	3,014	1,106
New Brunswick	780	84	3,675	312
Prince Edward Island	90	27	86	36
Manitoba	240	120	240	120
British Columbia	750	330	1,474	724
Total	103,625	$16,571	163,270	$27,444

IMPORTS OF FIRE BRICKS, TILES, ETC.

TABLE 22.

PROVINCES.	1886.	1887.
Ontario	$23,887	$21,221
Quebec	25,903	31,240
Nova Scotia	4,216	687
New Brunswick	6,735	7,778
Prince Edward Island	41	263
Manitoba	79	178
British Columbia	1,226	962
Total	$62,087	$62,329

IMPORTS OF CLAYS, ALL OTHER N. E. S.

TABLE 23.

PROVINCES.	1886.		1887.	
	Cwts.	Value.	Cwts.	Value.
Ontario	16,369	$3,238	15,433	$5,502
Quebec	12,787	1,553	1,245	473
New Brunswick	13,203	279	1,044	233
British Columbia	.....	.....	.....	3
Totals	42,359	$5,070	17,722	$6,211

IMPORTS OF EARTHENWARE.

TABLE 24.

ARTICLES.	Value.
Brown and colored Earthen and Stoneware and Rockingham ware...	$ 29,563
Decorated, printed or sponged, and all Earthenware, N. E. S.....	171,836
Demijohns or jugs, churns and crocks	6,448
Totals	$207,847

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA,

FROM THE

LABORATORY OF THE SURVEY,

BY

G. CHRISTIAN HOFFMANN, F. Inst. Chem., F.R.S.C.,
Chemist and Mineralogist to the Survey.

ASSISTANTS:

F. D. ADAMS, M.Ap.Sc.
E. B. KENRICK, B.A.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL:
DAWSON BROTHERS.
1888.

To ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S.,
Director of the Geological and Natural History Survey of Canada.

SIR,—I beg to submit, herewith, my report upon the work carried out in the Laboratory of this Survey during the past year. As will be seen, this was purely of a practical character, it having been confined exclusively to the examination of such minerals, etc., etc., as promised to prove of economic importance. During the period in question, some six hundred and ninety-eight mineral specimens were received, either for identification, for information in regard to their economic value, or for analysis or assay. The results obtained were in a large number of instances of no great interest, save to those immediately concerned, and have, therefore, not been incorporated in the present report, which embraces only such examinations, analyses, or assays, as were considered likely to prove of general interest.

Mr. F. D. Adams has—with the exception of about three and a-half months during the summer, when he was engaged in field-work—in the capacity of Assistant Chemist, rendered good service, and Mr. E.B. Kenrick worked faithfully and diligently as Junior Assistant Chemist, up to the end of August, when he left to accept an appointment at St. John's College, Winnipeg. His successor, Mr. R. A. A. Johnston, has also assisted in some of the work herein recorded.

Such examinations or analyses as were carried out by these gentlemen have, in all instances, been duly credited to them: those not otherwise designated, having been made by myself.

I have the honor to be,

Sir,

Your obedient servant,

G. CHRISTIAN HOFFMANN.

OTTAWA, December 31, 1887.

CHEMICAL CONTRIBUTIONS

TO THE

GEOLOGY OF CANADA,

FROM THE

LABORATORY OF THE SURVEY.

COALS AND LIGNITES.

[In continuation of previous reports on this subject, Report of Progress, 1882-83-84,—Report M, and Annual Report, 1885, Report M.]

Lignite from Egg Creek, North Saskatchewan.

52.—LIGNITE.—From seam near mouth of Egg Creek, North Saskatchewan River, opposite Victoria, township 58, range 17, west of the fourth initial meridian, District of Alberta, N. W. T. Seam thirteen inches thick. Geological position—Cretaceous, Pierre. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 117 E.

Structure, somewhat fine lamellar, tolerably compact; it contains numerous interposed patches of mineral charcoal; in parts coated with a film of ferric hydrate; color greyish-black to almost black; lustre along the surfaces of bedding dull, that of the cross-fracture sub-resinous to resinous; fracture uneven; apart from the patches of mineral charcoal, does not soil the fingers; powder dark-brown, inclining to blackish-brown; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air, splits in the direction of the bedding and falls to pieces.

Analysis by fast coking gave:

Analysis of.

Hygroscopic water	11·91
Volatile combustible matter	36·39
Fixed carbon	45·04
Ash	6·66
	100·00
Coke, per cent	51·70
Ratio of volatile combustible matter to fixed carbon	1 : 1·24

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, feebly luminous, smokeless flame. The ash has a light brownish-yellow color,—exposed to a bright red heat it becomes slightly agglutinated, at a most intense red heat it forms a slaggy mass.

Lignite from Big Island seam, North Saskatchewan.

53.—Lignite.—From the Big Island seam, North Saskatchewan River, twelve miles above Edmonton, township 51, range 25, west of the fourth initial meridian, District of Alberta, N. W. T. Seam three feet eight inches thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 112 E.

Structure, coarse lamellar—made up of layers of a greyish-black, dull, and dense, bright black coal, with numerous interposed patches of mineral charcoal; it was in parts stained with ferric hydrate; fracture uneven; apart from the patches of mineral charcoal, does not soil the fingers; powder brownish-black; it communicates a dark brownish-red color to a boiling solution of caustic potash; by exposure to the air becomes fissured, and as a result falls to pieces.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	8·92
Volatile combustible matter	28·70
Fixed carbon	37·44
Ash	24·94
	100·00
Coke, per cent	62·38
Ratio of volatile combustible matter to fixed carbon	1 : 1·30

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, smokeless flame. The ash has a reddish-white color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a slaggy mass.

Lignite from Ross' seam, North Saskatchewan.

54.—Lignite.—From Ross' seam, North Saskatchewan River, right bank, one and a-half mile below ferry at Edmonton, District of Alberta, N. W. T. Seam four feet thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 113 E.

Structure, fine lamellar—compact; color black; lustre resinous; fracture uneven; does not soil the fingers; it was in parts coated with a slight deposit of ferric hydrate; powder dark-brown, incli-

ning to blackish-brown; it communicates a deep brownish-red color to a boling solution of caustic potash; by exposure to the air, splits along the line of bedding and falls to pieces.

Analysis by fast coking gave:

Analysis of.

Hygroscopic water	11·47
Volatile combustible matter	36·12
Fixed carbon	48·57
Ash	3·84
	100·00
Coke, per cent	52·41
Ratio of volatile combustible matter to fixed carbon	1 : 1·34

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, somewhat luminous, slightly smoky flame. The ash has a dull yellow color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it readily fuses to a vitrified mass.

55.—Lignite.—From the Red Deer River, twelve miles above Tail Creek, township 38, range 24, west of the fourth initial meridian, District of Alberta, N. W. T. Seam ten feet, with three feet of interbedded sandstone and shale. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 60 E.

Lignite from Red Deer River, above Tail Creek.

Structure, somewhat fine lamellar—made up of greyish-black, dull, and bright black layers, with an occasional intervening layer of mineral charcoal; fracture uneven, occasionally, in parts verging on the conchoidal; it was, here and there, coated with a slight deposit of ferric hydrate; powder greyish-brownish-black; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air falls to pieces.

Analysis by fast coking gave:

Analysis of.

Hygroscopic water	7·66
Volatile combustible matter	25·90
Fixed carbon	34·53
Ash	31·91
	100·00
Coke, per cent	66·44
Ratio of volatile combustible matter to fixed carbon	1 : 1.33

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, smokeless flame. The

ash has a greyish-brown color—exposed to a bright red heat it becomes slightly agglutinated, at a most intense red heat it becomes fritted.

Lignite from Red Deer River, below Tail Creek.

56.—Lignite.—From the Red Deer River, four miles below Tail Creek, township 37, range 22, west of the fourth initial meridian, District of Alberta, N. W. T. Ten and a-half feet coal in an eighteen feet section, thickest seam three feet. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 61 E.

Structure, compact; color black; lustre resinous; fracture more or less conchoidal; does not soil the fingers; powder brownish-black; it communicates a deep brownish-red coloration to a boiling solution of caustic potash; by exposure to the air falls to pieces.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	10·02
Volatile combustible matter	32·11
Fixed carbon	45·19
Ash	12·68
	100·00
Coke, per cent	57·87
Ratio of volatile combustible matter to fixed carbon	1 : 1·41

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, smokeless flame. The ash has a light reddish-brown color,—exposed to a bright red heat it does not become agglutinated, at a most intense heat it forms a slaggy mass.

Lignite from Knee Hills Creek, Red Deer River.

57.—Lignite.—From seam on Knee Hills Creek (a tributary of the Red Deer River), township 29, range 23, west of the fourth initial meridian, District of Alberta, N. W. T. Seam four feet thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 72 E.

Structure, somewhat coarse lamellar—made up of greyish-black, dull, and bright black layers; fracture uneven; it contains, here and there, a little brownish-yellow transparent resin; does not soil the fingers; powder brownish-black; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air becomes slightly fissured, still remaining, however, tolerably firm and hence, in this regard, is superior to the generality of lignites.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	9·86
Volatile combustible matter	34·89
Fixed carbon	46·57
Ash	8·68
	100·00
Coke, per cent	55·25
Ratio of volatile combustible matter to fixed carbon 1 : 1·33	

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, somewhat luminous, smokeless flame. The ash has a yellowish-brown color,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat it forms a slaggy mass.

58.—Lignite.—From a seam on Meeting Creek (a tributary of Battle River), township 45, range 17, west of the fourth initial meridian, District of Alberta, N. W. T. Seam four and a-half feet thick. Geological position—Lower Laramie, Edmonton series. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 88 E. Lignite from Meeting Creek, Battle River.

Structure, fine lamellar—compact; color black; lustre resinous; fracture uneven; does not soil the fingers; powder brownish-black; it communicates a deep brownish-red color to a boiling solution of caustic potash; by exposure to the air splits in the direction of the bedding and falls to pieces.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	11·68
Volatile combustible matter	35·82
Fixed carbon	49·88
Ash	2·62
	100 00
Coke, per cent	52·50
Ratio of volatile combustible matter to fixed carbon 1 : 1·39	

It yields a non-coherent coke; the gases evolved during coking burnt with a yellowish, feebly luminous, smokeless flame. The ash has a reddish-brown color—exposed to a bright red heat it becomes agglutinated, at a most intense read heat it forms a slaggy mass.

59.—Lignitic Coal.—From Rocky Mountain House seam, one mile below the mouth of Clearwater River, on the North Saskatchewan

Lignitic coal from Rocky Mountain House seam, North Saskatchewan.

River, section 33, township 39, range 7, west of the fifth initial meridian, District of Alberta, N. W. T. Seam two feet or more. Geological position—Laramie. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 102 E.

Structure, compact; it is intersected by numerous thin plates of gypsum and calcite, and contains, in parts, a few films of iron-pyrites; shows well-defined planes of cleat; color black; lustre resinous; does not soil the fingers; powder brownish-black; it communicates a brownish-red color to a boiling solution of caustic potash; by exposure to the air becomes fissured, and hence somewhat tender. Another specimen from the same seam had a somewhat coarse lamellar structure, made up of layers of a greyish-black, dull, and bright black coal; this also showed well-defined planes of cleat; it contained only a few plates of calcite, and after the same length of exposure to the air as the other specimen, still remained hard and firm.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	7·01
Volatile combustible matter	34·63
Fixed carbon	50·34
Ash	8·02
	100·00
Coke, per cent	58·36
Ratio of volatile combustible matter to fixed carbon	1 : 1·45

It yields a non coherent coke; the gases evolved during coking burnt with a yellowish, somewhat luminous, slightly smoky flame. The ash has a dark brownish-yellow color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a slaggy mass.

Lignitic coal from Red Deer River, near outer edge of Foot Hills.

60.—Lignitic Coal.—From a seam on Red Deer River, near the outer edge of the Foot Hills, township 31, range 7, west of the fifth initial meridian, District of Alberta, N. W. T. Seam nine feet thick. Geological position—Laramie. Collected by Mr. J. B. Tyrrell, and referred to by him in Annual Report for 1886, p. 125 E.

Structure, very fine lamellar—compact; it contains interstratified, more or less disconnected, lenticular layers of jet black lustrous coal, and numerous patches of mineral charcoal; color greyish-black to black; lustre, apart from that of the layers above referred to, resinous; fracture uneven; powder dark-brown, inclining to blackish-brown; it communicates a brownish-red color to a boiling

solution of caustic potash; it, apparently, resists exposure to the air and is, on the whole, a firm coal.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	4·97
Volatile combustible matter	36·87
Fixed carbon	54·05
Ash	4·11
	100·00
Coke, per cent	58·16
Ratio of volatile combustible matter to fixed carbon 1 : 1·46	

It yields a non-coherent coke: the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a brownish-yellow color,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat it readily fuses to a vitrified mass.

61.—Lignitic Coal—From Lewes River (a branch of the Yukon River), four and a-half miles above Rink Rapid, N.W.T. Seam about three feet, but in part shaly. Geological position—Laramie. Collected by Dr. G. M. Dawson. Lignitic coal from Lewes River.

Structure, fine lamellar—compact; color greyish-black; lustre resinous; hard and firm; fracture uneven; it is, here and there, intersected by a few films of calcite; does not soil the fingers; powder brownish-black; it communicates a dark, but not deep, brownish-red color to a boiling solution of caustic potash; resists exposure to the air.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	6·03
Volatile combustible matter	36·92
Fixed carbon	49·03
Ash	8·02
	100·00
Coke, per cent	57·05
Ratio of volatile combustible matter to fixed carbon 1 : 1·33	

It yields a non-coherent coke. Color of the ash, brown with a faint reddish tinge, the same when exposed to a bright red heat does not agglutinate, at a most intense red heat it readily fuses to a vitrified mass.

62.—Coal—From the Bow River Coal Mine, south side of Bow River, a quarter of a mile S. 25° E. from mouth of Coal Creek, section 13,

Coal from Bow River Mine, south side of Bow River.

township 26, range 5, and section 18, township 26, range 4, west of the fourth initial Meridian, District of Alberta, N.W.T. Seam said to be ten feet ten inches, with three partings, total thickness of coal seven feet seven inches. The part of the workings from which this sample was taken is some three hundred feet from the outcrop, and about two hundred feet below the level of the prairie. From lower part of seam. Geological position—Lower Laramie. Received from Mr. J. W. Vaughan. Referred to in Annual Report for 1886, p. 122 E.

[Specimen 28—Report of Progress 1882-83-84, p. 32 M.—is from a natural exposure of the same seam on the north side of the river.] Structure somewhat coarse lamellar, made up of alternating layers of a greyish black, somewhat dull, and bright black coal; it contains a large amount of brownish-yellow resin diffused through its substance, as also an occasional film of calcite; the specimen examined was hard and firm; fracture, on the whole, irregular, that of the more lustrous layers, occasionally imperfectly conchoidal; does not soil the fingers; powder dark brown inclining to blackish-brown; it communicates a pale brownish-yellow color to a boiling solution of caustic potash; resists exposure to the air.

Analyses of.

Analyses by slow and fast coking gave:

	Slow coking.	Fast coking.
Hygroscopic water	4·41	4·41
Volatile combustible matter	33·89	40·32
Fixed carbon	54·70	48·27
Ash	7·00	7·00
	100·00	100·00
Coke, per cent	61·70	55·27
Ratio of volatile combustible matter to fixed carbon	1 : 1·61	1 : 1·20

It yields—by slow coking, a non-coherent coke—by fast coking, a firm compact coke, the coking being doubtless materially influenced by the presence of the resin; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a brownish-red color,—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a slaggy mass.

Coal from Peter seam, Marten Creek, Rocky Mountains.

63.—Coal—From the Peter seam, second crossing, Marten Creek, Crow Nest Pass, Rocky Mountains, British Columbia. Seam said to be fourteen feet thick. Geological position—Cretaceous, Kootanie series. Taken thirty feet in from outcrop. Locality

referred to by Dr. G. M. Dawson in Annual Report for 1885, p. 75 B.

This coal has a crumpled, foliated structure; shows slickensides color greyish-black to black; lustre resinous—that of the slickensided surfaces occasionally inclining to vitreous; firm; fracture irregular; slightly soils the fingers; does not contain any interlaminated calcite but occasionally, here and there, a delicate film of iron-pyrites; powder brownish-black; it communicates a faint brownish-yellow tinge to a boiling solution of caustic potash; resists exposure to the air,

Specific gravity 1·3052 (temp. 15·5°C.)—Weight of one solid cubic foot, calculated from the specific gravity, 81·57 pounds.

Analyses by slow and fast coking gave: Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	1·79	1·79
Volatile combustible matter	25·45	33·04
Fixed carbon	69·14	61·55
Ash	3·62	3·62
	100·00	100·00
Coke, per cent	72·76	65·17
Ratio of volatile combustible matter to fixed carbon	1 : 2·72	1 : 1·86

An ultimate analysis gave:

		Exclusive of sulphur, ash, and hygroscopic water.
Carbon	80·51	85·57
Hydrogen	5·20	5·53
Oxygen and nitrogen	8·37	8·90
Sulphur	0·51	—
Ash	3·62	—
Hygroscopic water	1·79	—
	100·00	100·00

Calorific power,* experimental, determined by Thompson's calorimeter Calorific power of,—experimental.

Indicated power of fuel in calories 8050
Indicated evaporative power ..... 14·99 pounds of water (at 100°C.) per pound of fuel.

deducting the units of heat necessary to vaporise the hygroscopic

* For data employed in calculating the calorific power, see Report of Progress, 1882-83-84, p. 4 M. under V[1]., and p. 43 M. et seq. under heading "Remarks on accompanying tables."

and combined water, and water of combustion of the fuel, we have an

Indicated power of fuel in calories 7790
Indicated evaporative power ..... 14·51 pounds of water (at 100°C.) per pound of fuel,

and these latter figures will express the greatest effect obtainable from this fuel, when used in generating steam.

Calorific power of,—theoretical

Calorific power, theoretical, calculated from its chemical composition.

Expressed in calories 7990
Pounds of water (at 100°C.) evaporated by 1 lb. of fuel 14.88

deducting from these figures the heat units required to vaporise the hygroscopic and combined water, and water of combustion of the fuel, we obtain the following values:

Expressed in Calories 7730
Pounds of water (at 100° C,) evaporated by 1 lb. of fuel 14.39

which latter give the closest approximation to the available heat.

It yields—by slow coking, a non-coherent coke—by fast coking, a compact, firm, coherent coke, in concentric layers, in which the form of the particles of coal from which it has been derived is entirely obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. Color of the ash white with a faint reddish tinge,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat it becomes slightly fritted.

Coal from Jubilee seam, Marten Creek, Rocky Mountains.

64.—Coal—From the Jubilee seam, second crossing, Marten Creek, Crow Nest Pass, Rocky Mountains, British Columbia. Seam said to be thirty feet thick. Geological position—Cretaceous, Kootanie series. Taken fifty-five feet in from outcrop. Locality referred to by Dr. G. M. Dawson in Annual Report for 1885, p. 75 B.

The description given of the immediately preceding coal, viz., that from the Peter seam, applies also to this one, the only difference being that this coal did not contain any visible iron-pyrites, and communicated a very pale brownish-yellow, and hence a somewhat more decided, color to a boiling solution of caustic potash.

Specific gravity 1·3088 (temp. 15·5°C.)—Weight of one solid cubic foot, calculated from the specific gravity, 81·80 pounds.

Analyses by slow and fast coking gave: Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	1·89	1·89
Volatile combustible matter	24·88	30·41
Fixed carbon	68·86	63·33
Ash	4·37	4·37
	100·00	100·00
Coke, per cent	73·23	67·70
Ratio of volatile combustible matter to fixed carbon	1 : 2·77	1 : 2·08

An ultimate analysis gave:

		Exclusive of sulphur, ash, and hygroscopic water.
Carbon	80·04	85·82
Hydrogen	4·94	5·30
Oxygen and nitrogen	8·28	8·88
Sulphur	0·48	—
Ash	4·37	—
Hygroscopic water	1·89	—
	100·00	100·00

Calorific power, experimental, determined by Thompson's calorimeter: Calorific power of,—experimental.

Indicated power of fuel in calories 8026
Indicated evaporative power ..... 14·94 pounds of water (at 100° C.) per pound of fuel.

deducting the heat units required to vaporise the hygroscopic and combined water, and water of combustion of the fuel, we have an

Indicated power of fuel in calories 7778
Indicated evaporative power ..... 14·48 pounds of water (at 100° C.) per pound of fuel.

and these latter figures will express the greatest effect obtainable from this fuel, when used in generating steam.

Calorific power, theoretical, calculated from its chemical composition: Calorific power of,—theoretical

Expressed in calories 7866
Pounds of water (at 100° C.) evaporated by 1 lb. of fuel .. 14·64

deducting from these figures the heat units required to vaporise

the hygroscopic and combined water, and water of combustion of the fuel, we obtain the following values:

Expressed in calories	7618
Pounds of water (at 100° C.) evaporated by 1 lb. of fuel	14·18

which latter give the closest approximation to the available heat. It yields—by slow coking, a non-coherent coke—by fast coking, a compact, firm, coherent coke, in concentric layers, in which the form of the particles of coal from which it has been derived is entirely obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. Color of ash, white—exposed to a bright red heat it remains unaffected, at a most intense red heat it becomes fritted.

Coal from north of Coal Harbor, Vancouver Island.

65.—Coal—From shaft sunk on two to three feet seam north of Coal Harbor, Quatsino Sound, Vancouver Island, British Columbia. Geological position—Cretaceous. Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 93 B.

Structure, very fine lamellar; the lines of bedding, which are very numerous and close together, are almost obliterated—compact; it is here and there intersected by thin plates of calcite, as also by an occasional film of pyrite; color, greyish-black—almost black; lustre resinous; hard and firm; fracture uneven; does not soil the fingers; powder dark brown, inclining to blackish-brown; it communicates only a just perceptible yellowish tinge to a boiling solution of caustic potash; resists exposure to the air; in appearance it resembles some varieties of coal of the Carboniferous system.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	1·05
Volatile combustible matter	34·38
Fixed carbon	54·01
Ash	10·56
	100·00
Coke, per cent	64·57
Ratio of volatile combustible matter to fixed carbon	1 : 1·57

It yields—by fast coking a firm, compact coke, in concentric layers, in which the form of the particles of coal from which it has been derived is perfectly obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a pale, dull yellowish-white color; exposed to a bright red heat, it

does not become agglutinated, at a most intense red heat it becomes slightly fritted.

66.—Coal—From a seam near Ya-koun River,—which flows into Massett Inlet—about twelve miles to the north of Skidegate Inlet, Graham Island, Queen Charlotte Islands, British Columbia. Seam said to be eighteen feet thick. Geological position—Cretaceous. Coal from Ya-koun River, Graham Island, Queen Charlotte Islands.

Structure, compact; hard and firm; color, black; lustre, resinous, in parts brilliant; fracture uneven, occasionally somewhat conchoidal; it is, here and there, intersected by thin plates of gypsum and calcite, as also by a few films of pyrite; does not soil the fingers; powder dark brown, inclining to blackish-brown; it communicates a just perceptible brownish-yellow tinge to a boiling solution of caustic potash; resists exposure to the air; in appearance it closely resembles some varieties of coal of the Carboniferous system.

Analyses by slow and fast coking gave: Analyses of.

	Slow coking.	Fast coking.
Hygroscopic water	2·65	2·65
Volatile combustible matter	30·59	38·19
Fixed carbon	61·33	53·73
Ash	5·43	5·43
	100.00	100·00
Coke, per cent	66.76	59·16
Ratio of volatile combustible matter to fixed carbon	1 : 2·00	1:1·41

It yields—by slow coking, a non-coherent coke—by fast coking, a firm, compact coke, in concentric layers, in which the form of the particles of coal from which it has been derived is entirely obliterated; the gases evolved during coking burnt with a yellow, luminous, smoky flame. Color of the ash, light reddish-white—when exposed to a bright red heat it remains unaffected, at a most intense red heat it becomes slightly fritted.

This coal agrees very closely in composition with that of the Newcastle seam, Wellington Mine, Vancouver Island, analyses of which are given in Report of Progress for 1882-84, p. 37 M., specimen No. 33.

67.—Coal—From Ki-uk River, the mouth of which is about three miles south of Beaver Harbor, Vancouver Island, British Columbia. Seam six inches thick. Geological position—Cretaceous. Coal from Ki-uk River, Vancouver Island.

Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 62 B.

Structure, for the most part, tolerably fine lamellar, with an intervening broad layer of compact, homogeneous, velvet-black, jet-like material, and an occasional interposed layer of mineral charcoal; apart from the latter, does not soil the fingers; it is intersected by numerous films of calcite; hard and firm; powder dark brown, inclining to blackish-brown; it communicates a pale brownish-yellow color to a boiling solution of caustic potash; resists exposure to the air.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	3·68
Volatile combustible matter	39·29
Fixed carbon	47·03
Ash	10·00
	100·00
Coke, per cent.	57·03
Ratio of volatile combustible matter to fixed carbon 1 : 1·19	

It yields—by fast coking, a firm, coherent coke; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a light reddish-grey color—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a more or less vitrified mass.

Coal from Suquash, Vancouver Island.

68.—Coal—From Suquash, north-east end of Vancouver Island, British Columbia. From site at which coal was mined by the Hudson Bay Company. There are two seams at this locality, the upper—that from which the present specimen was taken—having a thickness of from one to two feet, and which is separated from the lower seam of some six inches, by a parting of about one foot of soft shale. Geological position—Cretaceous. Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 62 B.

Structure, on the whole, moderately fine lamellar, of grayish-black color and dull lustre, with occasional somewhat coarse layers of shining, velvet-black coal; it is, here and there, intersected by a few films of calcite, and contains, in parts, a little lemon-yellow subtransparent resin; hard and firm; fracture uneven; powder dark brown, inclining to blackish-brown; it communicates a brownish-yellow color to a boiling solution of caustic potash; resists exposure to the air.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	5·03
Volatile combustible matter	41·51
Fixed carbon	46·52
Ash	6·94
	100·00
Coke, per cent	53·46
Ratio of volatile combustible matter to fixed carbon	1 : 1·12

It yields—by fast coking, a moderately firm coke; the gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a light bluish-grey color—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it readily fuses to a vitrified mass.

69.—Coal—From a small stream, three-quarters of a mile due south of mouth of Klik-si-wi River, north-west coast of Vancouver Island, British Columbia. Seam sixteen inches thick. Geological position—Cretaceous. Collected by Dr. G. M. Dawson, and referred to by him in Annual Report for 1886, p. 62 B. Coal from Klik-si-wi River, Vancouver Island

Structure, tolerably fine lameller—compact; color black; lustre resinous; hard and firm; fracture uneven; does not soil the fingers; powder dark brown, inclining to blackish-brown; it communicates a brownish-yellow color to a boiling solution of caustic potash; on exposure to the air it becomes, in parts, incrusted with a white efflorescence, resulting from the oxidation of iron pyrites; in appearance, it is not unlike some varieties of coal of the Carboniferous system.

Analysis by fast coking gave: Analysis of.

Hygroscopic water	3·65
Volatile combustible matter	42·23
Fixed carbon	39·84
Ash	14·28
	100·00
Coke, per cent	54·12
Ratio of volatile combustible matter to fixed carbon	1 : 0·94

It yields—by fast coking, a coherent but tender coke; the gases evolved during coking burnt with a yellow, luminous, smoky flame; color of the ash, reddish-brown—exposed to a bright red heat it becomes slightly fritted, at a most intense red heat it forms a more or less vitrified mass.

Semi-anthracite from Marsh's Mine, Rocky Mountains.

70.—Semi-anthracite—From Marsh's mine, about one and a-half miles south of Bow River, at Gap siding, Rocky Mountains, District of Alberta, N.W.T. There are two seams, an upper about twelve feet thick, and a lower about ten feet thick, separated by about fifty feet of shales and sandstone. Geological position—Cretaceous. Collected by Mr. R. G. McConnell, and referred to in Annual Report for 1885, p. 133 B.

Material of upper seam:

Upper seam.

Structure compact, highly contorted, shows slickensides in an eminent degree; made up of alternating layers of a greyish-black, dull, and jet-black coal of brilliant lustre; brittle; fracture, on the whole, uneven, that of the more lustrous layers conchoidal; does not soil the fingers; the specimen examined was hard and firm; powder black; it communicated only a just perceptible yellowish tinge to a boiling solution of caustic potash; resists exposure to the air.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	0·70
Volatile combustible matter	11·03
Fixed carbon	79·78
Ash	8·49
	100·00

Ratio of volatile combustible matter to fixed carbon 1 : 7·23

It yields a non-coherent coke; when heated in a covered crucible it evolves a small amount of yellowish, somewhat luminous, almost smokeless flame. The ash, which is white, does not agglutinate at a bright red heat, and at a most intense red heat becomes only very slightly fritted.

Lower seam.

71.—Material of lower seam:

Structure foliated, crumpled—made up of layers of dull greyish-black material, consisting, apparently, of carbonaceous shale and velvet-black coal of brilliant lustre; shows slickensides; does not soil the fingers; hard and firm; at a first glance, might readily be mistaken for a fuel of excellent quality.

Analysis of.

Analysis by fast coking gave:

Hygroscopic water	1·02
Volatile combustible matter	7·24
Fixed carbon	36·16
Ash	55·58
	100·00

NATURAL WATERS.

1.—Water from one—that usually referred to as the principal spring—of the thermal springs at Banff, District of Alberta, North West Territory. Collected by Mr. R. G. McConnell. Water from thermal spring at Banff, District of Alberta, N.W.T.

Referring to this spring Mr. McConnell says—"The water has a temperature of 111°F. in summer, but it is said to rise to 119°F. in winter. The lower temperature in summer may be caused by the water being affected to some extent by the surface drainage, which is more active at that season. It has a regular flow, and is forced up in large quantities through an aperture several inches in diameter."

Mr. Frank D. Adams has made an analysis of this water and with the following results:—

At the time of examination it contained a certain amount of suspended and sedimentary matter, this for 1000 parts, by weight, of the water amounted to 0·0288, and was found to be composed of a dark colored sand, a portion of which consisted of minute grains of magnetic iron-ore, some argillaceous and vegetable matter, small quantities of carbonates of iron, lime, and magnesia, together with a very small amount of sulphate of lime. The filtered water had a specific gravity, at 15·5°C., of 1000·99. It was colorless, even when viewed in a column two feet in length, was devoid of odor and any marked taste; reaction, faintly alkaline. 1000 parts, by weight, of the water, at 15·5°C., contained:—

Potassa	·0052
Soda	·0097
Lime	·2960
Magnesia	·0690
Alumina (very small amount)	undet.
Ferrous oxide	·0008
Chlorine	·0067
Sulphuric acid	·4784
Carbonic acid	·1454
Silica	·0398
Organic matter	trace
	1·0510
Less oxygen equivalent to chlorine	·0015
	1·0495

The foregoing acids and bases are most probably combined in the water as follows:

(Carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous)

Water from thermal spring at Banff, District of Alberta, N.W.T., cont.

Chloride of sodium	·0110
Sulphate of soda	·0089
" potassa	·0096
" magnesia	·2070
" lime	·5627
Carbonate of lime	·1148
" iron	·0013
Alumina	undet.
Silica	·0398
Organic matter	trace.
	·9551

Total dissolved solid matter, by direct experiment, dried at 180°C., 0·9743.

Carbonic acid, half-combined	·0510
" , free	·0434
	1·0495

An Imperial gallon of the water—at the aforementioned temperature—would contain:—

(Carbonates calculated as anhydrous bi-carbonates, and the salts without their water of crystallisation.)

	Grains.
Chloride of Sodium	0·771
Sulphate of soda	0·624
" potassa	0·673
" magnesia	14·504
" lime	39·428
Bi-carbonate of lime	11·583
" iron	0·126
Alumina	undet.
Silica	2·789
Organic matter	trace.
	70·498
Carbonic acid, free	3·041
	73·539

The water was examined for lithia, iodine, and bromine, but no other constitutents. Distinct evidence was obtained of the presence of lithia. Iodine and bromine were not detected: this does not necessarily imply that they are not present in the water, inasmuch as the amount of water operated on was far less than would be required for the detection of traces, or even very small quantities of these substances.

2.—From a spring in the vicinity of the Belvedere iron mine, lot eight

of the ninth range of Ascot, Sherbrooke county, Province of Quebec. Examined for Mr. E. Clark.

Water from a spring near Belvedere iron mine, Ascot, Sherbrooke county, P.Q.

Mr. E. B. Kenrick made a qualitative examination of this water and found it to contain:—

Potassa	trace.
Soda	small proportion.
Lime	rather large proportion.
Magnesia	rather large proportion.
Ferrous oxide	trace.
Sulphuric acid	large proportion.
Carbonic acid	small proportion.
Silica	trace.
Chlorine	small proportion.

Total dissolved saline matter, dried at 180°C., equalled 0·0746 parts in 1000.

IRON ORES.

1.—Red hematite from Mr. W. McDonald's farm near Avondale Post Office, about one hundred yards north of T roads at the house, on the west side of the main road, Pictou county, Nova Scotia.

Hematite from near Avondale Post Office, Pictou county, N.S.

The sample, which was collected by Mr. Hugh Fletcher, and consisted of picked specimens, weighed five pounds. A fair average of the same was found, by Mr. E. B. Kenrick, to contain:—

Metallic iron	33·76 per cent.

2.—Magnetic iron ore from the vicinity of Kinnear's Mills, township of Leeds, Megantic county, Province of Quebec. Examined for Mr. J. H. Bartlett.

Magnetite from vicinity of Kinnear's Mills, Megantic county, P.Q.

The sample consisted of an association of fine crystalline magnetite and hematite, through which was disseminated a large amount of a siliceous gangue and some iron-pyrites. Weight of specimen, about seven and a-half pounds. Mr. E. B. Kenrick found it to contain:—

Metallic iron	37·23 per cent.
Titanium dioxide	none.
Insoluble matter	44·31 per cent.

3.—A specular schist from lot seven, range nine of Sutton, Brome county, Province of Quebec.

Specular schist from Sutton, Brome county, P.Q.

A sample of this material, forwarded to the Survey for examination, was found by Mr. F. D. Adams to contain about forty per cent. of insoluble matter, and gave a very strong re-action for titanic acid.

Magnetite from lot 16, range 2 of Wollaston, Hastings county, Ont.

4.—Magnetic iron-ore from lot sixteen, range two of Wollaston, Hastings county, Ontario. This and the two following specimens were examined for Mr. W. Jenkins. The determinations were made by Mr. E. B. Kenrick. It contained:—

Metallic iron.....26·94 per cent.
Titanium dioxide.....none.

Magnetite from lot 15, range 2 of Wollaston, Hastings county, Ont.

5.—Magnetic iron-ore from lot fifteen, range two of Wollaston, Hastings county, Ontario.

A fine crystalline magnetite: it contained:—

Metallic iron.....56·50
Titanium dioxide.....none.

Magnetite from lots 9 and 10, range 15 of Wollaston, Hastings county, Ont.

6.—Magnetic iron-ore from lots nine and ten, range fifteen of Wollaston, Hastings county, Ontario.

A fine crystalline magnetite: it contained:—

Metallic iron.....28·42 per cent.
Titanium dioxide.....trace.

Magnetite from Bedford, Frontenac county, Ont.

7.—Magnetic iron-ore from lot twenty-eight, range four of Bedford, Frontenac county, Ontario. Examined for Mr. W. Davis.

A coarse crystalline magnetite. Determinations by Mr. E. B. Kenrick gave:

Metallic iron.....62·98 per cent.
Titanium dioxide.....none.

Magnetite from South Sherbrooke, Lanark county, Ont.

8.—Magnetic iron-ore from lot nineteen, range three of South Sherbrooke, Lanark county, Ontario. Examined for Mr. W. A. Allan.

Small crystals of apatite were disseminated through portions of this sample. A fair average of thirty-seven pounds of this ore was found, by Mr. E. B. Kenrick, to contain:—

Metallic iron.....40·81 per cent.
Titanium dioxide.....none.

Magnetite from Carlow, Hastings county, Ont.

9.—Magnetic iron-ore from a deposit occurring on the north halves of lots six and seven, range sixteen of Carlow, Hastings county, Ontario. The examination was conducted by Mr. F. D. Adams.

The sample received was made up of fragments which differed materially in appearance, some consisting, apparently, of very pure, others of a very impure ore. The former were separated from the latter, thus dividing the original material into two portions—A, and B. Portion A, consisting of the apparently pure fragments, constituted 36·42 per cent. of the original sample. On

closely examining the various fragments composing it, it was found that whereas some consisted of a coarsely crystalline magnetite, strongly magnetic, and having a distinct octahedral cleavage, the remainder were not at all magnetic and proved to consist of ilmenite. This portion contained :—

Metallic iron	68·47 per cent.
Titanium dioxide	undet.

Portion B, contained a large amount of rock matter. Some of the fragments consisted, apparently, of gneiss carrying more or less magnetite. Analysis gave :—

Metallic iron	34·16 per cent.
Titanium dioxide	trace.

The insoluble matter amounted to over forty per cent. Calculation showed the sample, as received, to contain :—

Metallic iron	46·66 per cent.
Titanium dioxide	undet.

10.—Magnetic iron-ore from the vicinity of Little Gull Lake, District of Thunder Bay, Lake Superior, Ontario. Collected by Mr. E. D. Ingall. There were two specimens, taken from different points. The examinations were made by Mr. E. B. Kenrick. Magnetite from Little Gull Lake, District of Thunder Bay, Ont.

The one specimen was strongly magneti-polar. It contained :

Metallic Iron	39·76 per cent.
Titanium dioxide	none.

The other was also found to possess polarity, but in a far less degree than the one just alluded to. Determinations gave :

Metallic iron	45·57 per cent.
Titanium dioxide	none.

11.—Hematite from Big Island, Lake Winnipeg, Manitoba. Examined for Mr. F. Proudfoot. Hematite from Big Island, Lake Winnipeg, Man.

This specimen contained a good deal of finely disseminated iron-pyrites, also a large amount of a calcareous and siliceous gangue. Determinations—by Mr. F. D. Adams—of the more important constituents, gave :

Ferric oxide	50·343
Phosphoric acid	0·009
Sulphur	2·026
Insoluble matter	22·330
Water, hygroscopic	0·644
Metallic iron	35·240
Phosphorus	0·004
Sulphur	2·026

Magnetite from Albany River.

12.—Magnetic iron-ore from the Albany River, two and a-half miles below the junction of the Etow-i-ma-mi. Collected by Dr. R. Bell.

A very fine-granular, almost compact, dark bluish-grey magnetite. Agreeably with the results of determinations made by Mr. E. B. Kenrick, it contained:—

Metallic iron	42·09 per cent.
Titanium dioxide	none.

Hematite from near Spence's Bridge, Thompson River, B.C.

13.—Hematite, var. specular iron, from the vicinity of Spence's Bridge, Thompson River, Cascade Range, British Columbia. Received from Mr. James Crawford. Determinations by Mr. E. B. Kenrick, gave:

Metallic iron	33·13 per cent.
Titanium dioxide	none.

Gold and Silver Assays.

GOLD AND SILVER ASSAYS.

PROVINCE OF NOVA SCOTIA.

Assays Nos. 1 *and* 2 *were conducted by Mr. F. D. Adams.*

Province of Nova Scotia.

1.—From North Bend, East Bay, Cape Breton county. Examined for Mr. E. T. Moseley.

It consisted of a dark-brown zinc-blende, coated with ferric hydrate and other decomposition products. Weight of specimen, four ounces. It was found to contain:

Gold	none.
Silver	trace.

2.—Said to have come from near Truro, Colchester county. Examined for Mr. E. A. Charters.

It consisted of galena in association with a dark-brown limestone. The former constituted, approximately, four-fifths, by weight, of the whole. Weight of specimen, ten and a-half ounces.

It contained neither gold nor silver.

3.—From St. Ann's Mountain at Big Bras d'Or, Victoria county, Cape Breton. Examined for Mr. J. McPherson.

A greyish-white sub-translucent quartz, carrying a somewhat large amount of iron-pyrites, together with some magnetite: the whole was more or less stained with ferric hydrate. Weight of specimen, seven and a-half ounces. Assays, by Mr. R. A. A. Johnston, gave:

Gold	trace.
Silver	none.

Province of New Brunswick.

Province of New Brunswick

4.—From the "Mineral Vale" property, parish of Alma, Albert county. Examined for Mr. E. A. Charters.

A finely-crystalline galena, together with a little copper-pyrites, disseminated through a dolomitic gangue. Weight of specimen, fifteen and three-quarter ounces. Mr. E. B. Kenrick found it to contain:

Gold..... trace.
Silver..... 1·458 ounce to the ton of 2,000 lbs.

Province of Quebec.

Assays Nos. 5 *to* 8 *and* 22 *to* 27 *inc., were conducted by Mr. E. B. Kenrick—Nos.* 9 *to* 14 *inc., by Mr. R. A. A. Johnston, and Nos.* 16 *to* 21 *inc., by Mr. F. D. Adams.*

Province of Quebec.

5.—From one of numerous veins in the vicinity of the town of Sherbrooke, Sherbrooke county.

It consisted of an association of iron-pyrites, galena, and quartz. Weight of specimen, ten and a-half ounces. Assays gave:

Gold..... trace.
Silver..... 9·479 ounces to the ton of 2,000 lbs.

6.—From the township of Litchfield, Pontiac county. Examined for Mr. H. K. Egan.

A coarsely crystalline galena, in association with a very small quantity of calcite. Weight of specimen, three and a-quarter ounces. It contained:

Gold..... none.
Silver..... 2·188 ounces to the ton of 2,000 lbs.

7.—From range nine, lot twenty-four of Cranbourne, Dorchester county. Quartz, in association with a dark bluish-grey shale; it contained a little iron-pyrites and magnetite, and was in parts stained with ferric hydrate. Weight of specimen, thirteen ounces.

It contained neither gold nor silver.

8.—From Onslow, Pontiac county.

A coarsely crystalline galena, in association with a small quantity of calcite. Weight of specimen, nine and a-half ounces. It was found to contain:

Gold..... none.
Silver..... 0·729 of an ounce to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of Quebec, cont.

9.—From lot twelve, range one, N. E. St. Francis, Beauce county.

A white sub-translucent quartz, in association with chloritic schist; it contained a good deal of iron-pyrites, also a small quantity of galena, and was more or less stained with ferric hydrate. Weight of specimen, one pound one ounce. Assays showed it to contain:

Gold..... 0·117 of an ounce to the ton of 2,000 lbs.
Silver..... none.

10.—From the Coulonge River, about eighteen miles up.

A greyish-white to white sub-translucent quartz, carrying a somewhat large amount of zinc-blende, and, here and there, a few specks of galena and magnetic-pyrites. It was in parts stained with ferric hydrate. Weight of specimen, one pound two ounces.

It contained neither gold nor silver.

11.—From near the headwaters of the Abitibi branch of the Ottawa River, eight miles south of height of land. Examined for Mr. C. C. Farr.

An association of copper-pyrites and quartz. Weight of specimen, one and a-half ounce. It contained:

Gold..... trace.
Silver..... none.

12.—From R. N. Klocks and Company's limit, north shore of Lac des Quinze. Examined for Mr. C. C. Farr.

An association of iron-pyrites, magnetic-pyrites, and translucent quartz. Weight of specimen, four and a-half ounces. Assays gave:

Gold..... trace.
Silver..... none.

13.—From the north-east end of Lac des Quinze.

Consisted of iron-pyrites in a gangue of white and greyish-white sub-translucent quartz, in parts coated with with ferric hydrate. Weight of specimen, eight ounces. Assays showed it to contain:

Gold..... trace.
Silver..... trace.

14.—From lot six, range eleven, of Whitton, Compton county.

A full description of this material will be found under Miscellaneous Examinations, examination No. 4, where it is referred to as "the bulk of the material." It was found to contain:

Gold..... trace.
Silver..... none.

15.—From the so-called Bothwell gold mine, range nine, lot seventeen, of Buckingham, Ottawa county. Taken from a depth of about seven or eight feet. This, and the following specimen were examined for Mr. W. A. Allan.

It consisted of an association of quartz and felspar, together with a little pyroxene and garnet, a trifling amount of apatite, some graphite and iron-pyrites. Weight of specimen, four pounds ten ounces.

It contained neither gold nor silver.

16.—From the same locality and opening as the preceding specimen, but from a depth of abont twenty feet.

This cousisted of a somewhat coarsely crystalline rock, composed of quartz, grey felspar, a good deal of calcite and a little pyroxene. It contained a large quantity of pyrite and hydrated peroxide of iron; also, a little pyrrhotite. Weight of specimen, one pound.

It contained neither gold nor silver.

17.—From lot nineteen, range five of Buckingham, Ottawa county. Examined for Mr. L. P. Labouglie.

A grey garnetiferous gneiss, through which was disseminated a little graphite, carrying a somewhat large amount of iron-pyrites; the latter constituting a band in the rock. Weight of specimen, two and a-half pounds. It contained:

Gold..... trace.
Silver..... none.

18.—This, and the two following specimens were stated, by Mr. W. Macintosh, for whom they were examined, to have come from the vicinity of Whitefish Lake, Ottawa county.

It consisted of a very fine-grained steel-grey ore, consisting of an intimate mixture of zinc-blende, galena, copper-pyrites, quartz and calcite. The copper-pyrites was present only in very small amount; the galena constituted about 13·8 per cent., by weight, of the whole. Weight of specimen, four pounds six ounces. Assays showed it to contain:

Gold..... distinct trace.
Silver..... 13·125 ounces to the ton of 2,000 lbs.

19.—A white translucent quartz, in association with a small quantity of a dark, somewhat micaceous schist; it held a small amount of coarsely crystalline iron-pyrites. Weight of specimen, three pounds twelve ounces.

It contained neither gold nor silver.

Gold and Silver Assays, cont.

Province of Quebec, cont.

20.—Consisted of greyish quartz, carrying a good deal of iron-pyrites; also, a little galena and zinc-blende. Half of one of the fragments consisted of an impure grey limestone, apparently the wall rock. Weight of specimen two pounds fifteen and a-half ounces. Assays gave:

Gold..... 0·058 of an ounce to the ton of 2,000 lbs.
Silver..... 0·262 " " "

21.—From lot ten, range four of Calumet, Pontiac county.

A more or less intimate association of zinc-blende and galena, together with small quantities of iron-pyrites. The proportion of the two latter, more especially the galena, to the former, varied greatly in different specimens. A fair average of numerous specimen, was found, on assay, to contain:

Gold..... trace.
Silver..... 11·666 ounces to the ton of 2,000 lbs.

22.—This, and the four following specimens, are from quartz veins occurring on a hill on the north side of the Ottawa River, and opposite to the village of Mattawa. They were collected, at the instance of Dr. R. Bell, by Mr. A. E. Barlow and in such wise as to thoroughly represent the respective veins from which they were taken.

The material from the first vein, which occurs about one and a half miles north-east of the Mattawa village, consisted of a translucent quartz in association with a little red and white felspar. Weight of specimen, twelve ounces.

It contained neither gold nor silver.

23.—From a vein about one hundred feet from, and running parallel with, the last mentioned. Width of vein, about seven feet.

A translucent quartz. Weight of specimen, one pound thirteen ounces.

It contained neither gold nor silver.

24.—From a vein occurring about half a mile W. 15° N. of that from which the last mentioned specimen was taken. Strike of vein about S. 55° W.

Translucent quartz in association with a little felspar. Weight of specimen, eight pounds fourteen ounces.

It contained neither gold nor silver.

25.—From a vein about two feet wide, of much the same character and having the same strike as the one last referred to.

Consisted of a translucent quartz in association with a little felspar. Weight of specimen, four pounds nine ounces. Gold and Silver Assays, cont. Province of Quebec, cont.

It contained neither gold nor silver.

26.—From a vein occurring at the back of the hill.

It consisted of a translucent quartz, through which was disseminated small flakes of a gold-yellow colored mica. Weight of specimen, four and three-quarter ounces.

It contained neither gold nor silver.

27.—From an opening on the north-west claim of the Mattawa Gold Mining Company. The claim is three miles due north of the village of Mattawa. Collected by Dr. R. Bell.

A translucent quartz with which was associated a little felspar, and in some instances a micaceous schist. Weight of specimen, five pounds.

It contained neither gold nor silver.

Province of Ontario.

Assays Nos. 28 *to* 49 *inc., were conducted by Mr. E. B. Kenrick —Nos.* 50 *to* 53 *inc., by Mr. R. A. A. Johnston, and Nos.* 54 *to* 56 *inc., by Mr. F. D. Adams.*

28.—This, and the two following specimens were collected by Dr. R. Bell. Province of Ontario.

From main opening, McCool's Mill location, Mattawa Gold Mining Company, about half a mile north of McCool's Mill, Mattawan River, and three miles west of Mattaw village, district of Nipissing.

It consisted of translucent quartz in association with some felspar. Weight of specimen, three pounds six ounces.

It contained neither gold nor silver.

29.—From the south opening, McCool's Mill location, Mattawa Gold Mining Company, about thirty feet south-west of the opening whence the last mentioned specimen was taken.

A translucent quartz. Weight of specimen, three pounds.

It contained neither gold nor silver.

30.—From a vein running N. 45° E. (mag.), and about two chains north-west of the opening last referred to.

Consisted of a translucent quartz in association with a little felspar. Weight of specimen, two and three-quarter pounds.

It contained neither gold nor silver.

Gold and Silver Assays, cont.

Province of Ontario, cont.

31.—From lot three, range one of the township of Snider, district of Algoma. Examined for Mr. T. M. Kirkwood.

A moderately coarse crystalline galena in the form of more or less contorted layers, having an average thickness of about a-quarter of an inch. Assays gave:

Gold.....none.
Silver.....5·104 ounces to the ton of 2,000 lbs.

32—From a ten feet vein at the northern end of Lake Temagami, district of Nipissing. Received from Mr. E. B. Haycock.

It consisted of iron-pyrites through which was disseminated a little quartz and calcite. Weight of specimen, seven and a-quarter ounces. It was found to contain:

Gold.....trace.
Silver.....none.

33.—From about six miles from Gravel River Station on the line of the Canadian Pacific Railway, district of Thunder Bay. Vein eighteen inches wide. Received from Mr. Hugh Wilson.

A coarsely crystalline galena in a gangue consisting almost exclusively of quartz. Weight of specimen, one and a-quarter ounce. It contained:

Gold.....none.
Silver.....1·094 ounce to the ton of 2,000 lbs.

34.—This, and the following fifteen specimens were collected by Mr. E. D. Ingall.

From Jarvis Island, north-west shore of Lake Superior, between Thunder Bay and Pigeon River.

An association of calcite and a greyish-green chloritic mineral, through which was disseminated a little iron-pyrites and zinc-blende. Weight of specimen, ten and a-quarter ounces. It was found to contain:

Gold.....none.
Silver.....0·350 of an ounce to the ton of 2,000 lbs.

35.—This, and the two following specimens are from location 97 T., Rabbit Mountain district.

Zinc-blende in a gangue consisting of a dark grey shale, calcite and some fluorite. The gangue constituted but a small proportion, by weight, of the whole. Weight of specimen, one pound eleven ounces. It was found, on assay, to contain:

Gold.....trace.
Silver.....336·700 ounces to the ton of 2,000

36.—From upper slope.

It consisted of zinc-blende and a trifling amount of iron-pyrites, in a gangue of calcite with a little fluorite. Weight of specimen, seven ounces. Assays gave:

Gold.....trace.
Silver.....none.

37.—From bottom of shaft.

An association of a dark grey shale, quartz and some fluorite, carrying small quantities of zinc-blende and a little galena. Weight of specimen, six and a-half ounces.

It contained neither gold nor silver.

38.—From a vein on location 264 T., Whitefish Lake.

An association of quartz and calcite, with some shale and a little fluorite, carrying a trifling quantity of zinc-blende. Weight of specimen, two pounds five ounces. It was found to contain:

Gold.....none.
Silver.....1·867 ounces to the ton of 2,000 lbs.

39.—From a vein on location 176 T., Whitefish River.

It consisted of calcite, in association with a little quartz and fluorite, carrying small quantities of zinc-blende and a little galena. Weight of specimen, thirteen ounces.

It contained neither gold nor silver.

40.—From location R. 110, Whitefish Lake.

An association of calcite, shale, and small quantities of fluorite, carrying a little iron-pyrites and galena. Weight of specimen, eight and three-quarter ounces.

It contained neither gold nor silver.

41.—From location R. 235, Silver Mountain district.

An association of quartz and calcite. Weight of specimen, fifteen and a-quarter ounces.

It contained neither gold nor silver.

42.—From a vein on location 95 T., Silver Mountain district.

It consisted of calcite in association with a little fluorite, and contained, here and there, a trifling amount of silver-glance. Weight of specimen, five ounces. Assays gave:

Gold.....none.
Silver.....2·567 ounces to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of Ontario, cont.

43.—From a vein on Tchiatay's location, Silver Mountain district.

It consisted of calcite together with a little fluor, carrying small quantities of zinc-blende and some galena. Weight of specimen, fourteen ounces. It was found to contain:

Gold..... trace.
Silver..... none.

44.—From a vein on Woodside's location, Silver Mountain district.

An association of a white translucent quartz with a little shale, calcite, and fluorite, carrying small quantities of zinc-blende. Weight of specimen, eleven and a-half ounces.

It contained neither gold nor silver.

45.—From Silver Mountain vein, from test pit.

A dark grey shale with some quartz and a little fluorite, carrying a trifling amount of zinc-blende and silver-glance. Weight of specimen, two pounds eleven ounces. Assays showed it to contain:

Gold..... trace.
Silver..... 353·442 ounces to the ton of 2,000 lbs.

46.—From Silver Mountain vein, No. 2 tunnel, breast.

An association of calcite and a dark grey shale with some quartz and fluorite, carrying a little iron-pyrites. Weight of specimen, fifteen ounces.

It contained neither gold nor silver.

47.—From Silver Mountain vein, No. 2 tunnel, near crosscut.

An association of calcite and shale together with some quartz and fluorite, carrying a little iron-pyrites, zinc-blende, and silver-glance. Weight of specimen, seventeen pounds. It contained:

Gold..... district trace.
Silver..... 102·083 ounces to the ton of 2,000 lbs.

48.—From Osinawe Lake, Seine River district.

A milky white quartz, in association with a greenish-grey chloritic schist: it contained, here and there, a few specks of iron-pyrites and, in parts, cavities lined with ferric hydrate. Weight of specimen, fourteen and three-quarter ounces.

It contained neither gold nor silver.

49.—From Michipicoten Island, Lake Superior.

A white, reddish-white, and grey calcite in association with a

small quantity of an apple-green talcose mineral. Weight of specimen, seven and a-half ounces. It was found to contain:

Gold..... distinct trace.
Silver..... 0·467 of an ounce to the ton of 2,000 lbs.

50.—From lot two, range five, of Snider, district of Algoma. Examined by Mr. J. McCormick.

A greyish-white translucent to snb-transparent quartz, in association with a greenish chloritic mineral, carrying small quantities of iron-pyrites. It was more or less stained and coated with ferric hydrate. Weight of specimen, six pounds thirteen ounces. Assays gave:

Gold..... trace.
Silver..... none.

51.—From the Thompson vein, location H., township of McIntyre, Thunder Bay, Lake Superior. Examined for Mr. W. A. Allan.

A white sub-translucent quartz, in association with a dark-grey rock. It was slightly stained with ferric hydrate, and contained a little iron-pyrites. Weight of specimen. two and three-quarter pounds. Assays showed it to contain:

Gold..... trace.
Silver..... none.

52.—From the township of Escott, Leeds county. Examined for Mr. T. Storey.

It consisted of iron-pyrites with a somewhat large amount of intermixed ferric hydrate. Weight of specimen, ten ounces. It was found, on assay, to contain:

Gold..... trace.
Silver..... trace.

53.—From about five and a half miles south of Kinmount, Peterborough county.

An association of iron-pyrites and magnetic pyrites in a felspathic gangue: the latter constituted but a small proportion, by weight, of the whole. Weight of specimen, five and a-half ounces. Assays gave:

Gold..... distinct trace.
Silver..... none.

54.—From the south-east corner of township 94, district of Algoma. Examined for Mr. W. Russel.

Gold and Silver Assays, cont.

Province of Ontario, cont.

A greyish translucent quartz associated with a small quantity of a light colored micaceous mineral and holding a little iron-pyrites. Weight of specimen, two pounds. It contained:

Gold ..... trace.
Silver ..... none.

55.—From the vicinity of Sudbury Station on the line of the Canadian Pacific Railway, district of Nipissing.

Quartz carrying a small amount of copper-pyrites and magnetic pyrites. Weight of specimen, four and three-quarter ounces. It was found to contain:

Gold ..... distinct trace.
Silver ..... 0·414 of an ounce to the ton of 2,000 lbs.

56.—From lot sixteen, range three of the township of Dalhousie, county of Lanark. Examined for Mr. David MacLean.

An association of galena, calcite, and barite. The calcite constituted 17·7 per cent., and the barite about 40 per cent. of the material. Weight of specimen, two and three-quarter ounces. Assays showed it to contain:

Gold ..... none.
Silver ..... 1·951 ounce to the ton of 2,000 lbs.

District of Keewatin.

District of Keewatin.

57.—From an island eighteen miles south-west of Rat Portage, Lake of the Woods. Examined for Mr. J. C. Gough.

It consisted of quartz stained, and more or less coated, with ferric hydrate, with here and there a few specks of galena and iron-pyrites. Weight of specimen, nine and a-half pounds. Assays, by Mr. E. B. Kenrick, showed it to contain:

Gold ..... 0·350 of an ounce to the ton of 2,000 lbs.
Silver ..... 0·293 " " "

North-West Territory.

Assays Nos. 58 to 64 inc., were conducted by Mr. F. D. Adams.

North-we Territory.

58.—This, and the following five specimens were collected by Dr. G. M. Dawson.

From Hoo-che-koo Bluff, Lewes River, a branch of the Yukon.

An exceedingly fine grained, brown weathering, argillaceous rock, containing a little disseminated copper-pyrites and much stained with green carbonate of copper. The rock is traversed by

thin veins of white calcite. Weight of specimen, eleven ounces. Assays gave:

Gold..... minute trace.
Silver..... 0·088 of an ounce to the ton of 2,000 lbs.

59.—From Frances Lake, head of Liard River.

A greyish translucent quartz, somewhat stained with ferric hydrate and containing a little chloritic matter and iron-pyrites. Weight of specimen, ten ounces. It contained:

Gold..... minute trace.
Silver..... none.

60.—From Frances Lake, head of Liard River, from another exposure.

A greyish translucent quartz, traversed by small veins and strings of a very ferruginous dolomite, and associated with a little chloritic matter. Weight of specimen, one pound one ounce. Assays showed it to contain:

Gold..... trace.
Silver..... none.

61.—From Finlayson River, head of Liard River.

A grey translucent quartz, more or less coated with ferric hydrate. The specimen, which was made up of numerous fragments taken from different parts of a very large quartz vein, weighed eleven ounces.

It contained neither gold nor silver.

62.—From Pelly River, head waters of the Yukon.

A very fine grained dark grey siliceous rock, impregnated with mispickel and traversed by small veins of calcite. Weight of specimen, twelve ounces. It was found to contain:

Gold..... distinct trace.
Silver..... none.

63.—From Tagish or Tahko Lake, Lewes River, a branch of the Yukon.

A very fine grained, somewhat calcareous, greenish-grey, rusty weathering, felsite, through which was disseminated a little magnetic-pyrites. Weight of specimen, one pound seven ounces.

It contained neither gold nor silver.

64.—From a large vein in Red Mountain, Bennett Lake, Lewes River, Collected by Mr. W. Ogilvie.

A rather fine grained granitic rock holding a little magnetic

Gold and Silver Assays, cont.

pyrites. Weight of specimen, one pound two ounces. Assays gave:

Gold..... distinct trace.
Silver..... none.

PROVINCE OF BRITISH COLUMBIA.

Assays Nos. 69 *to* 112 *inc.*, 122, 123, *and* 136 *to* 159 *inc.*, *were conducted by Mr. E. B. Kenrick—Nos.* 65 *to* 67 *inc.*, 113, 120, 121, *and* 131 *to* 134 *inc.*, *by Mr. F. D. Adams, and Nos.* 68, 114 *to* 119 *inc.*, 124 *to* 130 *inc.*, 135, 160, *and* 161, *by Mr. R. A. A. Johnston.*

Province of British Columbia.

65.—From one of the Hepburn claims on Idaho Mountain, south-east side of Stump Lake, east side of the Nicola Valley stage road, from eight hundred to one thousand feet above the level of the lake, Nicola Valley, Examined for Senator W. E. Sanford.

It consisted of quartz, in parts honeycombed and more or less stained and coated with yellowish and brownish ochres, carrying small quantities of galena. Weight of specimen, nine and a-half pounds. It was found to contain:

Gold..... 0·759 of an ounce to the ton of 2,000 lbs.
Silver..... 406·574 ounces. " " "

66.—From Stump Lake, Nicola Valley.

It consisted of a coarse crystalline galena, through which was disseminated a rather small amount of copper-pyrites and a very small quantity of an indigo-blue sulphide, apparently resulting from the alteration of the copper-pyrites, and allied to covellite, as likewise a little quartz. It contained:

Gold..... distinct trace.
Silver..... 20·339 ounces to the ton of 2,000 lbs.

Two samples of the galena of this specimen, carefully freed from all associated material, were assayed and found to contain:

The first—Gold..... none.
Silver.... 32·900 ounces to the ton of 2,000 lbs.

The second—Gold... none.
Silver.. 31·135 ounces to the ton of 2,000 lbs.

The galena from different parts of the specimen is, therefore, not quite constant in its content of silver.

The copper-pyrites carefully freed from associated material, still containing, however, a small quantity of the above mentioned

indigo-blue mineral, which it was found impossible to exclude entirely, gave:

Gold..... distinct trace.
Silver..... 1·600 ounce to the ton of 2,000 lbs.

67.—From the same locality as the last mentioned.

It consisted of a rather fine-grained mixture of galena, iron-pyrites and quartz. One portion of the specimen contained, intimately associated with the quartz, a considerable amount of tetrahedrite. The tetrahedrite, freed from associated minerals, still containing some quartz, however, was assayed and found to contain:

Gold..... 1·823 ounce to the ton of 2,000 lbs.
Silver..... 434·328 ounces " "

The amount of quartz in some of the material employed for assay was estimated and found to amount to 17·475 per cent. The quantities of the precious metals in the pure tetrahedrite would, therefore, be as follows:

Gold..... 2·209 ounces to the ton of 2,000 lbs.
Silver.....526·299 " " "

68.—Also, from Stump Lake, the precise locality was not stated.

It consisted of a white sub-translucent quartz, carrying a considerable quantity of galena: some portions of the specimen were stained with ferric hydrate, and in parts lightly coated with green carbonate of copper. Weight of specimen, two pounds five ounces. Assays showed it to contain:

Gold..... 6·096 ounces to the ton of 2,000 lbs.
Silver..... 90·650 " " "

69.—A specimen of ore, examined on a former occasion, from the property of what was formerly known as the Nicola Milling and Mining Company on Mineral Hill, south-east side of Stump Lake, west side of the Nicola Valley stage road, Nicola Valley, and which consisted of galena in association with tetrahedrite, small quantities of iron-pyrites, copper-pyrites, and a little bornite, in a gangue of quartz, the latter frequently very much honeycombed—the whole presenting a more or less weathered appearance, and for the most part coated with ferric hydrate, in parts with carbonate of lead, and here and there with a little green carbonate of copper, was found to contain:

Gold..... 0·729 of an ounce to the ton of 2,000 lbs.
Silver.....104·271 ounces " "

Gold and Silver Assays, cont.

Province of British Columbia, cont.

70.—This and the following specimen, also examined on a former occasion, is from the southern extremity of Stump Lake, Nicola Valley.

It consisted of a fine crystalline galena, associated with a little iron-pyrites, in a gangue of greyish-white translucent quartz. The metallic sulphides constituted, approximately, one-fourth, by weight, of the whole. Weight of specimen, three and a-half ounces. Assays showed it to contain :

Gold.....	0·729 of an ounce to the ton of 2,000 lbs.
Silver.....	15·094 ounces " "

71.—A somewhat coarse crystalline galena, in association with iron-pyrites, copper-pyrites, and a white translucent quartz; the latter constituted but a very small proportion of the whole. Weight of specimen, three and a-quarter ounces. Assays gave :

Gold.....	1·969 ounce to the ton of 2,000 lbs.
Silver.....	17·063 ounces " "

Of the following specimens, Nos. 72 to 112 inc., are from the District of Cariboo, and of these Nos. 72 to 109 inc., were collected by Mr. Amos Bowman.

72.—From Little Snow-shoe Creek, Cariboo District. T. Haywood's Discovery claim.

A white translucent quartz, with a little chlorite and a trifling amount of iron-pyrites, with here and there a pseudomorph of limonite after pyrite. It was, in parts, thickly coated with ferric hydrate. Weight of specimen, eight ounces. It was found to contain :

Gold.....	0·408 of an ounce to the ton of 2,000 lbs.
Silver.....	0·058 " " "

73.—From the same locality as the last.

It consisted of quartz, in association with a little chlorite, it contained small quantities of iron-pyrites, and was in parts coated with ferric hydrate. Weight of specimen, one pound ten ounces. Assays gave :

Gold.....	distinct trace.
Silver.....	none.

74.—Also, from the same locality as No. 72.

A white sub-translucent quartz, with a little chlorite and a trifling amount of iron-pyrites; the whole was, for the most part,

coated with ferric hydrate. Weight of specimen, three and a-half ounces. It contained:

Gold ..... very distinct trace.
Silver ..... none.

75.—From summit of Harvey Creek trail, Cariboo District.

A white sub-translucent to translucent quartz, in association with small quantities of a chloritic mineral: it was in parts coated with ferric hydrate. Weight of specimen, six and a-half ounces. Assays showed it to contain:

Gold ..... trace.
Silver ..... none.

76.—From Harvey Creek, below Falls, "Ironstone" ledge, Cariboo District.

Siderite, through which was disseminated small quantities of magnetic-pyrites and a little iron-pyrites. Weight of specimen, twelve ounces.

Assays gave:

Gold ..... very distinct trace.
Silver ..... none.

77.—From same locality as the last, about two hundred feet lower down the Creek.

An association of siderite and ankerite, through which was disseminated small quantities of iron-pyrites. The specimen was thickly coated with ferric hydrate. Weight of sample, three pounds eleven ounces.

It contained neither gold nor silver.

78.—From Duck Creek, Borland's ledge, Cariboo District.

A white translucent quartz, through which was disseminated a little iron-pyrites and a small amount of chlorite: it was in parts stained and coated with ferric hydrate. Weight of specimen, one pound fifteen ounces. It contained:

Gold ..... distinct trace.
Silver ..... none.

79.—From North Fork of Quesnel, near mouth of Spanish Creek, Cariboo District.

A white sub-translucent quartz, in parts thickly coated with

Gold and Silver Assays, cont.

Province of British Columbia, cont.

ferric hydrate. Weight of specimen, eight and a-half ounces. It was found to contain:

Gold..... trace.
Silver..... none.

80.—From Duck Creek, three hundred feet above the bridge, Cariboo District.

A white, translucent quartz carrying small quantities of galena, and a little iron-pyrites and zinc-blende: it was in parts coated with ferric hydrate. Weight of specimen, two pounds twelve ounces. It contained:

Gold..... very distinct trace.
Silver..... 3·850 ounces to the ton of 2,000 lbs.

81.—From Cunningham Creek, near Sharp's, Cariboo District.

An association of ankerite and quartz, together with a little chlorite: it was in parts thickly coated with ferric hydrate. Weight of specimen, three and a-half ounces. Assays gave:

Gold..... trace.
Silver..... none.

82.—From Antler Creek, near Porter's cabin, Cariboo District.

It consisted of limestone with intermixed ankerite: the specimen was thickly coated with ferric hydrate. Weight of specimen, three pounds.

It contained neither gold nor silver.

83.—From Antler Creek, below site of old Antler town. Cariboo District.

A white sub-translucent quartz, in parts honeycombed, the cavities holding ferric hydrate; portions of the specimen were also thickly coated with this latter. Weight of specimen, two pounds. It was found to contain:

Gold..... trace.
Silver..... none.

84.—From same locality as the last, but from a different ledge.

A white translucent quartz, in parts slightly honeycombed, the cavities holding ferric hydrate. Weight of specimen, four ounces. Assays gave:

Gold..... distinct trace.
Silver..... none.

85.—From Cunningham Creek, near head of Sharp's Ditch, Cariboo District.

It consisted of iron-pyrites in a gangue of quartz. Weight of specimen, one pound two ounces. Assays showed it to contain:

Gold ..... very distinct trace.
Silver ..... none.

86.—From Sugar Creek, cañon above Wiley's, upper ledge, Cariboo District.

A white sub-translucent quartz, carrying small quantities of iron-pyrites and a little copper-pyrites: it was for the most part stained with ferric hydrate. Weight of specimen, one pound nine ounces. It contained:

Gold ..... distinct trace.
Silver ..... none.

87.—From Sugar Creek, cañon above Wiley's, lower ledge.

A white sub-translucent quartz, in association with a small quantity of siderite: it was in parts coated with ferric hydrate. Weight of specimen, twelve ounces. Assays gave:

Gold ..... distinct trace.
Silver ..... none.

88.—From Sugar Creek, cañon above Wiley's.

A white sub-translucent quartz, with here and there, a little siderite and a trifling amount of chlorite: it was in parts much honeycombed, the cavities holding ferric hydrate. Weight of specimen, one pound one ounce. It contained:

Gold ..... distinct trace.
Silver ..... none.

89.—From Sugar Creek, at Wiley's cabin.

A white sub-translucent to translucent quartz, with a little chlorite and a trifling amount of zinc-blende: it was for the most part thickly coated with ferric hydrate. Weight of specimen, one and a-quarter pound. Assays showed it to contain:

Gold ..... trace.
Silver ..... none.

90.—From Sugar Creek, opposite Walker's cabin.

A white sub-translucent quartz, containing small quantities of iron-pyrites: it was in parts thickly coated with ferric hydrate. Weight of specimen, eight ounces. It contained:

Gold ..... distinct trace.
Silver ..... none.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

91.—From Sugar Creek, branch half a mile south of junction.

A white sub-translucent quartz, carrying a little galena and iron-pyrites: it was for the most part stained with ferric hydrate. Weight of specimen, fourteen ounces. Assays gave:

Gold..... very distinct trace.
Silver..... 0·525 of an ounce to the ton of 2,000 lbs.

92.—From Mosquito Creek, Saunder's diggings, Cariboo District.

An association of a white sub-translucent quartz and felspar, with here and there, a few flakes of silvery-white mica: it was for the most part, stained and coated with ferric hydrate. Weight of specimen, fourteen ounces. It was found to contain:

Gold..... trace.
Silver..... none.

93.—From Mosquito Creek, Flynn's diggins.

An association of galena and iron-pyrites, in parts coated with ferric hydrate: it was apparently free from gangue. Weight of specimen, eight ounces. It contained:

Gold..... 0·182 of an ounce to the ton of 2,000 lbs.
Silver..... 36·458 ounces " "

94.—From Mosquito Creek, also, from Flynn's diggins.

A white translucent quartz, with small quantities of siderite and chlorite. Weight of specimen, two pounds one ounce. Assays showed it to contain:

Gold..... trace.
Silver..... none.

95.—From "Lady of the Lake," Jack of Clubs Lake.

A white translucent quartz, in association with a small quantity of carbonaceous matter, carrying iron-pyrites: it was in parts stained with ferric hydrate. Weight of specimen, one pound ten ounces. It contained:

Gold..... very distinct trace
Silver..... none.

96.—From Grouse Creek, "Fountain Head" claim.

A white sub-translucent quartz, in association with a little chlorite: it was in parts much honeycombed, the cavities holding ferric hydrate. Weight of specimen, twelve and a-half ounces. It was found to contain:

Gold..... distinct trace.
Silver..... none.

97.—From Grouse Creek, "Dufferin" ledge.

It consisted of iron-pyrites in a gangue of white sub-translucent quartz, with which was associated a small quantity of carbonaceous matter. Weight of specimen, two and a-half pounds. Assays showed it to contain:

Gold ..... 2·042 ounces to the ton of 2,000 lbs.
Silver ..... 0·292 of an ounce " "

98.—From Barkerville, "Proserpine" ledge at Wilkinson House.

A white sub-translucent quartz, with which was associated a small quantity of carbonaceous matter and a little siderite, carrying a small amount of iron-pyrites: it was for the most part stained with ferric hydrate. Weight of specimen, two pounds one ounce. Assays gave:

Gold ..... trace.
Silver ..... none.

99.—From Barkerville, "Proserpine" ledge at "Proserpine" shaft.

An association of iron-pyrites and galena in a gangue, consisting of quartz and chlorite. Weight of specimen, two pounds thirteen ounces. It was found to contain:

Gold ..... 0·787 of an ounce to the ton of 2,000 lbs.
Silver ..... 20·738 ounces " "

100.—From Barkerville, "Home Rule" ledge.

An association of galena, iron-pyrites and limonite. Weight of of specimen, one pound. Assays showed it to contain:

Gold ..... 0·029 of an ounce to the ton of 2,000 lbs.
Silver ..... 6·562 ounces " "

101.—From Barkerville, also, from the "Home Rule" ledge.

A coarse crystalline galena, with here and there a small quantity of white translucent quartz: it was, in parts, coated with ferric hydrate. Weight of specimen, one pound fourteen ounces. It contained:

Gold ..... distinct trace.
Silver ..... 25·521 ounces to the ton of 2,000 lbs.

102.—From Barkerville, "Sergeant Lindsay" ledge.

A white sub-translucent quartz, for the most part stained and coated with ferric hydrate. Weight of specimen, two pounds eleven ounces. Assays gave:

Gold ..... trace.
Silver ..... 1·808 ounce to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

103.—From Barkerville, "Stanley" ledge, opposite "Van Winkle" dump.

A white sub-translucent quartz, in association with a small quantity of a dark bluish-grey chloritic mineral: it contained in parts a little ferric hydrate. Weight of specimen, two pounds fifteen ounces. It was found to contain:

Gold	distinct trace.
Silver	none.

104.—From Barkerville, "Stanley" ledge, opposite "Van Winkle" Company's house.

This material was very similar in character to that of last mentioned specimen. Weight of sample, nine ounces. It contained:

Gold	trace.
Silver	none.

105.—From Burns Mountain, "Jacques" ledge.

A white translucent quartz, carrying small quantities of galena and iron-pyrites. Weight of specimen, one and a-quarter pound. Assays gave:

Gold	very distinct trace.
Silver	3·442 ounces to the ton of 2,000 lbs.

106.—From Burns Mountain, "Perkins" ledge.

A white translucent quartz, much honeycombed, carrying a little galena: it was for the most part stained with ferric hydrate. Weight of specimen, one pound. Assays showed it to contain:

Gold	2·625 ounces to the ton of 2,000 lbs.
Silver	3·033 " " "

107.—From Burns Mountain, also from "Perkins" ledge.

A coarse crystalline galena, with here and there a few specks of pyrite, in association with a small quantity of white translucent to transparent quartz: it was in parts coated with ferric hydrate. Weight of specimen, two pounds ten ounces. It was found to contain:

Gold	0·365 of an ounce to the ton of 2,000 lbs.
Silver	29·896 ounces " "

108.—From Chisholm Creek, near Stanley; lowest stringers.

A white, sub-translucent quartz with a little chlorite: it was

for the most part stained with ferric hydrate. Weight of specimen, eleven ounces. It contained:

Gold ..... distinct trace.
Silver ..... none.

109.—From Lightning Creek, "Sam Montgomery's" ledge.

A white, sub-translucent quartz with which was associated a little chlorite: it was more or less stained with ferric hydrate. Weight of specimen, one pound fifteen ounces. Assays gave:

Gold ..... distinct trace.
Silver ..... none.

110.—From the "Hixon Creek" Mine, Hixon Creek, Upper Fraser River. Taken from a depth of about 200 feet.

It consisted of an association of chlorite and iron-pyrites, with a little calcite. Weight of specimen, three and three-quarter ounces.

It contained neither gold nor silver.

111.—Another specimen from this mine was found to contain:

Gold ..... 0·408 of an ounce to the ton of 2,000 lbs.
Silver ..... 1·225 ounce " "

112.—From the "Dunlevy" ledge, Island Mountain.

It consisted of iron-pyrites in a gangue of quartz. Weight of specimen, two pounds. It was found to contain:

Gold ..... 0·233 of an ounce to the ton of 2,000 lbs.
Silver ..... 0·350 " " "

113.—From near Granite Creek, Similkameen River.

It consisted of an impure rudely banded limestone stained with ferric hydrate. Weight of specimen, thirteen and a-half ounces. Assays gave:

Gold ..... trace.
Silver ..... 0·029 of an ounce to the ton of 2,000 lbs.

114.—From Otter-Tail, seven miles south-east of Otter-Tail Station, Canadian Pacific Railway, Rocky Mountains. This, and the following five specimens were examined for Mr. G. Pollock.

It consisted of galena, through which was disseminated a very large amount of ferric hydrate. Weight of specimen, two and a-half ounces.

It contained neither gold nor silver.

115.—From the vicinity of Otter-Tail Station, Canadian Pacific Railway, Rocky Mountains.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

The specimen, which consisted of purple copper ore, weighed two and three-quarter ounces. Assays showed it to contain:

Gold..... none.
Silver..... 19·687 ounces to the ton of 2,000 lbs.

116.—From the same locality as the last mentioned.

It consisted of a fine crystalline galena in association with small quantities of iron-pyrites and dolomite. Weight of specimen, one ounce. It was found to contain:

Gold..... none.
Silver..... 4·739 ounces to the ton of 2,000 lbs.

117.—This, and the two following specimens are from within two miles west of Field Station, on the line of the Canadian Pacific Railway, Kicking Horse (Hector) Pass, Rocky Mountains.

A white sub-translucent quartz, more or less coated with ferric hydrate. Weight of specimen, nine ounces.

It contained neither gold nor silver.

118.—A white translucent quartz thickly coated with ferric hydrate. Weight of specimen, eight ounces.

It contained neither gold nor silver.

119.—A white sub-translucent quartz, carrying copper-pyrites: it was for the most part coated with ferric hydrate, and here and there with a little green carbonate of copper. Weight of specimen, five ounces.

It contained neither gold nor silver.

120.—From mountain near Hope, Fraser River.

It consisted of magnetic-pyrites and a little iron-pyrites, together with a small quantity of a dark siliceous rock. Weight of specimen, twelve ounces. Assays showed it to contain:

Gold..... distinct trace.
Silver..... 0·263 of an ounce to the ton of 2,000 lbs.

121.—Described as casing rock of preceding specimen.

A rather fine-grained, greyish, banded silicious rock, containing a good deal of calcite, and here and there a few small grains of iron-pyrites. Weight of specimen, five and a-half ounces. Assays gave:

Gold..... trace.
Silver..... 0·116 of an ounce to the ton of 2,000 lbs.

122.—From Kamloops Lake, near Cherry Creek.

An association of quartz, calcite, and serpentine, with a little specular iron and a few specks of copper-pyrites. Weight of specimen, fourteen ounces. It was found to contain:

Gold..... trace.
Silver..... 0·350 of an ounce to the ton of 2,000 lbs.

123.—From the North Thompson, above Clearwater River.

A white opaque quartz carrying small quantities of a dark leaden colored mineral (which was not identified as the abstraction of a sufficient amount of material to enable this to be done, would have injured the specimen for assay), and a little limonite. Weight of specimen, four and three-quarter ounces. It contained:

Gold..... 4·375 ounces to the ton of 2,000 lbs.
Silver..... 21·350 " "

124.—From the head of Waterton River, Rocky Mountains. Examined for Mr. G. Cusick.

An association of a white sub-translucent quartz, chloritic schist, and a little dolomite, carrying galena, magnetic-pyrites and a small amount of copper-pyrites: it was, in parts, coated with ferric hydrate, and here and there, stained with green carbonate of copper. Weight of specimen, eight ounces. Assays gave:

Gold..... trace.
Silver..... 1·575 ounce to the ton of 2,000 lbs.

125—From a vein on the west side of the Upper Kootenay River, between the mouth of Finlay Creek and the upper crossing. This, and the five following specimens were examined for Mr. A. B. Grohman.

A milky white quartz in association with a little dolomite and greenish-grey chloritic schist: the whole was more or less coated with ferric hydrate. Weight of specimen, eleven ounces. It was found to contain:

Gold..... trace.
Silver..... none.

126.—From a lead on the south bank of Elk River, between the bridge and lower ford.

A white opaque quartz in association with small quantities of a bright green chloritic mineral: it contained, in parts, a little hematite and ferric hydrate. Weight of specimen, fifteen ounces.

It contained neither gold nor silver.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

127.—From a lead on the south slopes of Cinnabar Mountain, Upper Kootenay River, above Canal flat.

An association of dolomite, red and white calcite, and crystalline quartz: it was, in parts, stained with ferric hydrate. Weight of specimen, six and a-half ounces.

It contained neither gold nor silver.

128.—From a lead on the south bank of the Kootenay River, about two miles above the upper crossing.

A white opaque, and greyish-white translucent quartz: in parts stained with ferric hydrate. Weight of specimen, seven and a-half ounces,

It contained neither gold nor silver.

129.—From near the outlet of Kootenay Lake.

Consisted, apparently, exclusively of bornite, through which was disseminated a few grains of colorless, transparent quartz. Weight of specimen, three-quarters of an ounce. It was found, on assay, to contain:

Gold ..... none.
Silver..... 119·218 ounces to the ton of 2,000 lbs.

130.—From the south-east quarter of lot eleven, township fifteen, New Westminster district.

A white translucent quartz, in association with chloritic schist: it contained a trifling amount of copper-pyrites, was in parts coated with ferric hydrate, and here and there, stained with green carbonate of copper. Weight of specimen, one pound five ounces. Assays gave:

Gold..... trace.
Silver..... none.

131.—From the vicinity of Illecillewaet Station, on the line of the Canadian Pacific Railway.

A very fine-grained bluish-grey siliceous rock, through which was disseminated a small quantity of magnetic-pyrites in very minute grains. Weight of specimen, one ounce.

It contained neither gold nor silver.

132—This, and the three following specimens are from the Illecillewaet district. They were examined for Mr. W. McGirr.

A coarsely crystalline galena. Weight of specimen, two ounces. On assay was found to contain :

Gold..... mere trace.
Silver..... 64·859 ounces to the ton of 2,000 lbs.

133.—A translucent quartz, carrying iron-pyrites : it was more or less stained with ferric hydrate. Weight of specimen, one and a-half ounces.

It contained neither gold nor silver.

134.—Consisted of zinc-blende, together with a few specks of copper-pyrites, in a gangue of greyish translucent quartz. Weight of specimen, ten and a-half ounces. Assays gave :

Gold..... distinct trace.
Silver..... 0·262 of an ounce to the ton of 2,000 lbs.

135.—A white translucent quartz, carrying a good deal of copper-pyrites. Weight of specimen, one pound five ounces. It was found to contain :

Gold..... trace.
Silver..... 2·946 ounces to the ton of 2,000 lbs.

136.—This, and the two following specimens are from within about a mile of the Illecillewaet Station, on the line of the Canadian Pacific Railway.

A moderately coarse crystalline galena, in a gangue of translucent quartz. Weight of specimen, one pound two ounces. It contained .

Gold..... none.
Silver..... 24·208 ounces to the ton of 2,000 lbs.

137.—An association of zinc-blende, galena, magnetic-pyrites and iron-pyrites, in a quartzose gangue. Weight of specimen, twelve and a-quarter ounces. Assays gave :

Gold..... trace.
Siiver..... 1·823 ounce to the ton of 2,000 lbs.

138.—Consisted of magnetic pyrites. Weight of specimen, one ounce. It was found to contain :

Gold..... trace.
Silver..... none.

139.—From the border of a lake in the vicinity of the Illecillewaet Station, on the line of the Canadian Pacific Railway. About two miles from the track, south side.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

A magnetic sand. Weight of specimen, one pound five and a-half ounces. It was found, on assay, to contain:

Gold..... trace.
Silver..... none.

140.—From four miles east of the Illecillewaet Station, north side of the line of the Canadian Pacific Railway.

It consisted of magnetite, in a gangue of quartz and chlorite. Weight of specimen, six and a-quarter ounces.

It contained neither gold nor silver.

141.—This, and the following specimen are from about fifteen miles west of summit of the Selkirk Range, and three miles north of the line of the Canadian Pacific Railway.

It consisted of quartz, carrying a little galena. Weight of specimen, eleven ounces. It contained:

Gold..... trace.
Silver..... 6·475 ounces to the ton of 2,000 lbs.

142.—Consisted of galena, magnetic-pyrites, and iron-pyrites, with a little quartz. Weight of specimen, fourteen and a-quarter ounces. Assays gave:

Gold..... none.
Silver..... 10·937 ounces to the ton of 2,000 lbs.

143.—From the Illecillewaet River.

An association of a coarsely crystalline galena, zinc-blende, and a little iron-pyrites, in a gangue consisting of translucent to transparent quartz, and chlorite. The metallic sulphides constituted, approximately, sixty-seven per cent., by weight, of the whole. Weight of specimen, six and a-quarter ounces. It was found to contain:

Gold..... trace.
Silver..... 45·208 ounces to the ton of 2,000 lbs.

144.—Same locality as the last.

A modeartely coarse, to coarse crystalline galena, with a little zinc-blende, and a small quantity of iron-pyrites, in a gangue composed of translucent quartz, together with a little chlorite and calcite: it was, in parts, stained and coated with ferric hydrate. The metallic sulphides constituted but a very small proportion of the whole. Weight of specimen, about thirteen pounds. Assays showed it to contain:

Gold..... trace.
Silver..... 9·683 ounces to the ton of 2,000 lbs.

145.—From the Illecillewaet River, Selkirk Range, north side of the valley. Received from Mr. G. R. Wright.

An association of iron-pyrites and galena, in a gangue of white, translucent quartz. Weight of specimen, three ounces. Assays gave:

Gold..... none.
Silver..... 247·917 ounces to the ten of 2,000 lbs.

146.—From the Illecillewaet River, Selkirk Range, south side of the valley. Received from Mr. G. R. Wright.

An association of galena, tetrahedrite and a little iron-pyrites, with some quartz. Weight of specimen, one and a-quarter ounce. It contained:

Gold..... none.
Silver..... 484·167 ounces to the ton of 2,000 lbs.

147.—A sample of material, from the same opening as the last, as dressed for shipment, and consisting, apart from a very small quantity of iron-pyrites, almost exclusively of tetrahedrite, was ound to contain:

Gold..... distinct trace.
Silver..... 816·667 ounces to the ton of 2,000 lbs.

148.—This, and the following eight specimens are from the Illecillewaet district.

A white opaque quartz, carrying a little tetrahedrite and a trifling amount of copper-pyrites: it was in parts coated with ferric hydrate; also with a little green and blue carbonate of copper. Weight of specimen, one ounce. Assays gave:

Gold..... trace.
Silver..... 248·646 ounces to the ten of 2,000 lbs.

149.—A moderately coarse crystalline galena, in association with quartz and a little hydrated peroxide of iron. Weight of specimen, two ounces. It contained:

Gold..... none.
Silver..... 47·396 ounces to the ton of 2,000 lbs.

150.—An opaque quartz, carrying small quantities of a moderately coarse crystalline galena and a trifling amount of iron-pyrites: it also contained, in parts, a little hydrated peroxide of iron. Weight of specimen, two ounces. It was found to contain:

Gold..... trace.
Silver..... 5·833 ounces to the ton of 2,000 lbs.

Gold and Silver Assays, cont.

Province of British Columbia, cont.

151.—A white opaque quartz, carrying galena, tetrahedrite, zinc-blende and a little iron-pyrites. Weight of specimen, one and a-half ounces. Assays showed it to contain:

Gold..... trace.
Silver..... 127·604 ounces to the ton of 2,000 lbs.

152.—A moderately coarse crystalline galena. Weight of specimen, two ounces. It was found, on assay, to contain:

Gold..... trace.
Silver..... 57·604 ounces to the ton of 2,000 lbs.

153.—Quartz carrying small quantities of galena and tetrahedrite: it was, in parts, coated with a little ferric hydrate and green carbonate of copper. Weight of specimen, four ounces. It contained:

Gold..... none.
Silver..... 0·729 of an ounce to the ton of 2,000 lbs.

154.—An association of moderately coarse crystalline galena and translucent quartz. Weight of specimen, three and three-quarter ounces. Assays gave:

Gold..... distinct trace.
Silver..... 54·687 ounces to the ton of 2,000 lbs.

155.—A coarsely crystalline galena, in association with a small proportion of translucent quartz: it was in parts stained and coated with ferric hydrate. Weight of specimen, not quite four ounces. It was found to contain:

Gold..... trace.
Silver..... 67·813 ounces to the ton of 2,000 lbs.

156.—An association of moderately coarse crystalline galena and tetrahedrite, together with small quantities of white, opaque, quartz. Weight of specimen, one and a-half ounce. Assays gave:

Gold..... none.
Silver..... 180·104 ounces to the ton of 2,000 lbs.

157.—From the "Kitawat" ledge, Kitawat, Gardner Inlet. Received from Mr. W. Downie.

It consisted of a white translucent quartz: carrying small quantities of copper-pyrites, zinc-blende, and galena. Weight of specimen, four pounds seven ounces. Assays showed it to contain:

Gold..... distinct trace.
Silver..... 4·433 ounces to the ton of 2,000 lbs.

158.—From Discovery Passage, Vancouver Island. Collected by Dr. G. M. Dawson. Gold and Silver Assays, cont.

A white sub-translucent quartz, carrying a little copper-pyrites. Weight of specimen, one pound ten ounces. Assays gave: Province of British Columbia, cont.

Gold	very distinct trace.
Silver	0·175 of an ounce to the ton of 2,000 lbs.

159.—From the Malaspina copper-mine, north-east side of Texada Island. Collected by Dr. G. M. Dawson.

It consisted of an association of copper-pyrites and iron-pyrites, together with a little magnetite, in a gangue composed of calcite, small quantities of a dark green chlorite, and a little quartz. The metallic sulphides constituted, approximately, fifty-five per cent., by weight, of the whole. Weight of specimen, five pounds five and a-quarter ounces. It was found to contain:

Gold	trace.
Silver	10·209 ounces to the ton of 2,000 lbs.

160.—From Harriet Harbor, Skincuttle Inlet, Queen Charlotte Islands.

The material here in question is referred to in the Report of Progress for 1878-79, Part B, p. 52, where it is described by Dr. G. M. Dawson as "a material which appears to be a felspathic ash rock containing a large proportion of calcareous matter. It is grey in color, speckled by the mixture of light and dark fragments, and shot through with iron-pyrites in small concretions and veins." Weight of specimen, one pound six ounces.

It contained neither gold nor silver.

161.—From the vicinity of the iron mine, north of Gillies Bay, Texada Island. Collected by Dr. G. M. Dawson and referred to by him in the Annual Report, vol ii., part B, p. 35.

It consisted of a granitoid rock, through which was disseminated a little iron-pyrites. Weight of specimen, one pound six ounces.

It contained neither gold nor silver.

MISCELLANEOUS EXAMINATIONS.

1.—Iron-pyrites.—From lot five, range four of the township of Darling, Lanark county, Ontario. Examined for Mr. H. Torrance. Iron pyrites from Darling, Lanark county, Ont.

Mr. F. D. Adams has made an analysis of a sample of ore from this locality, and with the following results:—

Sulphur		49·228
Arsenic		0·174
Iron (calculated)		43·074
Insoluble matter 6·353	gangue	8·299
Carbonate of lime 1·946		
Water, hygroscopic		0·141
		100·916

Other samples from this deposit have recently been assayed by Mr. R. A. A. Johnston for gold and silver—the results were negative.

Chromic-iron-ore from Thetford, Megantic county, P.Q.

2.—Chrome-iron-ore.—From lot seventeen, range four of Thetford. Megantic county, Province of Quebec. Examined for Dr. James Reed.

The specimen consisted of chromite in intimate association with massive and fibrous serpentine. Mr. E. B. Kenrick found it to contain :—

Chromic oxide ..... 35·46 per cent.

Limestone from Agassiz Station, B.C.

3.—Limestone.—From near Agassiz Station, on the line of the Canadian Pacific Railway, British Columbia.

Three specimens of material from this deposit have been examined by Mr. F. D. Adams. The first, when treated with dilute hydrochloric acid left a considerable amount of a gritty insoluble residue. When burnt, the resultant product slaked readily, affording a fairly white lime of good quality. The second, when treated with acid, left a good deal of insoluble residue. The burnt material slaked readily, yielding a lime of very pronounced color, due to the presence of small quantities of iron-pyrites in the original stone. The lime could be used for all purposes where color was no object. The third, contained a very large amount of insoluble matter amounting, approximately, to rather more than fifty per cent. of the rock. The burnt material slaked but imperfectly. This stone is unsuited for the preparation of a lime.

Tin ore, reported finding of.

4.—Tin ore, reported finding of.—The material here referred to was brought to the Survey by Dr. J. Latimer, who stated that it had been taken from an opening on the sixth lot of the eleventh range of Whitton, Compton county, Province of Quebec.

It weighed eight pounds fourteen and a-half ounces: the material composing it was for the most part in the form of fragments, the balance was in the form of coarse sand and dust, this constituted, however, but a comparatively small proportion, by weight, of the whole.

The "bulk of the material" consisted of a greyish-white to white sub-translucent quartz, and a dark grey rock, together with a little chlorite, and felspar, all of which were (with an occasional exception in favor of the two former—a few of the fragments consisting almost exclusively of the one or the other) in more or less intimate association. All the fragments here referred to contained more or less iron-pyrites, most frequently well crystallized in cubes, and were to a greater or less extent stained or coated with ferric hydrate. Intermixed with the foregoing were two fragments of arsenical pyrites (one consisting almost exclusively of arsenopyrite, the other of an association of arsenopyrite with white translucent quartz), a fragment of intermixed magnetite and specular iron, and numerous fragments of tin stone, one of which weighed not less than nine and a-half ounces. The tin stone, which was in parts well crystallized, was remarkably free from gangue, containing but a trifling amount of rock matter consisting, essentially, of white translucent to opaque quartz. On two of the fragments of tin stone were observed, what apparently consisted of, the remains of imperfectly removed labels. In no instance could, even so much as a speck of tin stone be detected in any one single fragment of some three hundred fragments which went to make up what has been above described as "the bulk of the material," and which it was left to be inferred constituted the original gangue of the tin stone. The locality whence the foregoing was stated to have been obtained, was subsequently visited by Dr. R. W. Ells, of this Survey, who collected and forwarded me a sample of material, weighing some forty pounds, from the same opening. This was examined by Mr. F. D. Adams, who found the rock matter composing it to be very similar in character to that of the sample received from Dr. Latimer, it contained, however, much less iron-pyrites, no arsenical-pyrites, nor so much as a speck of tin stone.

The material of the first mentioned sample was, after separation of the cassiterite, submitted to assay, and found to contain a trace of gold but no silver.

5.—Terra cotta.—A clay well suited for the manufacture of this ware, occurs on the east-half of lot two, range seven, of the township of Nassagaweya, Halton county, Ontario. When burnt, it assumes a very pleasing color, one that would more especially recommend it for works of an architectural character, such as bas-reliefs, friezes, and the like.

Terra cotta, clay suitable for manufacture of. From Nassagaweya Halton county, Ont.

6.—Zinc-blende.—What may prove to be an important deposit, the

Zinc-blende.

extent of which has not, however, as yet been ascertained, of this ore occurs on the tenth lot of the fourth range of Calumet, Pontiac county, Province of Quebec. It consists of a more or less intimate association of zinc-blende and galena, together with small quantities of iron-pyrites. The proportion of the two latter, more especially the galena, to the former, varied greatly in different specimens. A fair average of numerous samples of this material was submitted to assay, and found to contain 11·666 ounces of silver to the ton of 2,000 lbs., together with traces of gold.

Magnetite pseudomorph after pyrite.

7.—Magnetite crystals pseudomorph after pyrite. When examining the sample of iron ore from the vicinity of Kinnear's Mills, referred to on a preceding page under Iron Ores—No. 2, Mr. E. B. Kenrick observed, imbedded in the same, some small crystals which were in the form of cubes with faces striated parallel to the edges of the pyritohedron. They were black in color and showed a high metallic lustre and brilliant faces. The best crystals had cubic edges, measuring one millimetre or less in length. The crystals were very magnetic, being easily picked up with a magnet. Streak brown. Soluble in aqua regia with very slight residue. Gave off water in closed tube. A crystal weighing ·0083 gram lost on ignition ·0008 gram, or 8·6 per cent. of water. This crystal was magnetic after ignition, and remained unchanged in appearance. It would appear that the crystals are pseudomorphs after iron-pyrites in an intermediate stage between limonite and magnetite.

Stibnite from Foster's Bar, Fraser River, B.C.

8.—Stibnite. This mineral has been found near Foster's Bar, about twenty-three miles from Lytton, Fraser River, British Columbia. The sample received, and which weighed rather less than four pounds, was remarkably pure, being almost entirely free from gangue. Assays showed it to contain a trace of gold, and 2·187 ounces of silver to the ton of 2,000 lbs.

Rose-colored muscovite from Villeneuve, Ottawa county, P.Q.

9.—Rose-colored muscovite.—Amongst some of the interesting specimens recently collected by Mr. C. W. Willimott was one—found by him on lot thirty-one of the first range of Villeneuve, Ottawa county, P. Que.—consisting of a rose-red colored mica and pale-green muscovite, in a matrix composed of albite with a little white translucent quartz. The first mentioned, when heated before the blowpipe, was found to be difficulty fusible and to give a slight yet distinct lithia re-action. It apparently, closely resembles, if indeed it is not identical with, the rose-red colored muscovite of Goshen, Mass., examined by Prof. J. W. Mallet.

INDEX VOL. III.

(NEW SERIES.)

ABBREVIATIONS.

Al.	District of Alberta.	N.W.T.	North-West Territory.
B.C.	British Columbia.	O.	Province of Ontario.
Ma.	Manitoba.	Q.	Province of Quebec.
N.B.	New Brunswick.	Sk.	District of Saskatchewan.
N.S.	Nova Scotia.	V.Is.	Vancouver Island.

	PAGE
Abenaquis, Lake, Q., Cambro-Silurian	14 K
Abies subalpina	116, 186 B
Abitibbi branch of Moose River	17 J
Abitibbi branch of Ottawa River, ore, assay	28 T
Abpichotinachits, Lake, Bishop Roggan R.	42, 43 J
Abrasive materials, statistics	8 S
Acadia colliery, N.S	16 S
Acer macrophyllum	189 B
Adams, F. D., work by. 27, 43, 84, 102	A, 3 T
on rocks from Yukon district	235 B
Adams River and Lake, B.C., gold	135 R
Admiralty chart of James Bay	15 J
Admiralty Island, B.C., sandstone	157 R
salt spring	162 R
Agalmatolite	80 S
Agassiz, B.C., lime	159 R
limestone (anal.)	56 T
Agassiz, Lake, glacial	18 A, 9 E, 175 F
Agates, B.C.	110 R
N. of Lake Superior	8 H
localities	71 S
moss, N.S.	72 S
Aga-zi-za River, Frances R.	105 B
Agglomerate, Clear-water Lake	29 F
schists, Cedar Lake	44 F
Strawberry Lake	50 F
felspathic, Crow Lake	48 F
thickness of formation	49 F
felsite, Bluff Lake	51 F
Manitou Lake	54 F
Pickerel Lake, described	83 F
or tuff, Shanty Point, "	92 F
Pipestone Lake, "	92 F
felsitic, Clear-water L., "	95 F
Grindstone Narrows, "	97 F
Agglomerates, origin of	84, 91 F
Agnes, Mount, B.C.	13, 23 C
Agoomski Island, James Bay	42 J
Agricultural lands, Nechacco R.	66 A
Cariboo district	16 C
north-west Ma.	17 A, 7 E
Rainy R	176, 178 F
Lake of the Woods	177 F
north of Lake Superior	23 H
James Bay	17 J
Upper St. John R., Q.	14 K
northern N.B.	10, 29 M
north-eastern N.B.	96 A, 28–31 N
Agriculture in Yukon district	18 A, 23 B
Stikine River	23, 60 B
Dease Lake	77 B
Dease River	89, 92 B
Rainy River	178 F
Aigles, Lac des, Q.	28 M
Ai-yan Indians, B.C.	203 B
Alaska coast, glaciation	39 B
gold mining	54 R
Alaskan archipelago	10 R
Albanel, père C. (1672), expedition to James Bay	9 J
Albany, Fort, James Bay, established	9 J
Albany River, James Bay	17 J
mouth of	14, 22 J
iron ore (anal.)	26 T
Alberni, V.Is., marble	158 R
Alberni Canal, V.Is., coal	147 R
iron	151 R
Albert Cañon, B.C., hot spring	163 R
Albert county, N.B., gypsum	31 S
Albert Manufacturing Co., N.B., plaster	30 S
Albert mine, Capelton, copper	21, 84 S
Albion coal mine, N.S.	20 S
Alexandria, B.C., gold placers	117 R

	PAGE
Alexandrite	66 S
Algoma, township 94, O., ore, assay	35 T
Algoma silver mine, McGregor, O.	64 H
Algoma silver mine, Neebing, O.	66 H
Alkow Harbour, B.C., plumbago	161 R
Alleguash River, St. Francis R.	6, 50 M
Alluvial plain, Rainy River	20 F
Alluviums, north-eastern N.B.	22–26 N
Alma, N.B., ore, assay	27 T
Almandine garnet	68 S
Alnus rubra	188 B
Along-the-Hill, Lake, Rainy L., schist, described	76 F
Alum, Medicine Bluff	100 H
and aluminous cake, imports.	7 S
Amador Creek, B.C., gold	122 R
Amazon stone	74 S
Amber, B.C.	111, 161 R
Amelanchier alnifolia	188 B
American Bar, Fraser R., gold	116 R
Amethists	69 S
north of Lake Superior	8 H, 69 S
Ami, H. M., work by	36, 49, 107 A
fossils collected	10, 77, 116 K, 19 M
fossils examined	15, 24, 50 K, 13, 21 M
Ammonia, sulphate of	61 S
Analyses of coal from B.C.	86–98 R
and assays in laboratory	1–58 T
Andalusite	76 S
Ancient Lorette, Q.	19 K
Anderson, James, census of Indian population, Yukon district	205 B
Anderson Creek, B.C., gold	123 R
Anderson Lake, B.C., gold placer.	118 R
Anderson River, B.C., gold placer	118 R
Anderson River series	29 R
Andradite	68 S
Angus Islands, L. Superior, silver	40 H
Animikie rocks, N. of L. Superior	8, 85 H
relationships of	23 H
outline of (fig.)	24 H
thickness of	25 H
subdivision of	81 H
on Whitefish Lake	97–103 H
Animikite, Silver Islet mine	27, 33 H
Anorthosite, Eastern Townships.	27, 85 A
Anthracite, Skidegate Inlet (anal.)	85 R
semi-, analyses of	20 T
Anthracite, Al., mines at	17 S
Anticlinal, Sutton Mountain	5, 89 K
Anticlinals, Lévis	49 K
Orleans Island	72 K
gold in	99 A, 88 K
Antimony, statistics	5, 6, 7, 10 S
British Columbia	104, 156 R
mine, South Ham	30 A
Antler Creek, B.C., gold placers	37, 123 R
ores, assays	42 T
Anvil Mountain, Dease River	88 B
Apachi hits River, Big River	44 J
Apatite, statistics	59 S
Apatite, mode of occurrence	62, 79 S
sundered, in diabase (fig.)	65 F
Apophyllite	78 S
Aqua marine	66 S
Arastra, Cariboo	45 C
Archæan country, Hunter's Island	76 A
volcano, Rainy L.	57, 141 F
north of L. Superior	8, 86 H
silver in	54, 66 H
country, E. of James Bay	18, 20 J
iron ores and phosphates in.	62 S
Archer Creek, B.C, gold placers.	37, 123 R
Argentite, Silver Mtn. vein	90 H
mode of occurrence	109 H
Argillite, Wiatchiwan R.	59 J
Argillites, Wrangell	32 B
Stikine River	55 B
Animikie formation, Lake Superior	24, 49 H
contact with trap	42, 46, 48, 80 H
probable origin of	85 H
silicified	84, 89 H
altered, (described)	116 H
Arichat, N.S., gypsum	31 S
Aroostook county, Maine	5, 39 M
Aroostook River, St. John R.	43 M
Arquerite, B.C.	42, 73, 145 R
Arrow Lake, upper, B.C., vein mining	63 R
hot and soda springs	162, 163 R
Arrow River Mining Co., Whitefish L.	103 H
Arsenic	5, 7, 11 S
native, B.C.	106, 161 R
Arthabaska, Q., synclinal	63, 64 K
Asbestus, statistics	5, 6, 7, 12 S
Stewart River, B.C.	27 B, 161 R
Eastern Townships.	28, 87 A, 106-111 K
Ascot, Q., natural water (anal.)	22 T
Ashcroft, B.C.	9 C
Ashland, Maine	44 M
Ashtinoulou River, B.C., gold	127 R
Asphaltum, import	7 S
Assays, gold and silver	26–55 T
ores from B.C.	62 A, 31–48 C
list of	76–79 R
natures	30 C
silver ores, L. Superior	110 H
Assiniboine Lake, post-glacial	15 E
Assiniboine River, N.W.T.	73 A, 6, 16 E
valley	13 E
Astronomical observations, B.C.	261 B
Atheson Ledge, Cariboo	36 C
Atic Lake, O., silver	96 S
Atlak Creek, V.Is., gold	142 R
Atlin Lake, Yukon district	169 B
Attawapishkat River, James Bay.	17 J
Augite, polysomatic, in trap	154 F
in diabase, Pipestone L., (fig.)	159 F
North-west Bay, "	160 F
Grassy Narrows, "	161 F
Australia gold-bearing rocks	49, 53 R

	PAGE
Australia, vein-mining in	52 R
and Quebec rocks, similar	34 K
Avanturine felspar	75 S
Avondale, N.S., hematite (anal.)	23 T
Awahagats, Lake, James Bay	44 J
Awatsish Creek, V.Is., gold	142 R
Awichinawigachi Lake, James Bay	41 J
Axinite	74 S
Babine portage, B.C., coal	150 R
Back Bay, N.B, fossils	48 M
Back Point, Rainy L., trap and diabase, described	66 F
Bad Vermilion Lake, O	56 F
schists, described	81 F
gabbro, "	99 F
granite, "	145 R
Badger silver mine, Port Arthur	128 H, 89, 94 S
Bailey, Prof. L. W., work by	35, 91 A
report by	1-52 M
Bailey, J. W., work by	35 A
Baker iron mine, O	63 S
Baker Lake, St. John R	6 M
Bancroft, referred to	20 R
Banff, Al., thermal springs (anal.)	21 T
Barite, statistics	5, 7, 46 S
and trap, Silver Mtn. vein	88 H
in silver veins, N. of Lake Superior	9, 41, 107 H
Colchester, N.S	98 A, 46 S
Barkerville, B.C., latitude and longitude	10 C
gold mining	35, 123 R
ores, assays	15 T
Barlow, A. E., work by	22, 77 A, 5 F
Barlow, Scott, work by	8 F
Barr-Andlau contact zone, comparison with	95, 108 F
Barrande, referred to	32 K
Barrière River, B.C., gold	135 R
Barry Creek, B.C., gold	122 R
Barton colliery, N.S	16 S
Basalt in Yukon district	37 B
Stikine River	56 B
Tahltan River	64, 71 B
Upper Liard River	101 B
Pelly River	122, 132 B
Lewes River	145 R
Miles Cañon, Lewes R	162 B
Cariboo district	16 C
Basford Creek, B.C., gold	123 R
Bat Lake, Rainy L., contact	33 F
granite	144 F
Bate's, B.C., copper	154 R
Bathurst, N.B., section near	11 N
Batiscan River, Q	39 A
Bayfield, Capt., quoted	26 K
Bayley, W. S., examination of rocks	115 H
Bayly, Gov. Ch. (1670), Hudson Bay Co	9 J
Baynes Sound coal mine, V.Is.	81, 89, 151 R
Beaches, gravel, north-western Ma.	10 E
raised, James Bay	29, 30 J
Wiachtiwan River	58 J
Beady Creek, Dease R., gold	138 R
Beady Mountain, Dease Lake	77 B
Bean, Dr. T. H., fishes determined	231 B
Bear Creek, B.C., gold	129 R
Bear Islands, James Bay	25 J
Bear River, V.Is., gold	143 R
Bear River and Lake, valley, B.C.	14 C
gold	124 R
coal	149 R
Bear River beds, B.C	16 C
Bear's Passage, Rainy L	36 F
gabbro, described	60 F
trap, "	68 F
Coutchiching belt	102, 106 F
gneiss bosses	102, 117 F
molybdenite	181 F
Bears, polar, James Bay	36 J
Beaumont, Q	65, 81 K
Beauport, Q., Trenton limestone	21 K
Beavers, Charlotte Island	28 J
Beaver Cove, V.Is., marble	158 R
Beaver silver mine, Rabbit Mountain	40 A, 88, 89, 90 S
plan and section (plate)	72 H
richer ore discovered	126 H
Becancour, Q., Cambro-Silurian	17 K
Becke, Fr., referred to	60 F
Becker, G. F., quoted	58 R
Bed Rock Bar, Liard R., gold	139 R
Bedford, O., iron ore (anal.)	24 T
Beers, A. H., work by	94 A
Bell, F., Lepidoptera collected	231 B
Bell, Dr. R., work by	22, 80 A
referred to	16, 32 D, 9, 27, 170 F
quoted	36 J
Bellechasse county, Q., work in	5 K
Bellingham Bay, Washington Territory, coal (anal.)	95 R
Belmina, Q., asbestus	112 K
soapstone	113 K
" Benches " or terraces, Fraser R.	25 R
Bennett Lake, Lewes River	166, 171 B
ore, assay	37 T
Berry Island, Rainy Lake, trap, described	64, 65 F
Beryl	66 S
Betula glandulosa	188 B
papyrifera	188 B
Bibliography, geology of B.C	15 R
geology of Rainy L. region	9 F
silver mining, L. Superior	123 H
Quebec group	6 K
Big Bar, Fraser R., gold	117 R
Big Bend of Columbia R., gold placers	39, 65, 133 R
gold-bearing quartz	60, 144 R

	PAGE
ores, assays	78 R
Big Island, L. Winnipeg, hematite (anal.)	25 T
Big Island Seam, North Saskatchewan R., lignite (anal.)	6 T
"Big Ledge," Round Top Mtn	43 C
"Big Ledge," Yank's Peak	46 C
Big River, Hudson Bay	20, 81 A, 20, 37 J
mouth of, a good harbour	22 J
tributaries of	38, 46 J
upper course of	45 J
Big Canoe River route, Rainy L., gneisses	114 F
glacial striæ	166 F
Big Salmon River, Lewes R., gold	81 B, 140 R
Big Saw-bill Lake, Rainy L., contact	34 F
Big Sevogle River, N.B., erosion	19 N
terraces	20 N
trees	30 N
Big Slide gold mine, B.C.	72 R
Big Trout Bay, L. Superior	50 H
Big Turtle River, Rainy L.	10, 43 F
schist, described	77 F
Bigsby, Dr. J., referred to	9, 169, 171 F
quoted	25 K
Billings, E., fossils collected	11 K
on Lévis rocks	31, 33, 38 K
fossils determined	16 M
Birds in museum	106, 108-113 A
of James Bay	25, 29 J
Bishop Roggan River, James Bay	20, 42 J
origin of name	43 J
South Branch	43 J
country drained by	44 J
Bismuth, Little Shuswap L.	161 R
Bitumen, Queen Charlotte Islands	161 R
Black Bay, Rainy L., contact	39, 100 F
Black Bay, L. Superior, galena	13 H
Black Hills, Dakota, section (fig.)	49 R
Black Lake, Q., serpentine	94 K
copper mine	103 K
asbestus mining	88 A, 108, 110 K, 12 S
Black Point, L. Temiscouata, conglomerates	32 M
Black River, Liard R., gold	81 B, 139 R
Black River, N.B., valley	9 N
section near	10 N
Black Rivers, Little and Big, St. Francis R.	6, 38 M
Black Bear Creek, B.C., gold	25 R
Black Jack Gulch, B.C., gold	136 R
Blacklead, statistics	7, 29 S
Blackwater River, B.C., coal	149 R
Blairton iron mine, O.	63 S
Blake, P. W., quoted	52 B
Bleak Bay, Rainy L.	18, 100 F
diabase, described	64 F
mica-schist, "	108 F
Blende Lake, L. Superior, silver	65 H
Blessington, O., iron and phosphate mines	63 S
Blockhouse colliery, N.S.	16 S
Bloodstone	72 S
Blue River, Dease River	91 B
Bluff Lake, O., contact	42, 51 F
gneiss	119 F
Boisbouscache River, Trois Pistoles River	26 M
Bois Brulé Mountain, Q.	17 M
Bolger, Thos. O., quoted	20, 177 F
Bombs, concretionary, Silver Mtn.	84 H
Bonanza Ledge, Cariboo, gold ore, assays	32 C
Bonanza Queen, B.C., gold ore, assay	62 A
Bone's Gulch, Skeena R., gold	141 R
Bones, imports and exports	61 S
Borax, imports	7 S
Borings, St. Grégoire	33 A
Borland Ledge, Cariboo, ore, assays	46 C, 41 T
Boston Bar, Fraser R., gold	117 R
Boswell, T., on Teslintoo R.	155 B
Botanical work	53, 114 A
Botany, *see* Plants, Trees.	
Boulders, Frances Lake	107 B
piled by ice, Ma.	11 E
James Bay region	24, 27, 34 J
packed by ice	29, 30, 45 J
granite, in schists, Rainy L.	82 F
glacial, distribution of	164 F
limestone, Rainy R.	175, 182 F
gneiss, Agoomski Is.	24 J
gneiss and schist, Charleton Is.	27 J
Silurian limestone	34 J
Wiachtiwan valley	19 J
Laurentian, Eastern Townships	99 K
St. John River	9 M
coral-conglomerate, on Lake Metapedia	15 M
glacial, north-eastern N.B.	14 N
glaciated, in drift	13 N
Boulder Creek, Kootanie R., gold	132 R
Boulder Creek, Otter River, B.C., gold	62 A, 129 R
Boulder Gulch, Cassiar, copper	155 R
Boulder-clay, Strutton Islands	30 J
Twin Islands	33 J
Big River	38 J
Great Whale River	53 J
Wiachtiwan River	59 J
northern N.B.	26 M
north-eastern N.B.	12, 17 N
distribution	16 N
Boundary Creek, B.C., gold	129 R
copper	154 R
Bow River, Al., coal mine	17 S
coal (anal.)	11 T
Bowman, A., work by	13, 60, 66 A
report by	1-49 C
referred to	57 R
Boyd's Home, Cariboo, coal	149 R

	PAGE
Brass, imports	7 S
Bricks and tiles, statistics	5, 7, 106 S
fire, tiles, etc	7, 109 S
Bridge River, B.C., gold placers	119 R
Bridgeport colliery, N.S	16 S
Bridgeville, N.S., iron	33 S
Bridgewater, O., asbestus	12 S
Brimstone, imports	83 S
Brisco Range, Rocky Mtns, copper ore	154 R
Bristol, O., iron mining	40 A
British Bar, Fraser R., gold	118 R
British Columbia, progress of work in	4, 59 A
geological features of, continued in Yukon district	31, 33 R
report on mineral wealth of	1-163 R
region unexplored	10 R
ores, assays	38-55 T
Broadbent, R. L., work by	46, 104 A
Brockville, O., chemical works	85 S
Brookfield, N.S., barite and limonite	98 A
gold district	26 S
Broughton, Q., serpentine	96, 111 K
copper ore	105 K
asbestus	87 A, 111 K
soapstone and lime	113 K
Brown, Mount, B.C., height	6 R
Brown's Gulch, Cassiar, gold	140 R
Bruce copper mine, L. Huron	10 H
Brulé Narrows, Rainy L.	17, 100 F
Brumell, H. B., work by	40, 42, 100 A, 4 H, 3 S
Buckingham, Q., graphite	28 S
ores, assays	29 T
Buffalo remains in gravel ridge	172 F
Buhrstones, imports	7, 9 S
Building stone, *see* Stone.	
Bull River, B.C., gold	131 R
Cañon, hematite	152 R
Burns Creek, B.C., gold	121 R
Burns Mountain, Cariboo	29 C
ores, assays	46 C, 38 T
Burrard Inlet, B.C., coal	67 A, 94, 147 R
granite quarry	157 R
Burton's Island, Lake of the Woods	27 F
Button, Sir T. (1611), expedition to Hudson Bay	7 J
Cabano village, L. Temiscouata	32 M
Cabano Lake, Temiscouata region	9 M
Cacholong, N.S	73 S
Cadwalladar Creek, Bridge River, gold	119 R
Cair-gorm, N.S	69 S
Calciferous formation, Q	34 K
-Chazy fauna, Q	47 K
Calcite, interstitial, Silver Mtn	82 H
pearly, Whitefish Lake	103 H
in silver veins, L. Superior	107, 111 H
Caldwell Island, L. Superior	50 H
Caldwell Point, "	46, 48 H
Caldwell's vein, Whitefish L	101 H
Caledonia colliery, N.S	16 S
California and B.C. gold-bearing rocks compared	19 C, 12, 51 R
Callbreath, J. C., on Tahltan Indians	195 B
meteorological observations	248 B
Calumet, Q., silver ore, assay	30 T
zinc-blende, assay	58 T
Cambrian, lower, L. Superior	22 H
Eastern Townships	43, 45, 84-88 K
Cambro-Silurian, Yukon district	33, 94 B
Eastern Townships	12-25 K
and Cambrian, Eastern T	25-84 B
area, north-eastern N.B	7 N
soil on	30 N
Cameron, A., work by	100 A
Cameron's Bar, Fraser R., gold	116 R
Campbell, R. (1840), explorations in Yukon district	14, 81, 136 B
Campbell Creek, B.C., gold	123 R
Campbell Mountains, B.C	107 B
Campbell River, V.Is., coal	146 R
Canadian Creek, B.C., gold	123 R
Canadian Pacific Railway, B.C.	65 A, 14 R
surveys, Rainy L. region	8, 11, 14 F
L. Superior silver district	15, 21 H
Canoe Island, St. Lawrence R.	75, 81 K
Cañon, Great, Stikine River	46 B
Little, " "	49 B
Kloochman, " "	49 B
Lower, Upper Liard River	98 B
galena	155 R
Middle, Frances River	103 B
False, " "	105 B
Upper, " "	106 F
Hoole, Pelly River	120, 122 B
Granite, " "	130 B
Miles, Lewes River	161 B
of Williams Creek	35 R
of Great Whale River	52 J
Capelton, Q., copper mines	41 A, 21 S
pyrite	81, 83, 84 S
silver	88 S
Cap Rouge, Q	18 K
Sillery rocks, fault	57, 63 K
Caraquette, N.B., section	21 N
Carbone in silver veins, Lake Superior	28, 33, 105 H
considered a favorable indication	108, 112 H
Carboniferous, Yukon district	33 B
McDame Creek	93 B
Frances River	104 B
Lewes River	170 B
Cariboo district	15, 16, 20 C
area, north eastern N.B	6 N
soils on	28 N
Cariboo gold district, B.C	20 R
report on	1-49 C

	PAGE
importance of	5 C
limits of	6 C
schists	16 C
placer-mining	30-38, 46 R
vein-mining	56-59 R
ores, assays	76 R, 40 T
gold placers	120-126 R
lead in silver ores	156 R
production of gold	24 S
Cariboo Lake, B.C., gold	124 R
Cariboo Range, B.C.	13 C, 7 R
Cariboo Island, Thunder Bay	65 H
Caribou, N.S., gold district	26 S
Carlow, O., iron ore (anal.)	24 T
Carne's Creek, B.C., gold	134 R
springs	163 R
Carnelians, N.S	71 S
Cary Island, James Bay	28, 29 J
Cascade Range, B.C	9 R
Cassiar, B.C., possible origin of name	198 B
Cassiar Bar, Lewes R., gold	153, 181 B
Cassiar district, gold	10 A, 26, 78-86, 182 B, 21, 43 R, 24 S
silver	74 R
ores, assays	78 R
gold placers	137 R
coal	150 R
Cassiar Range	13, 86 B, 7 R
eastern slope of	90, 102 B
Cassiar Trail	64-73 B
tuff? described	237 B
Casupscal River, Q	13 M
Caswell, J., examination of rocks	58 H
Catalogue of mineral collection, prepared	102 A
of Canadian plants, published	114 A
Catcha, Lake, N.S., gold district	26 S
Cayoosh Creek, B.C., gold	64 A, 71 R
silver	71 R
gold placers	118 R
Cedar Creek, Quesnel R., gold	125 R
Cedar Creek, Tulameen, gold	129 R
Cedar Lake, Clear-water L., schists	44 F
Cedar Narrows, Pickerel L., fault	13, 33, 51 E
schists	33 F
described	76 F
contact of, with syenite	125 F
Cements, statistics	5, 6, 7, 102 S
hydraulic	104 S
Portland	7, 105 S
trass for, B.C	109, 160 R
Census of Indian population, Yukon district	205 B
Chalcedony	71 S
Chalk, imports	7, 48 S
Chalmers, R., work by	94 A
report by	1-33 N
Chamberlain Lake, Maine	6 M
Champion Creek, B.C, gold	129 R
Chapman, Prof., quoted	56, 62 H
Chapman's Bar, Fraser R., gold	116 R

	PAGE
Chappell, Lieut. E. (1814), visit to Hudson Bay	13 J
Charcoal, production	5, 20 S
Charles, Fort, Rupert L., founded	8 J
Charlesbourg, Q., Cambro-Silurian	80 K
Charleton Island, James Bay	19 A, 7, 25 J
Little, or Trodiley Is., James Bay	31 J
Chase River, V. Is., sandstone quarry	158 R
Château Richer, Q., Trenton rocks	24 K
Chatham Cove, B.C., granite	158 R
Chaudière junction, Q	56 K
Chaudière gold district, Q	29, 86 A
Devonian	9 K
Cambro-Silurian	12 K
fossiliferous slates	37 K
Sillery rocks	61 K
Cambrian	85 K
Pre-Cambrian	90, 92 K
granite, diorites	93 K
serpentine	96 K
Chazy formation, Q	34 K
upper, N. of St. Lawrence R.	64 K
Chemical contributions to the geology of Canada	1-55 T
Chemical work, progress of	42, 101 A
Cherry Creek, Shuswap R., gold	64 A
silver ore	68 R
gold placers	130 R
ores, assays	79 R
Cherry Bluff Creek, Kamloops L., gold	135 R
magnetite	152 R
copper	154 R
Chert, L. Superior, described	58, 120 H
Silver Mtn., ferruginous	82 H
Cherts, Caribou	20, 21 C
Cheval, Point, N.B., section	23 N
Cheverie, N.S., gypsum	31 S
manganese	44 S
Chiastolite	76 S
Chignecto colliery, N.S	16 S
Chilacco River, B.C., gold	119 R
lignite	149 R
Chilcotin River, B.C., gold	119 R
lead	155 R
Chilkat Indians, B.C	205 B
Chilkat Pass, Yukon district	21 B
coal	150 R
Chilkoot Indians, B.C	205 B
destroy Fort Selkirk	139 B
Chilkoot or Taiya Pass	174 R
Chilliwack River, V.Is., coal	147 B
China Creek, V.Is., gold	142 R
Chinaman's Diggings, Cariboo, veins	42 C
Chin-oo-kun-dl Brook, Queen Charlotte Islands, lignite	146 R
Chisholm Creek, Cariboo, quartz-veins	40 C
gold placers	122 R

	PAGE
Chisholm Creek, ore, assay	46 T
Chlorastrolite	78 S
Chloride of lime, imports	7 S
Chromic iron, production	5, 48 S
Thetford, examined	56 T
Chrysoberyl	66 S
Chrysolite	76 S
Chrysoprase	72 S
Cinnabar, Golden, B.C	66 R
Clay, statistics	7, 109 S
fire	108 S
miscellaneous products	5 S
brick-, north-eastern N.B	32 N
red, used as paint	33 N
see also Boulder-clay.	
Clays, bedded, Rainy L. region	170, 173 F
blue, Rainy R	171, 182 F
N. of L. Superior	87 H
and sands, James Bay	16 J
Shatachiwan Lake	47 J
Madawaska River	9 M
Clayoquot Sound, V.Is., coal	147 R
Clear Grit Ledge, Cariboo, veins	42 C
Clearihue, J., meteorological observations	254 E
Clearwater River, Stikine R	50 B
Clear-water Lake, Rainy L	16, 19 F
Keewatin rocks	28, 44 F
schists, described	87 F
porphyries, "	88 F
agglomerate, "	95 F
serpentine, "	98 F
gneiss, "	130 F
Clearwater Lake, Clearwater R	57 J
Cearwater River, Hudson Bay	55 J
Climate, Yukon district	21, 29 B
Stikine River	58 B
Dease Lake	75 B
Dease River	91 B
E. of Cassiar Range	90 B
Lewes River	173 B
soil frozen	91, 121, 125, 183 B
modified by trees	80 A, 8 E
Clinton, B.C	15 C
gold ore	144 R
Cloud Lake, O., silver	50 H
Clouston (1824), survey of East Main R	19 J
Coal, statistics	5, 6, 7, 13 S
discovered at Kamloops	61 A
Westminster	66 A
Port Moody	68 A
on Lewes R. (anal.)	148 B
in Cretaceous and Tertiary rocks, B.C	12, 83, 88, 94 R
fields, B.C	80-91 R
yield	81 R, 17 S
imports and exports, B.C	82 R
Vancouver Island	66 A, 81, 86 B
superiority of coal	91 R
Comox area (anal.)	65 A, 81, 89 R
Nanaimo area (anal.)	81, 90 R
Koskeemo (anal.)	87 R
Suquash	87 R
bituminous, Ya-koun River (anal.)	86 R
Puget Sound (anal.)	92, 94 R
Crow Nest Pass (anal.)	93 R
Skeena River	93 R
Peace River	94 R
Nicola R. (anal.)	96 R
Bellingham Bay (anal.)	95 R
table of analyses, B.C	98 R
list of localities, B.C	145 R
search for, Minnedosa	73 A
field, Pictou, mining	97 A
Coal Brook, B.C., coal	150 R
Coal Harbour, V.Is	67, 69 A
coal, analyses	16 T
Coals and lignites, analyses	5-20 T
Coast Ranges, B.C	12, 31, 48 B, 9 R
eastern edge of	170 B
silver mines	72 R
gold placers	141 R
Coates, Capt. W. (1727-51), notes on Hudson Bay	12 J
quoted	21 J
referred to	32 J
Cobequid Mountains, N.S	94 A
Cochrane, A. S., work by	22, 80 A
Coe Hill mine, O., iron	63 S
Cœnograptus zone, Quebec rocks	45, 47 K
Coke	5, 20 S
Coldwater River, B.C., lignite	61 A, 148 R
Coleoptera, list of, from James Bay	75 J
Coleraine, Q., serpentine	94 K
asbestus	87 A, 109 K, 12 S
Collection, botanical, additions to	54, 114 A
conchological, "	50, 108-112 A
entomological, "	111 A
ethnological, "	112, 113 A
mineralogical, "	44, 102 A
palæontological, "	50-53, 108 113 A
zoological, "	50-53, 107-113 A
number of specimens	106 A
Collections supplied, of fossils	49, 107 A
of botanical specimens	55, 114 A
of minerals	46, 105 A
Collin's Gulch, B.C., gold	128 R
Colorado gold-bearing rocks	53 R
Columbia Lakes, B.C., gold placers	131 R
upper lake, hot spring	162 R
Columbia Range, B.C	7 R
Columbia River, gold placers	133 R
mineral springs	163 R
valley	7 R
see also Big Bend.	
Colway River, Q., iron ore	106 K
lime	113 K
marble	113 K
Commerell, Cape, V.Is, gold	143 R
iron	151 R

	PAGE
Commis, Mount, Q.	17 M
Commission on mineral resources of Ontario	79 A
Comox, V.Is., coal field ..65 A, 81, 89, 146 R	
section	89 R
analysis of coal	90 R
Conchological collection, additions to 50, 108-112 A	
Conglomerate, Lewes River 146 150 R	
"Shasta," Cariboo	18 C
Cretaceous, gold bearing, on Fraser R. 29, 48 R	
of Dakota	49 R
Rainy Lake region 38, 84 F	
Rat-root Bay, described	82 F
Seine River, "	82 F
Pickerel Lake, "	83 F
Schist Lake, "	83 F
Silver Mountain	83 H
in Archæan hollows	84 H
limestone, Lévis, Q..40, 49, 54-74, 81 K	
pebbles, fossils in...40, 42, 50, 56, 81 K	
fossils determined	81 K
three zones, Eastern Townships	83 K
coral-, boulders, L. Metapedia	15 M
Rimouski River	24 M
Lake Temiscouata	32 M
Aroostook River	45 M
Conklin Gulch, Cariboo, gold	120 R
Contact of Keewatin and Laurentian, Rainy L. 23-43, 131 F	
metamorphism at 38, 74, 125 F	
brecciated or intrusive .23, 32, 35, 42, 51, 56, 139 F	
of Keewatin and Coutchiching 36, 80, 84, 103 F	
of Coutchiching and Laurentian 102, 104, 131 F	
metamorphism at 38, 104, 108 F	
brecciated or intrusive 106, 130, 132 F	
of trap dykes 149, 157 F	
of trap and argillites, Lake Superior 42-48, 80 H	
of Animikie and Archæan	102 H
of Laurentian and Huronian, Great Whale R.	54 J
Cook, Cape, V.Is., gold	143 R
Cooper's Gulch, Cariboo, quartz veins (assays)	40 C
Copper, statistics 5, 6, 7, 20 S	
native, Thibert Creek	82 B
mining, Toad Mtn 60, 101 R	
Howe Sound	102 R
Texada Is. 102, 152 R	
ores, B.C.	152 R
L. Superior	8 H
N. of L. Huron	10 H
Sudbury	2 A
mining, Eastern Townships.	102 K
Copper Bay and Copper Islands, Queen Charlotte Islands, copper	153 R
Copper Creek, Kamloops L., copper	154 R
Copper Island, Barclay Sound, iron-pyrite	161 R
Copper Island, Shuswap Lake, copper	154 R
Copper Mountain, N.W.T., copper ore	66 R
Copperas, imports	7 S
Coquette Creek, B.C., gold	125 R
Coquihalla River, B.C., gold placers	118 R
Cordillera metalliferous belt, B.C. 27 B, 6 R	
Cornish Bar, Fraser R., gold	116 R
Cornish silver mine, Thunder Bay	67 H
Cornwallis, N.S., manganese	44 S
Cortez Island, B.C., molybdenum.	157 R
Corundum	8 S
Coste, E., work by 39, 100 A	
report by 1-110 S	
Cotter, J. S., insects collected	75 J
Cottonwood Cañon, Fraser River, gold placer	118 R
Cottonwood Creek, Dease R. 88, 92 B	
Cottonwood Creek, Kootanie L., gold	133 R
gold-bearing veins	144 R
Coulonge River, Q., ore, assay	28 T
Coulter Creek, B.C., gold	121 R
Courtis, W. M., quoted 27, 36, 56, 112 H	
Coutchiching Rapids, Rainy R... 11, 106 F	
mica-schists, described	107 F
gneiss, " 108, 130 F	
Coutchiching series, stratigraphy. 21, 99-106 F	
contact with Keewatin. 36, 80, 84, 103 F	
with Laurentian, *see* Contact.	
between Keewatin and Laurentian 38, 55, 103, 105 F	
area, Little Turtle L.	35 F
belt, E. of Rainy L.	100 F
Bear's Passage 102, 106 F	
Open-water Narrows	102 F
Rice Bay	104 F
thickness of 101, 103, 104, 141 F	
petrography of 107-111 F	
origin of	141 F
cut by granite	145 F
Cove fields, Quebec, graptolite zone 45, 48 K	
Cow Bay, N.S., coke	20 S
Cowgitz, Queen Charlotte Islands, coal	145 R
Cowichan River, V.Is., gold	142 R
coal	147 R
molybdenite	157 R
ores, assays	79 R
Coxheath, N.S., copper mines	21 S
Cranberry Bay, Rainy L., mica-schist	109 F
Cranbourne, Q., serpentine	97 K
ore, assay	27 T
Crane Island, St. Lawrence R. 61, 76 K	

	PAGE
Cretaceous, Yukon district	35 B
Stikine River	57 B
Lewes River, fossils	146 B
Lake Labarge, fossils	159 B
Lower Cariboo district	16, 19 C
coal-bearing rocks	67 A, 12, 84, 88 R
gold-bearing rocks, B.C.	29 R
north-western Ma	16 E
Cross Bar, Fraser R., gold	116 R
Crow Lake, Rainy L. region	19, 47 F
diabase, described	71, 72 F
gabbro, "	72, 99 F
clastic rocks, "	91 F
serpentine, "	97 F
Crow Portage, Sabaskong Bay, contact	23, 74 F
Keewatin rocks	22 F
gneiss, description	127 F
Crow Nest Pass, B.C., coal (anal.)	93, 148 R
Crown mine, Capelton, copper	21 S
pyrites	84 S
Crown Point Silver mine, Silver Mtn	92 H
plan and section (plate)	88 H
trap, described	118 H
Cruikshank, J. M., work by	100 A
Crystalline rocks, Eastern Townships	93 K
Cultivation affecting temperature	9 E
Cumberland House, N.W.T., built (1773)	12 J
Cumberland River, Q., gold	102 K, 28 S
Cumsheva, Queen Charlotte Islands, lead	155 R
antimony and arsenic	156 R
Cunningham, A. R., meteorological observations	80 J
Cunningham Creek, Cariboo, quartz ledges	44 C
gold placers	24 R
ores, assays	42, 43 T
Currents, tidal, James Bay	28, 29 J
Daaquam River, Q	13 K
D'Abbadie or Big Salmon River, Lewes R	151 B
Dadoxylon	106 A
Dakota gold-bearing rocks	49 R
vein-mining, yield	52 R
Dalhousie, O., ore, assay	36 T
Dalhousie, N.B., fossils	15 M
Dall, W. H., referred to	15, 22 B
Danby Island, James Bay	28, 29 J
Danville, Q., asbestus	113 K, 12 S
Dauphin Lake, Ma	7 E
Davis Creek, Cariboo, gold	123 R
Dawson, Dr. G. M., work by	4, 59 A
report on Yukon district	1-277 B
report on mineral wealth of B.C.	1 163 R
referred to	9, 170 F, 10 N
Dawson, S. J., quoted	13, 176 F
Dawson, Sir Wm., referred to	10 N
fossils determined by	126, 146, 149 B
Dawson route	21 H
Dawson silver mine, McIntyre	68 H
Day Bar, Fraser R., gold	117 R
Deadman Creek, Cariboo, gold	122 R
Deadman River, Thomson River, gold	135 H
Deadwood Creek, B.C., gold	122 R
Dean Canal, B.C., copper	152 R
Dease Creek, Dease L.	78 B
gold placers	76, 80 B, 138 R
Dease Lake, Dease R.	5, 8 A, 75 86 B, 43 R
gold on	76 B
ancient outlet of	69 B
igneous rock, described	236 B
Dease River, Liard R.	8 A, 83, 86-92 B
geology of	92-96 B
lignite	150 R
Deer Creek, B.C., gold	132 R
Defot Creek, Cañon Creek, Dease River	80 B
gold	138 R
Deloro mine, O., arsenic	11 S
Dendrites, L. Superior	110 H
Denison township, O., gold	28 S
Dennis Creek, Cassiar, gold	139 R
Deposits, recent, Cariboo	16 C
gold-bearing, Cariboo	24, 50 R
Tertiary	47 R
alluvial, Ma	12 E
Eastern Townships	9 K
surface, north eastern N.B.	9-28 N
classification	9 N
pre-glacial	10 N
on Carboniferous rocks	28 N
Des Plantes River, Q	86 A, 102 K, 28 S
Despair Lake, Rainy Lake, hornblende schists	30 F
schists, described	76 F
serpentine, "	98 F
Devereux, W. B., quoted	49 R
Devil's Cañon, B.C., gold	121 R
Devil's Cascade, Manitou route	18 F
gneiss, described	123 F
Devonian, north-western Ma	16 E
E. of James Bay	16 J
Eastern Townships	9 K
Deyeuxia Columbiana, n. sp.	228 B
Diabase porphyrite, Stikine R., described	235 B
Marsh Lake, described	235 B
tuff, Stikine River, described	235 B
and gabbro, differences of, Rainy L	58 F
altered, Grassy Is., described (fig.)	61 F
Swell Bay, described (fig.)	60-63 F
Seine R., "	64 F
Bleak Bay, "	64 F
Berry Island, "	64 F

	PAGE
Rat-root Bay, " (fig.)	65 F
Redgut Bay, "	68 F
Manitou Lake, "	69, 71 F
uralitic, Seine Bay, "	63 F
Squall Point, "	68 F
porphyrite, Crow L., described	71 F
saussurite, Pipestone L., described	72 F
effect of stretching on (figures)	65, 70 F
dykes	159 F
Pipestone Lake, described (fig.)	159 F
North-west Bay, described.	160 F
Grassy Narrows, "	161 F
Rat-root Bay, "	162 F
Diabases, L. Superior, described	116, 117 E
Diamond	66 S
Diamond, Cape, Q	44 K
D'Iberville (1690), expeditions to Hudson Bay	10 J
Dictyonema zone, Quebec rocks	45-48 K
Didymograptus zone, Lévis	52 K
Diopside	76 S
Diorite, Vermilion mine	59 A
dyke, Silver Lket	29 H
Duncan mine	58, 60 H
dykes, James Bay	42 J
Clearwater Lake and River associated with serpentine, Eastern Townships	60 J
Discovery Passage, B.C., copper	93 K
ore, assay	153 R
Distances, tables of, B.C.	55 T
Ditch Waterfall, Cariboo, veins	10, 12 C
Ditton township, Q., gold	41 C
Dolomite, L. Superior, described	28 S
Silver Mountain	58 H
Giroux vein	83 H
Dominion Ledge, Cariboo	102 H
Donald, Mount, B.C.	33 C
Dooley Ledge, Cariboo	7 R
Dorchester county, Q., work in	33 C
Douglas Creek, B.C., gold	5 K
Dowling, D. B., work by	141 R
Downie Creek, B.C., gold	14, 72 A, 5 E
soda spring	134 R
Dragon Creek, B.C., gold	163 R
Drift, N. of L. Superior	122 R
dam, Post Tertiary, Miramichi R.	87 H
Drift-wood, James Bay	12 N
Drummondville, Q., iron	32 J
Duck Creek, Cariboo, quartz ledges (assays)	20, 33, 34, 35 S
ore, assay	46 C
gold placers	41, 42 T
Duck Mountain, Ma	125 R
Dudswell, Q., lime	6, 13 E
Dufferin, Lady, Ledge, Cariboo, (assay)	113 K
Du Lièvre phosphate district, Q.	42 C, 45 T
Du Loup, River, Q.	83 A
	67, 70 K

	PAGE
Duncan or Shuniah silver mine, Port Arthur	14, 56 H
sections (plates)	56, 58 H
Dunes, Lake of the Woods	173 F
north-eastern N.B.	26 N
Dunlevy Ledge, B.C., ore, assay	47 T
Dutch Creek, B.C., gold	131 R
Dutchman's Bar, Fraser R., gold.	116 R
Dykes, diorite, *see* Diorite.	
trap, age of, Rainy L. district.	148 F
Eagle Creek, B.C., gold	129 R
Eagle Lake, Maine.	42 M
Eagle River, Dease River	88 B
gold	138 R
Earthenware, imports	7, 110 S
East arm of Rainy L., glacial striæ	168 F
East Bay, N S., iron	33 S
ore, assay	26 T
East Main River, James Bay	19 J
mouth of	22 J
East River colliery, N.S.	16 S
East Wellington colliery, B.C.	17 S
Eastern Townships, Q., work in	27, 85 A
report on	1-114 K
Economic geology, Rainy L. district	176 F
materials, north-eastern N.B.	32 N
minerals, B.C.	1-163 R
Eastern Townships	101 K
Egg Creek, N. Saskatchewan R., lignite (anal.)	5 T
Eight-mile Creek, B.C., gold	123 R
Eight-mile Creek Cañon, B.C.	22 C
Elæagnus argentea	189 B
Elevations, *see* Heights.	
Elgin Silver Vein, Rabbit Mtn.	76 H
Elizabethtown, O., pyrite	85 S
Elk River, B.C., sulphur springs.	162 R
ore, assay	49 T
Ellerslie Channell, B.C., copper.	153 R
Ellis, J. B., work by	54 A
Ells, Dr. R. W., work by	28, 85 A
report by	1-114 K
referred to	11, 12 M
Elmore Gulch, B.C., gold	136 R
Emery, imports	7, 9 S
wheels, imports	7, 9 S
Emily iron mine, O.	63 S
Emily Rock, James Bay	35 J
Emmons, referred to	32 K
Emmons' silver mine, McIntyre.	67 H
Emory's Bar, Fraser R., gold	116 R
England and Quebec rocks, similar	34 K
Enstatite in dykes	157 F
Entomological collection, additions to	111 A
specimens from Yukon district	229 B
from James Bay	75 J
Epidote	74 S

PAGE

Equan Point, James Bay..... 14 J
Equan River, " " ..... 17 J
Erosion of gold-bearing rocks, B.C. 29 C
glacial, N.B..... 8 M
Escuminac, Point, N.B., section.. 24 N
Escott, O., ore, assay..... 35 T
"Esquisse géologique" (1855)... 29 K
Essonite..... 68 S
Estuarine flats, north-eastern N.B. 28 N
Etchemin River, Q., Cambro-Silurian..... 13, 60, 68 K
Cambrian..... 85 K
Ethnological collection, additions to..... 112, 113 A
notes, Yukon district..... 191 213 B
relics, N.B..... 31 N
Evans, J., quoted..... 32 R
Evotomys Dawsoni, n. sp..... 25, 232 B
Expenditure..... 57, 117 A

Fall Creek, Cassiar, gold..... 139 R
Famine River, Q., Cambro-Silurian 13 K
gold mining..... 102 K
Fargo Bar, Fraser R., gold..... 117 R
Faribault, A. P., work by..... 100 A
Faribault, E. R., work by..... 38, 99 A
Fatsia horida..... 190 B
Fault, Cedar Narrows..... 13, 33, 51 F
probable, Rainy L. to L. of the Woods..... 151 F
St. Nicholas..... 15 K
Montmorency Falls..... 22 K
great, Quebec..... 31, 44, 59 F
Wolfe's Cove, St. Foye..... 44 K
St. Joseph..... 65 K
Faults, Etchemin River..... 61 K
Fauna, *see* Birds, Game, Insects, Mammals, Shells.
Faunas, ecological, Quebec rocks. 47 K
Felsite, Tagish L., described.... 237 B
Felsites, Bluff Lake..... 51 F
Pickerel Lake..... 52 F
Felspar, avanturine..... 75 S
absence of, in altered rock.. 108 F
crystals sundered (fig.)..... 71 F
Ferguson Bar, Fraser R., gold... 118 R
Fernie Creek, B.C., gold..... 134 R
Ferro-manganese..... 39 S
Ferro-silicon..... 39 S
Fertilizers, statistics..... 5, 7, 59, 61 S
Field, B.C., ores, assays..... 48 T
Fifteen-mile stream, N.S., gold district..... 26 S
Findlay Creek, B.C., gold placers. 131 R
gold ore..... 144 R
Finlay River, B.C., gold..... 137 R
Finlayson Lake, Yukon district.. 115, 117 B
Finlayson River, " " 112, 116 B
gold..... 140 R
ore, assay..... 37 T

PAGE

Fire-bricks, tiles, etc., imports... 7, 109 S
clay, imports..... 108 S
First-quill Lake, Rainy L..... 19, 31 F
schists, described..... 75 F
Fish River, B.C., gold..... 132 R
Fish River, St. John R..... 7, 42 M
Fishes, Yukon district..... 25, 231 B
Lewes River..... 163 B
Clearwater Lake..... 57 J
Fisheries, inland, E. of James Bay 23 J
Fishing, northern N.B..... 7 M
Fissure, lines of..... 150-152 F
Flagstone, statistics..... 5 7, 99, 100 S
Flesche d'amour..... 70 S
Fletcher, H., work by..... 38, 96 A
Fletcher, Jas., Lepidoptera determined..... 229 B, 75 J
Floods of Miramichi R..... 8 N
Flora, north-eastern N.B..... 29 N
see Plants, Trees.
Fluorite..... 79 S
in silver veins, L. Superior.. 108 H
Flynn's diggings, Cariboo, ledge in..... 37 C
ore, assay..... 44 T
Folding of Coutchiching series... ..... 100, 131, 140 F
of Keewatin series..... 131, 140 F
Foldings, Cariboo district..... 27 C
complicated, Q..... 75 K
Quatawamkedgwick R..... 20 M
Rimouski R..... 23 M
see also Anticlinal.
Foley iron mine, Q..... 63 S
Foley's Creek, V.Is., gold..... 142 R
Foliation in dyke..... 153 F
circular in gneiss..... 19, 113 F
Foot-hills, Rocky Mtns..... 14, 118 C
Fording River, B.C., coal..... 149 R
Forest clearing, effect of, O..... 80 A
fires, Ma..... 13 E
E. of James Bay..... 39, 42, 44 J
Miramichi River..... 30 N
Forests, Cariboo..... 14, 18 C
Formations, geological, Cariboo.. 16 C
similar, B.C. and U.S..... 11 R
Archæan, Rainy L..... 22, 139 F
Eastern Townships..... 9 K
Quebec Group..... 43 K
Orleans Island..... 71 K
northern N.B..... 10 M
Forsyth iron mine, O..... 63 S
Fort Frances, O., falls of, Rainy R. 21 F
gneiss, described..... 126 F
Forty-mile Creek, Pelly R., gold. 181 B, 141 R
Forty-nine Creek, B.C., gold..... 133 R
Forward Inlet, V.Is., coal..... 87, 146 R
Fossils added to museum..50-53, 108-113 A
publications on, printed.... 105 A
Post-Tertiary, Yukon district 41 B
Cretaceous, Lewes River.... 146 B

	PAGE
Fossils, Cretaceous, Lake Labarge	159 B
Triassic, Stikine River	56 B
Carboniferous, Yukon district	33 B
Ordovician, Dease River	95 B
plants, Pelly River	126 B
Lewes River	149 B
woods, Lewes River	146 B
Cretaceous, Cariboo	19 C
in sand ridge, Rainy River	172 F
in clay, Big River	38 D
Devonian and Silurian, Chaudière	10 K
Cambro-Silurian, Eastern Townships	15-24 K
Cambrian, zones of, Lévis	45 K
Lévis, Eastern Townships	50-55 K
Orleans Island	59 K
Sillery, Etchemin River	60 K
St. Michel	66 K
Notre Dame de Portage	68 K
Quebec city	77-80 K
in pebbles of conglomerate	40, 42, 50, 56, 81 K
none found in Cambrian, Q.	86 K
none found in Pre-Cambrian, Quebec	92 K
list of, Eastern Townships	116 K
northern N.B.	13 M
Silurian, Dalhousie	15 M
Neigette River	17 M
Bois Brulé Mtn.	17 M
Ste. Blandine	18 M
Pointe-aux-Trembles	32 M
Tuladi Lake	34 M
Squatook Lake	35 M
Siegas River	37 M
Square Lake	40 M
Aroostook River	44 M
Back Bay	48 M
Foster Bar, Fraser R., gold	117 B
stibnite, assay	58 T
Foster, T., Ledge, Cariboo	40 C
Fountain, B.C., gold placers	117 R
Fountain Creek, Swift R., gold	125 R
Fountain Head Ledge, Cariboo, quartz vein (assay)	42 C, 44 T
Four-mile Creek, B.C., gold	125 R
Fox Ledge, Cariboo, gold ore, assay	36 C
Frampton, Q., copper ore	105 K
Frances, Fort, Frances Lake	137 B
Frances Lake, Francis River	108, 114 B
gold	113 B
Frances River, Liard River	98, 100-108 B
lignite	103 B, 150 R
Francklyn colliery, N.S.	16 S
Franklin, Sir John (1820), surveys in N.W	13 J
Fraser River, B.C.	66 A
gold placers	19, 24, 115-119 R
origin of the gold	25 R
gold yield	27 R
lignite	94, 149 R
copper ore	154 R
platinum, mercury	156 R
granite	159 R
lime	160 R
nickel	161 R
Fred Hart Creek, Cassiar, gold	140 R
French Bar, Fraser R., gold	117 R
French Creek, Dease River	91 B
gold	139 R
French Creek, Gold Creek, gold placers	133 R
French Creek, Pleasant Valley, gold	123 R
French Snow-shoe Creek, B.C., gold	125 R
Frenchman's Creek, B.C., gold	134 R
Frosts, summer, absence of, Ma	8 E
Frue, Capt., quoted	31 H
Furs, Yukon district	28 B
Gabbro, irruptive, Crow L	49 F
collar, encircling granite boss	56 F
altered, Rocky Islet Bay, described	67 F
Rice Bay Narrows, described	68 F
Manitou Lake, described	69 F
saussurite, Swell Bay, "	60 F
Bear's Passage, "	61 F
Crow Lake, "	72 F
Bad Vermilion L., "	99 E
olivine, Crow Lake, "	99 F
Galena, argentiferous, Illicillewaet River	2 A
Selkirk Mtns	64 A
McDame Creek	82 B
intersected by quartz, Cariboo and free gold, Snowshoe Creek	34 C
	45 C
argentiferous, Omenica	42, 73 R
B.C.	55, 60-74, 103 R
in silver veins, L. Superior	13, 109 H
Galena Ledge, Cooper's Gulch, ore, assay	40 C
Galena Ledge, Snowshoe Creek, galena	45 C
Game, Agoomski Island	25 J
Charleton Island	28 J
Temiscouata, Madawaska	36 A, 7 M
Garden River, L. Superior, galena	13 H
Garnets, Stikine River	54 B, 68 S
in dykes, Rainy L	156 F
Gas in silver veins, L. Superior	28, 106, 108 H
natural, O. and Q.	32, 59, 100 A
Gaspé Cape, Q., section	12 M
Gaspé Peninsula	12 M
Pre-Cambrian	89 K
petroleum	2 A
glacial striæ	15 N

PAGE

Gaspé pebbles ..... 71 S
Gaspé series..... 11 M
Gatineau River, Ottawa R..... 25 A
Geographical results of Yukon expedition ..... 10 B
" Geology of Canada" (1863).12, 32 K, 11 M
quoted..... 32, 36 A
George, Fort, Big River.....13, 23, 37 J
rocks..... 39 J
George, Lake, N.B., antimony mine ..... 10 S
George River, N.S., iron..... 33 S
Germansen Creek, Omenica R., gold placer..... 136 R
Gilbert River, Q, gold..... 28 S
Giroux, N. J., work by..... 28, 85 A
Giroux's vein, Whitefish L:..... 102 H
Glace Bay colliery, N.S..... 16 S
Glacial drift, Yukon district..... 11, 40 B
Cassiar Trail ..... 73 B
Dease River..... 96 B
Finlayson River ..... 119 B
Pelly River.....121, 126, 130, 132 B
Lewes River.....149, 154 B
north-western Ma.....10, 13, 16 E
north-eastern N.B..... 12 N
Glacial striæ, Pelly River..... 130 B
Lewes River.....154; 171 B
Rainy L. region..... 164 F
Whitefish River..... 87 H
E. of Hudson Bay..... 61 J
Eastern Townships..... 99 K
north-eastern N.B..... 15 N
Glaciation, Yukon district ..... 9 A
Lake Labarge ..... 159 B
Lake Marsh ..... 164 B
effects of, B.C..... 13 C
Rainy L. region..... 163 F
E. of Hudson Bay..... 61 J
Temiscouata Lake ..... 9 M
Rimouski River..... 26 M
north-eastern N.B..... 16 N
southern N.B..... 94 A
Glacier, ancient continental, Hudson Bay..... 61 J
Glaciers of Stikine valley ..... 51 B
r ces ion of ..... 52 B
ancient, Ma..... 14 E
Glass, statistics ....6, 7, 49, 52 S
Glenlyon Mountains, B.C.....127, 129 B
Glenlyon River, Pelly River..... 127 B
Glenore, Stikine River..... 61, 60 R
Gloucester county, N.B., glacial striæ ..... 15 N
Gnarled Islands, B.C., copper.... 153 R
Gneiss, biotite, Upper Pelly River, described ..... 239 B
injected in schists, Rainy L. region ..... 23, 32 F
in Coutchiching schists.106,117, 118 F
contact of, with schists.....23-43, 80 F
areas, Obabicon ..... 41 F

PAGE

Sabaskong ..... 41, 117 F
Stanjikoming..... 41, 112 F
Minomin..... 42 F
Lake Harris..... 42, 119 F
Turtle Lake..... 118 F
bosses, Bear's Passage .....102, 117 F
concentric foliation, Stanjikoming area..... 116 F
banded ..... 118 F
inclusions in..... 130-139 F
James Bay ..... 35 J
Big River .....39, 42, 47 J
E. of James Bay ..... 43, 45 J
Bishop Roggan River..... 49 J
Great Whale River..... 51, 54 J
altered by contact..... 54 J
Clear-water River ..... 60 J
Laurentian, Eastern Townships ..... 85 A
Ancient Lorette..... 19K
Montmorency Falls ..... 22 K
Gneiss specimens described..... 107-136 F
micaceous, Coutchiching Rapids 108 F
grey, Rice Bay..... 111 F
Rainy River..... 111 F
biotite, W. of Rainy L.....112, 129 F
Open-water Narrows ..... 129 F
Rainy L..... 136 F
granite and syenite..... 120-130 F
Stanjikoming area..... 112 F
Stone-dam Lake ..... 120 F
Loon Lake..... 120 F
Jack-fish Lake..... 121 F
Foot-print Lake ..... 122 F
North-west Bay ..... 122 F
Devil's Cascade..... 123 F
Sphene Lake, (fig.)..... 123 F
Cedar Narrows..... 125 F
syenite and granite, poor in quartz..... 126 F
Fort Frances..... 126 F
Sand Bay..... 126 F
Stanjikoming Bay..... 127 F
Standing-stone Point..... 127 F
biotite, Crow Portage..... 127 F
Loon Lake..... 128 F
Stanjikoming Bay..... 128 F
Open-water Narrows..... 129 F
Pipestone Lake..... 129 F
Clear-water L..... 130 F
Jack-fish Lake..... 133 F
Redgut Bay ..... 136 F
Goat River, B.C., gold..... 126 R
Gold, statistics..... 5, 6, 23 S
in British Columbia..... 61 A
districts, Yukon and Cassiar. .....10, 71 A, 26 B
and granite, connection of... 34 B
on Stikine R., discovery .... 62, 79 B
on Dease Lake ..... 76 B
mining Cassiar district..... 78 B
on Upper Liard River ..... 101 B

PAGE

Gold on Frances Lake ..... 118 B
on Pelly River ..... 134 B
on Big Salmon River ..... 152 B
on Lewes River ..... 153, 178 B
placers, Cariboo, relation to veins ..... 28, 30 C
distribution of ..... 29 C
bearing rocks, B.C., compared to those of California ..... 19 C, 12, 49, 51 R
to those of Australia ..... 49, 52 R
discovery of, B.C ..... 14, 17 R
placer mining, B.C ..... 19, 24-45 R
considerations on ..... 45-51 R
list of localities ..... 115-143 R
vein mining, B.C ..... 51-54, 143 R
relation to sulphurets ..... 58 R
yield, B.C ..... 34-45 R
N. of L. Superior ..... 8, 13 H
Jack-fish Lake ..... 13 H
Sunbury, O ..... 58 A
in anticlinals, Q ..... 88 K
in drift, Eastern Townships ..... 28, 86 A, 100, 101 K
and silver assays ..... 26-55 T
Gold Creek, Kootanie R., gold placers ..... 132 R
Gold Creek, Csssiar, gold ..... 139 R
Gold Harbour, Queen Charlotte Islands, gold ..... 143 R
Gold Range, B.C ..... 7 R
metalliferous belt ..... 8, 12, 39 R
Gold River, V.Is., gold ..... 143 R
Golden, B.C, cinnabar ..... 66 R
Goldstream Brook, V.Is., gold ... 141 R
Goodfellow copper mine, N.B ... 21 S
Goose Creek, Cariboo L., gold .... 124 R
Gowrie colliery, N.S. ..... 16 S
Grand or Victoria Lake, Ottawa R. 24 A
Grand River, O., gypsum ..... 31 S
Granite, statistics ..... 5, 6, 97 S
graphic ..... 75 S
as building stone, V.Is ..... 106 R
localities ..... 158 R
Jamieson Creek ..... 64 A
Coast Ranges ..... 34 B
Stikine River ..... 54 B
Cassiar Range ..... 92 B
upper Frances River ..... 106, 113 B
Glenlyon Range ..... 129 B
Granite Cañon, Upper Pelly River ..... 130 B
Lewes River ..... 145, 171 B
Chilkoot Pass ..... 176 B
biotite, Wrangell, described. 237 B
Stikine River, " 238 B
upper Pelly R., " 239 B
Cariboo ..... 16 C
irruptive, Lake Harris ..... 42 F
bosses, Pickerel Lake ..... 52, 145 F
Bad Vermilion Lake ..... 56, 145 F
mass, Smooth-rock Lake .... 53 F

PAGE

boulders in schists, described 82 F
in conglomerates, " 85 F
intrusions in Coutchiching schists ..... 106, 147 F
sporadic, Rainy L ..... 116 F
character and age of ..... 142 F
cutting Laurentian gneiss ... 142-144 F
the Keewatin and Coutchiching ..... 145 F
described, North-west Bay ... 143 F
Squall Point ..... 143 F
Pickerel Lake ..... 145 F
Bad Vermilion L ..... 145 F
Pipestone Lake ..... 146 F
Lake Superior, described .... 117, 119 H
Eastern Townships ..... 93 K
Granite Creek, B,C., gold ..... 62 A, 21, 38 R
platinum ..... 104 R, 49 S
gold placers ..... 128 K
ore, assay ..... 47 T
Granitic axes, Yukon district .... 13, 34 B
age of ..... 35 B
Granulite, Thetford ..... 96, 114 K
Black Lake ..... 110, 114 K
Graphite, statistics ..... 5, 6, 7, 28 S
connected with silver ore, *see* Carbon.
Graptolite zones, Lévis beds .... 45 K
Graptolites, Dease River ..... 94 B
Grassy Island, Rainy L ..... 37 F
diabase, described (fig.) .... 61 F
schist, " ..... 77 F
Grassy Lake, Seine R ..... 55 F
schist, described ..... 81 F
conglomerate, described .... 82 F
Grassy Narrows, Rainy L ..... 17 F
augite in diabase, (fig.) ..... 161 F
Grauwackes, Rainy L. region .... 91 F
Eastern Townships ..... 25, 26 K
Gravel, statistics ..... 6, 7, 105 S
ridges, Ma ..... 10 E
ridge, Rainy R ..... 171 F
and sands, James Bay ..... 25, 26 J
pre-glacial, north-eastern N.B. 10, 33 N
Gravels, pre-glacial, Cariboo ..... 16 C
auriferous, Quesnel R ..... 17 C
and sands, Whitefish L ..... 87 H
and clays, north-eastern N.B. 17-22 N
Gravel River, O., ore, assay ..... 32 T
Grazing country, Cariboo ..... 16 C
Great Falls, B.C., gold placer ... 117 R
Great glacier, Stikine River ..... 52 B
Great Whale River, Hudson Bay. 81 A, 6, 13 J
mouth of ..... 23 J
upper course ..... 50 J
lower course ..... 51 J
Green Hills, B.C., coal ..... 149 R
Green River, St. John River ..... 6 M
Green River Mountain, N.B ..... 8 M
Green Timber plateau, Cariboo .. 15 C
Grindstone Narrows, Rainy L., clastic rock, described ... 97 F
Grindstones, statistics ..... 5, 6, 7, 8 S

	PAGE
Groisselier, de (1668), voyages to Hudson Bay	8 J
Grosse Isle, St. Lawrence R.	73 K
Grossularite	68 S
Grouse Creek, Cariboo, quartz veins	42 C
gold	123 R
ore, assay	32 T
Grub Gulch, William Creek, gold	120 R
Guichon Creek, B.C., gold	135 R
coal	148 R
Gulf Lake, Hudson Bay	55 J
Gun Creek, Bridge R., gold	119 R
Gun Flint Lake, O., iron	34 S
Guy's Mountain, Cariboo	15 C
Gypsum, statistics	5, 6, 30 S
ground	30, 61 S
St. Martin Lake	74 A
near Valley, N.S.	98 A
Haddington Island, B.C., sandstone	158 R
Hague, A., referred to	149 F
Halifax, Q., Pre-Cambrian	90 K
copper ores	103 K
Halifax, N.S, gypsum	31 S
Hall, Prof. J., referred to	31 K
Ham, South, antimony mine	30 A
Hannah Bay, James Bay	15, 16 J
Harbours, James Bay	20 J
Hardscrable Creek, B.C., gold	121 R
Hardy Island, B.C., granite	158 R
Harlaka, Q.	55 K
Harriet Harbour, Queen Charlotte Islands, magnetite	151 R
ore, assay	55 T
Harrington, Dr., analyses	86, 96 R
quoted	30 A
Harris Lake, Rainy L. region	42, 54 F
Laurentian area	42, 119 F
schists	53 F
Harrison Lake, B.C., Cretaceous	67 A
hot springs	162 R
Hartford mine, Capelton, pyrite	84 S
Harvey Creek, Cariboo, gold	124 R
quartz veins	46 C
ores, assays	41 T
Harvey Hill, Q., copper mines	29 A, 102 K
Haseltine Creek, B.C., gold	125 R
Haskell's Bar, Fraser R., gold	117 R
Hastings, B.C., coal	68 A
Hastings, O., iron district	34 S
Hat Creek, B.C., gold	119 R
coal	149 R
Haystack Mountain, Aroostook R.	47 M
Haywood's Arastra Ledge, Cariboo (assay)	44 C
Hearne, S. (1769), expeditions W. of Hudson Bay	12 J
Hector, Dr., referred to	9 F
Heights, Yukon district	8 A
Rocky Mountains	6 R
Rainy L. region	11, 12 F
above sea, Rainy L.	13 F
maximum	14 F
Eastern Townships	98 K
Heliotrope	72 S
Hematite	76 S
Colchester Co.	98 A
assays of	23, 25, 26 T
Hendryx mining camp, Kootanie.	62 K
lead	155 R
Henrietta Maria, Cape, Hudson Bay	14 J
Hill's Bar, Fraser R., gold	26, 116 R
Hills, Cariboo district	18 C
Rainy L. region	11 F
characteristic of Thunder Bay silver district	22, 24 H
Hillsboro', N.S., manganese	44 S
Hind, Prof. H. Y., referred to	9 E
quoted	9, 176 F
Hine's Creek, B.C., gold	129 R
Hine's Ledge, Cariboo, gold	31 C
Hixon Creek, Cariboo, gold veins	48 C, 126 R
ores, assays	47 T
Hoffmann, G. C., work by	42, 101 A
analyses of coal	149 B, 86 R
of mineral water	29 H
report by	1-58 T
Holmes Ledge, Cariboo, galena	156 R
Holt, G., discovers gold on Lewes River	179 B
Homathco River, B.C., gold	141 R
copper	153 R
mercury	156 R
Home Rule Ledge, Cariboo, (assays)	32 C, 45 T
galena	156 R
Hoo-chee-koo Bluff, Lewes River.	145 B
Hoole River, Pelly River	120 B
Hope, B.C., silver mines	72 R
ores, assays	79 R, 48 T
gold placers	115 R
magnetite	151 R
lime	159 R
Hopkins, A. W., work by	4 K
Hornblende crystal secondarily enlarged, (fig.)	60 F
schists, Rainy L. region	73 F
stretched and sundered	66 F
with pyroxene cores, in gneiss	121 F
paramorphic origin of	125 F
Hornstone	73 S
Horse Beef Bar, Fraser R., gold	117 R
Horse-fly River, B.C., gold placer.	126 R
Horse-shoe Gulch, Cariboo, quartz ledges	45 C
Hot Springs mining camp, Kootanie, silver	61 R
copper	61, 65 R
springs	162 R
Hotalinqu River, Yukon district.	16, 169 B

	PAGE
name wrongly applied to Teslintoo River	154 B
House Point, James Bay	26 J
Howe Sound, B.C., copper and silver	102, 152 R
Howser Creek, B.C., gold	133 R
Hudson, H. (1610), discovers Hudson Bay	6 J
Hudson Bar, Fraser R., gold	116 R
Hudson Bay, work on	19, 80 A
country east of, work in	1-94 J
previous explorations	6 J
former reports on	14 J
Hudson Bay Co. created (1670)	8 J
enterprise of, Yukon district	61, 83, 140 B
Hudson River strata, Eastern Townships	48, 58, 71, 77 K
not found S. of St. Lawrence River	47 K
on Orleans Island	20, 71 K
Huelva district, Spain, copper and silver ore	41 A
Huntelite, Silver Islet mine	27, 33 H
Hunter's Island, O	76 A
iron	34 S
Hurlburt's vein, Whitefish L	101 H
Huron, Lake, work north of	77 A
mines, north of	7 H
Huronian gold mine, Jackfish L	13 H
Huronian, Rainy L. region	22 F
Lake Superior	8 H
north of L. Huron	79 A
and Laurentian, contact, Great Whale River	54 J
schists, Q	44 K
Hyalite, Stump Lake	61 A
Hydraulic cement	104 S
Hydrothermal action on granite	54 R
Ice, packing boulders	29, 30 J
piling boulders, Ma	11 E
James Bay region	24, 27, 34 J
transporting boulders, Q	100 K
Ichthyophthalmite	79 S
Iddings, J., referred to	149 F
Idocrase	76 S
Igneous rocks, Eastern Townships	93 K
Il-es-too-a River, Frances Lake	109 B
Ilets, Lac des, Tuladi R	27 M
Illecillewaet, B.C., silver mines	2 A, 63 R
lead	63, 155 R
ores, assays	77 R, 50 T
Illecillewaet River, N. fork, gold	134 R
ores, assays	52 T
Ilmenite	78 S
Ilvaite	77 S
Inclusions in Laurentian gneiss	130-139 F
Indian population, census of, Mackenzie district	205 B
tribes of Yukon district	178, 191 B
vocabularies	208 B
hunting grounds, Ma	13 E
camping grounds, old, N.B	31 N
camping places, old, Tuladi R	29 M
Indians visiting Agoomski Is	26 J
Indicolite	68 S
Ingall, E. D., work by	21, 39, 82 A
report by	1-131 H
Insects, list of, from Yukon district	229 B
from James Bay	75 J
Intercolonial colliery, N.S	16 S
International " "	16 S
Intervales, north-eastern N.B	22 N
Inverness, Q	62 K
Pre-Cambrian	91 K
copper ores	104 K
asbestus mining	109 K
Iolite	69 S
Ireland, Q., asbestus	88 A
copper ores	104 K
Iron, statistics	5, 6, 7, 33 S
pig, production	5, 7, 35 S
and steel, imports and exports	6, 7, 38 S
and steel, production	5, 38 S
ores, B.C	99 R
Texada Is. (anal.)	99, 151 R
Sooke	100, 151 R
Queen Charlotte Islands	101, 151 R
list of locations, B.C	151 R
Seine River	180 F
L. Superior	8, 12, 24 H
Hunter's Island	77 A
Ontario	40 A
in Archæan, O. and Q	62 S
Eastern Townships	30 A, 106 K
Pictou Co	38 A
bog, Tracadie River	33 N
analyses of	23-26 T
colouring sands, N.B	17 N
Iron Mountains, Nicola, iron	152 R
Ironstone pebbles, Antler Creek	43 C
Ironstone Ledge, Cariboo	46 C
Iroquois Creek, B.C., gold	137 R
Irving, Prof. R. D., quoted	125 F, 29 H
Iskoot River, Stikine River	50 R
Island Bar, Fraser R., gold	117 R
Island Lake, Big Salmon River	152 B
Island Mountain, Cariboo, ledges	29, 34 C
ore, assay	47 T
Islands of James Bay	24-36 J
of lower St. Lawrence R	70 K
Ison-glass River, James Bay	10, 20 J
Jack-fish Lake, Rainy L	18 F
gneiss, described	121 F
gneiss with inclusions, descr	133 F
trap dyke, trap described	154-159 F
Jack-fish Lake, L. Superior, gold	13 H

	PAGE
Jack-of-Clubs Creek, Cariboo, gold	121 R
ore, assay	44 T
Jacques Ledge, B.C., ore, assay	46 T
Jacques Cartier River, Q., Cambro-Silurian	18 K
Jade	73 S
on Lewes River	38, 147 B
in B.C.	111 R
James, T. (1631), discovers James Bay	7 J
James Bay, report on	19 A, 1-94 J
description	14 J
Jamieson Creek, Thomson River, silver veins	64 A, 70 R
ores, assays	79 R
gold	135 R
Jarvis Inlet, B.C., gold	123 R
Jarvis Island, L. Superior, silver	43 H
rocks described	116 H
ore, assay	32 T
Jarvis Island silver mine	128 H, 82 S
plan and section (plate)	44 H
Jasper	72 S
L. Superior	83 H
conglomerate	72 S
Jawbone Creek, B.C., gold	123 R
Jenkin's iron mine, O	63 S
Jenny, Mr., referred to	49 R
Jet	80 S
in B.C.	111 R
Joggins colliery, N.S.	16 S
John's Ledge, Cariboo	35 C
Johnston, R. A. A., work by	43, 102 A, 3 T
Jones, Cape, Hudson Bay	15, 23 J
Jordon River, V.Is., gold	142 R
Jubilee Mountain, Lake Marsh	164 R
silver ore	67 R
copper and silver	102, 154 R
Judd, Prof., referred to	122, 149 F
Juniperus Virginiana	188 B

K 17 Location, Thunder Bay, silver	51 H
Kah-timi-agamak Creek, Rainy L.	23 F
Kah-timi-agamak Lake, "	32, 47 F
Kaiarskons Lake, "	49 F
route, glacial striæ	165 F
Kainite	61 S
Kames, Eastern Townships	99 K
northern N.B.	10 M
north-easte N.B.	20 N
Kamloops, B.C., al	61 A, 96, 148 R
Kamloops Lake, B.C., iron ore	152 R
copper ore	154 R
marble	159 R
ore, assay	49 T
Kanaka Creek, B.C., coal	68 A, 147 R
Kangaroo Creek, B.C., gold	125 R
Kapiscow River, James Bay	17 J
Kaska Indians, B.C.	199 B
Kawachagamichits Lake, Patitawagan R.	48 J
Kawachiwan River, Big River	46 J
Keating, W. H., referred to	21 F
Kedgwick Lake, N.B	22 M
Keewatin, O., ore, assay	36 T
Keewatin series, Rainy L., area of rocks	22-43 F
stratigraphy and structure	43-57 F
thickness	48 F
petrography	55-99 F
largely volcanic	105, 135 F
division and origin	141 F
cut by granite	145 F
metalliferous rocks	181 F
see also Contact.	
Keithly Creek, B.C., gold placer	124 R
Kelsey, Henry (1691), expedition in the N.W.	10 J
Kennicot Lake, B.C., hot spring	163 R
Kenrick, E. B., work by	43 A, 3 T
Ketsa River, Pelly River	123 B
Kettle River, B.C., gold placers	130 R
Keweenian rocks, L. Superior	8, 23 H
copper in	11 H
Kildare Gulch, B.C., gold	137 R
Kindberg, Dr. N. C., work by	54, 115 A
King's county, N.B., manganese	44 S
Kingston and Pembroke iron mining Co.	33 S
Kinmount, O., ore, assay	35 T
Kinnear's Mills, Q., iron ore (anal.)	23 T
magnetite pseudomorph	58 T
Kishkutena Lake, Rainy L.	12, 24, 26, 44 F
trap, described	72 F
Kishkutena Ridge	12, 24 F
Kishkutena route, gneiss	117 F
glacial striæ	164 F
Kitawat, B.C., ore, assay	54 T
Kitimat Inlet, B.C., copper ore	153 R
Kitsegueela, Skeena, coal	150 R
Ki-uk River, V.Is., coal	146 R
coal, analysis	17 T
Kliksiwi River, V.Is., coal	146 R
coal, analysis	19 T
Knee Hills Creek, Red Deer R. lignite (anal.)	8 T
Knight Inlet, B.C., iron	151 R
copper	152 R
molybdenite	157 R
Ko-has-gan-ko Stream, B.C., lignite	149 R
Kokesila River, V.Is., coal	147 R
silver mine	74 R
Kootanie or Kootenay, B.C., gold district	24 S
gold placers	39, 130 R
vein-mining	59, 65 R
ores, assays	76 R, 49 T
lignite	149 R
Kootanie Lake, lead	155 R
argentiferous galena	65 A
silver ore, assay	55 T
Kootanie Pass, North, coal	148 R

	PAGE
Koprino, V.Is., coal	87, 146 R
Koskeemo, V.Is., coal (anal.)	87, 146 R
Kotaniwanan Lake, James Bay	43 J
Krause, Dr. A., exploration, Yukon district	180 B
Kuhushan Point, V.Is., coal	146 R
Kunz, G., report by	3, 65-80 S
Kutchin Indians, B.C.	203 B
Kwikhpak channel of Yukon R.	15 B
Kyanite	77 S
Labarge, Lake, Lewes River	156 B
Laboratory, work in	42, 101 A
Labradorite	74 S
"Lady of the Lake" Ledge, Cariboo (assays)	34 C, 44 T
Laflamme, Prof., work by	31 A
La Hache, Lake, B.C.	9 C
Lake country, Rainy L. region	10-20 F
basins, rocky, " "	17-19 F
southern N.B	95 A
Lakes, north-western Ma	7 E
ancient, " "	9, 14 E
Rainy L. region, soundings	14 F
northern N.B	7 M
Laketon, Cassiar	156 B
meteorological observations at	254 B
Lambert Island, Thunder Bay, silver	65 H
Lambton, Q., petroleum	101 A
Cambro-Silurian	14 K
Lanark, O., iron pyrite (anal.)	55 T
Langevin, Q., Devonian	10 K
Lansdowne Mountain, Lake Marsh	163 B
La Pérouse, Admiral (1782), in Hudson Bay	13 J
Lapic River, Pelly River	123 B
Lapierre's House Portage, B.C.	71 A
Lapis lazuli	78 S
Laplante's trail, sections	98 H
Laplante's vein, Whitefish Lake	102 H
Lapworth, Prof. C., on graptolites from Dease River	94 B
referred to	45 K
Laramie, Yukon district	36, 126, 149 B
coal and lignite, B.C.	94 R
Lardo River, B.C., gold	133 R
auriferous quartz	144 R
Larix Americana	187 B
Lyallii	188 B
Last Chance Creek, Cariboo, gold	122 R
Laurentian areas, Rainy Lake region	41, 112-119 F
rocks, petrography	120-142 F
barrenness of	181 F
north of L. Superior	8, 86 H
north of L. Huron	79 A
gneiss, James Bay	35 J
Eastern Townships	85 A
Ancient Lorette	19 K
Montmorency Falls	22 K
see also Contact, Gneiss.	
Lauzon group	86 A, 36, 42 K
Lawson, Dr. A. C., work by	18, 76 A
report by	1-182 F
on Beaver mine	126 H
Lawson colliery, N.S.	16 S
Lazulite	77 S
Lead, statistics	5, 6, 7, 102 S
ore, B.C.	103, 155 R
Home Rule Ledge	33 C
Colchester Co., N.S.	98 A
Leda clay, north-eastern N.B.	20 N
Ledge Point, B.C., sandstone	158 R
Leech River, V.Is., gold placers	21, 141 R
Leeds, Q.	62 K
iron ore	30 A
serpentine	97 K
copper ore	105 K
Lehmann, J., referred to	30, 85, 96 F
Lepidoptera, diurnal, from Yukon district	229 B
from James Bay	75 J
Lesley, Prof., quoted	35 A
Lethbridge, Al., coal mines	17 S
Leucoxene stretched in diabase (fig.)	70 F
Lévis, Q.	49, 64 K
Lévis county, Q., work in	5 K
Lévis, Point, Q., fossils	45, 50 K
shales	44, 59, 64 K
Lévis group	6, 25, 32, 64 K
thickness and character	34 K
position	41 K
shales and conglomerates	44, 55 K
fossils	45 K
not found N. of St. Lawrence	59 K
and Sillery, relations	86 A, 62, 82 K
eastern limit	65, 80 K
Lewes River, Pelly River	16, 18, 141-156, 161 B
section of volcanic ash and drift	35 B
jade	38, 147 B
lignitic coal (anal.)	148 B, 150 R, 11 T
gold	153, 178 B, 140 R
general notes on	173 B
ore, assay	36 T
Liard River, Mackenzie River	9, 69 A 96-102 B
dangers of, as a route of travel	12 A, 141 B
gold placers	101 B, 139 R
lignite coal	101 B, 150 R
galena	155 R
Library, reports on	56, 116 A
Lightning Creek, Cariboo, lignite	15 C
auriferous veins (assays)	38-40 C
gold mining	30-34 R
section of valley (fig.)	32 R
gold placers	122 R
ore, assay	47 T

	PAGE
Lignites, B.C	84, 146 R
upper Liard River.....	101 B
Frances River.....	103 B
Similkameen River	62 A
Fraser River	66 A
Lightning Creek.....	15 C
in Miocene, Cariboo	16, 17 C
analyses	5-9 T
Lillooet, Fraser R., gold district..	117 R, 24 S
Lillooet River, B.C., gold placer..	118 R
molybdenite.	157 R
hot spring	162 R
Lime, statistics	5, 6, 7, 102 S
chloride of, imports	7 S
British Columbia.....	109, 159 R
Rainy L. region.....	182 F
Eastern Townships.....	103 K
Neigette River.....	17 M
Limestone, for iron flux, imports.	7 S
Cambro-Silurian, Yukon district.....	32 B
Carboniferous.	33 B
Stikine River.....	55, 70 B
McDame Creek	93 B
Frances River	103 B
Lake Labarge.....	157 B
Lewes River.....	170 B
Carboniferous, Cariboo.....	15, 16, 20 C
Agassiz, analysis.....	56 T
pebbles, Rainy R.....	175, 182 F
Cambro-Silurian, St. Lawrence R.....	16-23 K
bituminous, Quebec	25, 58, 84 K
graphitic, Somerset.....	63 K
St. Maurice R.....	31 A
Lake Metapedia	14 M
St. Gabriel	17 M
Limestone Ledge, Cariboo	43 C
Limonite, N S.....	39, 98 A
Lindeman Lake, Lewes River....	172 B
Line Bay, Pipestone L., schist, described	86 F
L'Islet, Q....	67 K
L'Islet county, Q., work in.....	5 K
Litchfield, Q., ore, assay	27 T
Litharge, imports	7, 48 S
Lithographic stone, imports.....	7, 43 S
in O.....	43 S
Little Canoe River route, glacial striæ	166 F
Little Grassy River, Lake of the Woods	26, 28 F
agricultural lands.....	177 F
Little Gull Lake, Thunder Bay, iron ore (anal.)	25 T
Little Pig silver vein, Rabbit Mtn.	75 H
Little Salmon River, Lewes River	147 B
Little Trout Bay, L. Superior....	46 H
Little Turtle Lake, Rainy L	35 F
Llandeilo formation, Q.....	46 K
Loadstone Mountain, B.C., iron..	152 R
Lob-stick Island, Rainy L., schist, described.....	109 F
Londonderry, N.S., iron mines and works.....20, 33, 35, 36 S	
Logan, Sir W., quoted.....	9 H
referred to.....	6, 27 K
on Quebec group.....	27, 42 K
Logan, Mount, Too-tsho Range...	111 B
Long, Major, referred to.....	21 F
Long Lake, Maine, section	42 M
Longue Sault Rapid, Rainy R....	20, 25 F
Keewatin rocks	40 F
schist, described	78 F
Loon Lake, Rainy L.....	18 F
gneiss, described.....	120 F
Loraine formation, Q.....	15, 19 K
Lorette, Q.....	19 K
Lorne Creek, B.C., gold.....	141 R
Lorne Mountain, Lake Marsh....	163 B
Lost Creek, B.C., gold	136 R
Lotti, B., referred to.....	149 F
Louis Creek, B.C., gold.....	135 R
Low, A. P., work by.....	19, 80 A
report by	1-94 J
Lowe, F A., quoted.....	28, 32 H
Lower Post, Lewes River	91 B
Lower Diggings Ledge, Cariboo..	42 C
Lowhee Creek, Cariboo, quartz ledges (assay)	34 C
gold.....	121 R
Lyster, Q.....	62 K
Lytton, B.C., gold placers	116 R
Mabou colliery, N.S.....	16 S
Macfarlane, T., quoted.....	18 H
Macfarlane band, trap dykes, L. Superior	26 H
Macfarlanite	27, 33 H
Mackenzie River, exploration....	70 A
petroleum beds	72 A
and Yukon R. compared	17 B
district, census of Indian population	205 B
MacMillan River, Pelly River....	18, 128 B
MacNutt, C. H., work by.....	6 J
Macoun, Prof. J., work by.....	53, 114 A
plants determined.....	215 B
Macoun, J. M., work by....19, 55,	114 A, 5 J
plants collected by.....	63 J
insects collected by	75 J
Macpherson Lake, near Frances L.	111 B
Madame Island, St. Lawrence R..	73 K
Madawaska county, N.B., work in	5 M
Madawaska River, St. John R....	6 M
valley, origin of	8 M
Madoc and Marmora, O., iron region	62 S
Magnetic variations observed, Yukon district.....	277 B
Magnetite, B.C.....	151 R
pseudomorph, Kinnear's Mills	58 T

	PAGE
Maiden Creek, B.C., mineral spring	163 R
Mailloux, Q., Cambrian	86 K
lime	113 K
Maine, U.S., work in portions of	5 M
Maitland, N.S., manganese	44 S
Malachite	80 S
Mamainse Point, Lake Superior, copper	11 H
Ma-min River, Queen Charlotte Islands, lignite	146 R
Mammalia in museum	106 A
notes on breeding habits of	76 J
Manganese, statistics	5, 6, 7, 44 S
oxide, imports	7, 45 S
Valley, N.S	98 A
Manitoba, progress of work in	14, 72 A
north-western, report on	1-16 E
Manitoba Lake, work on	73 A
Manitou Lake, Rainy L	12, 16, 52, 54 F
diabase, described	69, 71 F
gabbro, "	69 F
clastic slates, "	95 F
Manitou route, gneisses	114 F
glacial striæ	165 F
Manitounuck rocks, E. of James Bay	59 J
Mansen Creek, Omenica, gold	136 R
Mansen River, B.C., gold	137 R
Map, of Duck and Riding Mtns., notes on	1-16 E
sketch, Thunder Bay region	6, 77 H
Admiralty chart, Hudson Bay	15 J
asbestus region, Q	112 K
Maps, published	55, 115 A
of Yukon district	10 B
former	15, 178 B
former, of Stikine River	47, 63 B
of Rainy L. region	5 F
compilation of	8 F
of parts of Q. and N.B	5 M
Marble, statistics	5, 6, 7, 97 S
Eastern Townships	113 K
Marbles, B.C	107, 158 R
Marcou, Prof. J., referred to	32 K
Margaret Island, St. Lawrence R.	75 K
Maria Bar, Fraser River, gold	115 R
Mariner's Bar, Fraser River, gold	117 R
Markham mine, N.B., manganese	44 S
Marsh or Mud Lake, Lewes River	163 B
diabase, described	235 B
Marshes, fresh-water, north-eastern N.B	22 N
salt	27 N
Marsouin River, Q., graptolite zone	9, 45-47 K
Marten Creek, B.C., coal (anal.)	
Peter seam	12 T
Jubilee seam	14 T
Mascareen Peninsula, N.B., Silurian strata	48 M
Masquachiwi Lake, Great Whale River	50 J
Mattawa, O., ores, assays	30 T
Matthew, G. F., referred to	49 M
May Creek, B.C., gold	137 R
McArthur's Creek, Cariboo, gold	120 R
McConnell, R. G., work by	4, 12, 69 A, 6 B
quoted	47 B
referred to	10 N
McCulloch's Bar, Liard R., gold	84 B, 139 R
McCulloch Creek, Gold Creek, gold	133 R
McDame Creek, Dease R., gold placers	81, 89 B, 138 R
silver in galena	82 B
North forks of, gold placers	139 R
McDonald's 'oil spring,' Omenica River	163 R
McEvoy, J., work by	59 A, 7 C
McEvoy Lake, Finlayson River	116 B
McGillivery Creek, Anderson L., gold	118 R
McGoffery Dry Gold diggings, B.C	117 R
McInnes, W., work by	35, 91 A
report by	1-52 M
McIntyre, Thunder Bay	60 H
ore, assay	25 T
McKellar, P., quoted	55 H
McKellar Harbour, Lake Superior, galena	13 H
McKellar Island, L. Superior, silver	40 H
barite	40 H, 46, 47 S
silver mine, plan and section (plate)	40 H
McKellar Point, L. Superior	45 H
syenite, described	115 H
McLennan Creek, B.C., gold	126 R
McLeod, J., explorations, Yukon district	83, 136 B
McLeod Mountain, Dease R.	77 B
McMillan, J., work by	38, 100 A
Meeting Creek, Battle R., lignite (anal.)	9 T
Megantic county, Q., work in	5 K
Melanite	68 S
Memekwisi Lake, Rainy L	15 F
schist, described	78 F
Mercury, imports	7, 51 S
in B.C	12, 42, 105, 156 R
Merriam, Dr. J. H., on *Evotomys*	232 B
Mesozoic, Cariboo	17 C
Metalliferous belt of B.C	14 R
Metapedia, Lake, Q	13 M
Metapedia River, Q	15 M
Metamorphism, Cariboo	18, 20-22 C
of quartz-porphyry, Rainy L.	30, 36 F
of Keewatin schists	38, 74, 125 F
of Coutchiching schists	38, 104, 108 F

	PAGE
contact and regional	39 F
of traps	57 F
dynamic	57, 59 F
contact, N B	50 M
Meteorological observations, Yukon district	241 B
James Bay	80 J
Meteorology of north-western Ma.	8 E
James Bay	36 J
Metis River, Q	16 M
Mica, statistics	5, 6, 46 S
British Columbia	112, 161 R
Rainy L. region	180 F
Hunter's Island	77 A
Michie Mountain, Lake Marsh	163 B
Michigan, U.S., copper	9 H
Michipicoten Island, L. Superior, copper	11 H
ore, assay	35 T
Microcline	74 S
Microscopic examination of rocks from Yukon district	235 B
from Duncan mine	58 H
from Silver Mountain	81 H
from Thunder Bay region	115-122 H
see also Petrography.	
Mill, stamping, Silver Islet	38 H
Rabbit Mountain	70, 74 H
Mill River, Q., gold	28 S
Miller, Hugh, referred to	13 N
Mines and mining on L. Superior	1-131 H
Miner's Range, Lake Labarge	157 B
Mineral resources, Royal Commission on, O	79 A
resources, Rainy L. region	180 F
statistics, progress of work	39 A
statistics for 1887	1-110 S
wealth of B.C	1-163 R
Mineralogical collection, additions to	102 A
catalogue of	102 A
collections supplied	105 A
work, progress of	42, 102 A
Mining discouraged	10 H
difficulties experienced	16 H
pointed at by Geological Survey	10, 18 H
laws, retarding effect of	18 H
effect of erroneous ideas on	20 H
and mineral statistics of Canada for 1887	1-110 S
in B.C	61 A
and minerals, Yukon district.	26, 182 B
geology, Cariboo	26 C
vein-mining, B.C., causes of retardment	13 R
gold	51 R
silver	55 R
placer-mining	24-50 R
connexion with vein-mining	50 R
in O	40 A
in N.S	97 A
Mink Gulch, Cariboo, gold	120 R
Mink Island, L. Superior, silver	51 H
Minnedosa, Ma., height	6 E
search for coal at	73 A
Minomin Laurentian area, Rainy Lake	42 F
Miocene, Liard River	9 A
Cariboo	16 C
Miramichi River, N.B	7, 12, 18, 26 N
Post-Tertiary drift dam	12 N
agricultural lands	29 N
estuary, boulders N. of	14 N
Miscou Island, N.B	12, 23, 27 N
Mis-him-in-e-we-tan Lake, Great Whale R	50 J
Mission Creek, Okanagan L., section	48 R
gold placers	130 R
silver	145 R
Mission Hills, B.C., coal	147 R
Missionary work, Hudson Bay	14 J
Missus Lake, Rainy L	19, 42 F
Mitchell Creek, Cassiar, gold	140 R
Mitchell Harbour, Queen Charlotte Islands, gold	143 R
Mitchell, Mount, Cariboo	25 C
Molybdenite, Rainy L. region	181 F
N. of L. Superior	8 H
Molybd num, B.C	106, 157 R
Monashee gold mine, Cherry Creek	68, 144 R
Monazite	79 S
Montalban and Coutchiching series, similarity of	21 F
Montcalm county, Q., work in	27 A
Montmagny county, Q., work in	5 K
Montmorency Falls, Q	21, 22 K
Moonstone	74 S
Moor-head River, B.C., gold	125 R
Moore, J. H., work by	4 H
Moore's Ledge, Cariboo	47 C
Moose Factory, Moose River	21 J
summer temperature	36 J
Moose River, James Bay	17 J
mouth of	21 J
Moose Mountain, Q., diorites	93 K
"Morion"	69 S
Mormon Bar, Fraser R., gold	117 R
Mörtel structur of plagioclase in schists	79 F
Morton, C. S., work by	5 F
Mosquito Creek, Cariboo, quartz ledges	37 C
ores, assays	44 T
Mosquito Creek, Columbia R., gold	132 E
Mosquito Creek, Thibert Creek, gold	138 R
Mosquito Creek, Willow R., gold.	121 R

	PAGE
Mossy River, Ma	7 E
Moulding sand, production	5, 48 S
Mountain of rock, cañon of, coal	150 R
Mountain ranges, B.C	6 R
features, continued in U.S.	11 R
Mountains, Vancouver Is	54 A
Cariboo district	13, 21, 23 C
north-eastern N.B	7 N
see also Orography.	
Mourning Point, Hudson Bay	14 J
Mouse, Red-backed, new species	232 B
Moyie River, B.C., gold	132 R
Mud or Marsh Lake, Lewes River	164 B
Murchison, Mount, B.C	6 R
Murray, A., referred to	25 K
Muscovite, Villeneuve, described	58 T
Museum, additions to, *see* Collections.	
progress of work in	102 A
visitors to	57, 116 A
accommodation insufficient	3, 117 A
Musquegegish stream, Q	16 M
Mustang Creek, Cariboo, quartz ledges	42 C
Nadeau Lake, Maine	43 M
Nadeau Harbour, Queen Charlotte Islands, lignite	146 R
Nanaimo, V.Is., coal	80, 90, 146 R
colliery	83 R, 17 S
section	89 R
coal, analysis	91 R
sandstone	158 R
salt spring (anal.)	162 R
Nanaimo River, V.Is., gold	142 R
Napan River, N.B., valley	9 N
Nares, Lake, Lewes River	165, 169 B
Nass Indians, B.C	194 B
Nass River, B.C., galena	155 R
Nassagaweya, O., terra cotta	57 T
Nation River, B.C., gold	137 R
Natrolite	78 S
Navigable waters, Yukon district	19 B
Stikine River	46 B
Pelly River	133 B
Lewes River	165, 173 B
E. of James Bay	18 J
Nazco River, B.C., lignite	149 R
nitre	161 R
Ne Tye Ledge, Cariboo (assay)	47 C
Nechacco River, Fraser R., agricultural land	66 A
gold placers	119 R
lignite	149 R
Neepigon rocks, N. of L. Superior	8 H
Nehoialpitkwa River, B.C., gold	130 R
Neigette River, Q	17 M
Nelson, Q., copper ore	105 K
Nelson, N.B., section near	11 N
Nelson Creek, B.C., gold	121 R
Nelson River, Hudson Bay	7 J
Nephrite	73 S
Nepisiguit River, N.B	7, 9 N
terraces	18 N
New Brunswick, progress of work in	35, 91 A
northern, report on	1-52 M
north-eastern, report on	1-33 N
ores, assays	27 T
New Brunswick Bar, Fraser River, gold	117 R
New Creek, B.C., gold	121 R
New Westminster, B.C., mercury	157 R
ore, assay	50 T
Newberry or Tes-lintoo River, Lewes River	154 B
Newcastle Island, Nanaimo, sandstone	107, 157 R
Newfoundland, Quebec rocks on	25 K
thickness of formation	35 K
section	38 K
Nicaragua Bar, Fraser R., gold	116 R
Nickel, B.C	161 R
N. of L. Superior	8 H
Nicoamen, B C., gold	18, 29, 118 R
silver	145 R
coal	149 R
iron	151 R
Nicola River, B.C., vein-mining	69 R
gold placers	135 R
lignite coal	61 A, 96, 148 R
analysis	96 R
Nicolet Lake, Q., antimony mine	10 S
Nigger Creek, Cariboo L., gold	124 R
Nigger Creek, Moyie R., gold	132 R
Night-hawk Lake, Rainy L	23 F
Nimpkish Lake, V.Is., marble	158 R
Nine-mile Creek, B.C., gold	127 R
Ni-sutlin-bi-ni River, Teslintoo R.	155 B
gold	140 R
Nitchicoon post, E. of James Bay, routes to	19 J
Nitre, B.C	161 R
Nodules, fossiliferous, Assiniboine River	73 A
Nordenskiöld River, Lewes River	147 B
North arm of Rainy L	18 F
glacial striæ	166 F
North Carolina, U.S., gold-bearing rocks	53 R
North-east Bay, Rainy L	18 F
North-west Bay, "	18, 118 F
gneiss, described	122 F
granite, "	143 F
diabase, "	160 F
glacial striæ	166 F
North-west Territory, ores, assays	36 T
Northumberland county, N.B., glacial striæ	15 N
Norwood, J. E., referred to	169 F

	PAGE
Notre-Dame du Portage, Q.	68 K
Notre-Dame Mountains, Q.	16 M
Nottaway River, Little, James Bay	18 J
Nourse River, Taiya Inlet	175, 177 B
Nova Scotia, progress of work in.	38, 96 A
ores, assays	26 T
steel works	36 S
Nugget Gulch, Cariboo, auriferous quartz	43 C
gold placers	123 B
Obabicon Laurentian area, Rainy Lake	41 F
Obalski, referred to	94 K
Obolella pretiosa	51, 58, 60, 64-71 K
Obsidian	75 S
British Columbia	110 B
Ochre, production	5, 46 S
British Columbia	112 B
Off Lake, Rainy L.	25 F
schist, described	89 F
agglomerate, described	96 F
Ogilvie, W., work by	47 A, 6 S
Ogilvie Valley, Lake Labarge	157 B
Ohomichichits, Lake, Bishop Roggan R.	44 J
Okanagan River and Lake, B.C., gold placers	130 B
Oldham, N.S., gold district	26 S
Olivine	76 S
Omenica, B.C., gold district	24 S
Omenica Mountain, B.C.	7 B
Omenica River, B.C., gold placers	21, 41, 136 B
arquerite, silver	73 B
galena	73, 155 B
ores, assays	78 B
Onslow, Q., ore, assay	27 T
Onslow, N.S., mine, manganese	44 S
Ontario, progress of work in.	21, 76 A
Royal Commission on mineral resources	79 A
peninsula, natural gas	59 A
ores, assays	31-36 T
Ontario colliery, N S.	16 S
Opal	72 S
semi-	72 S
British Columbia	110 B
Opaline silica, Stump L.	61 A
Open-water Narrows, Rainy L.	17, 106 F
Coutchiching belt	102 F
schist, described	107 F
gneiss, "	129 F
Orchay River, Pelly River	123 B
Ordovician fossils, Dease River	95 B
in Quebec	46 K
Oriskany, Casupscal River	13 M
Orleans Island, St. Lawrence R.	49, 59, 64 K
Orographic features, northern N.B.	8 M
Orography, Yukon district	8 A, 12 B
see also Hills, Mountains.	
Orton, O., iron mine	63 S
Osinawe Lake, Seine R., ore, assay	34 T
Ottawa county, Q., phosphate district	82 A, 59, 62 S
Ottawa River, upper	24 A
Otter Cove, B.C., granite	158 B
Otter-tail, B.C., silver ore	66 B
ores, assays	77 B, 47 T
Otukamamoan Lake, Rainy L.	35, 43 F
schist, described	78 F
Otukamamoan route	19 F
Ou-ou-kinsh Inlet, V.Is., gold	143 B
Outlook Hill, Silver Mtn., trap	80 H
Outpost Hills, O.	24 H
Ouvarovite	68 S
Owen, D. D., referred to	9, 169 F
Paints, mineral statistics	5, 7, 47 S
Ste. Anne de Montmorency	113 K
Paiponge, Thunder Bay	66 H
Palæontological collection, additions to	50-53, 108-113 A
work, progress of.	47, 105 A
Palæozoic, Yukon district.	8 A
Cariboo	16, 20 C
Rocky Mountains.	7 B
Palisades Vein, Silver Mountain.	92 H
diabase, described	117 H
Palmer's Bar Creek, B.C., gold	132 B
Panorama Lake, Rainy L.	44 F
Paresseux Rapids, Kaministiquia River.	66 H
Parsnip River, B.C., gold.	137 B
coal	150 B
Paska River, B.C.	107 B
Patch Island, Crow Lake.	47 F
grauwacke, described	91 F
Patience Island, St. Lawrence R.	74 K
Patitawagan River, Big River.	45, 48 J
Patterson Creek, Cassiar, gold.	139 B
Peace River, B.C., gold placers.	21, 137 B
coal	94 B
Pearson, Mr., work by	115 A
Peat, bogs, north-eastern N.B.	22 N
for fuel	33 N
Pectolite	73 S
Peep Bay, Manitou L., diabase, described	69 F
Pelly Banks, Pelly River.	17, 137 B
Pelly Range, B.C.	120, 124 B
Pelly River, B.C., upper course.	17, 119-133 B
general notes on	133 B
gold placers	134 B, 140 B
confluence with Lewes R.	135 B
exploration of	136 B
and Yukon, identity of.	138 B

	PAGE
gneiss and granite, described.	239 B
coal	150 R
ore, assay	37 T
Pembroke, N.S., manganese	44 S
Pend d'Oreille River, B.C., gold	132 R
Pender Island, B.C., sandstone	157 R
Peridot	76 S
Peridotite rocks, Rainy L. region.	97 F
Peristerite	75 S
Perkins Creek, Cariboo, gold	122 R
Perkins Ledge, B.C., ore, assay	46 T
Perry Creek, B.C., gold placers	132 R
Petrography of Keewatin rocks, Rainy L. region	57-99 N
of Coutchiching rocks	107-111 F
of Laurentian rocks	120-139 F
of granites	145 F
of diabase traps	154-163 F
Petroleum, statistics	5, 6, 7, 53 S
British Columbia	112 R
Mackenzie River	72 A
search for, Vermilion R.	72 A
Lambton Co., O.	101 A
Gaspé	2 A
Phenacite	68 S
Philipsburgh, Vt., group	33, 35 K
compared to Lévis group	39 K
Phosphate, production	5, 59 S
deposits in Archæan rocks	62 S
district, Ottawa Co	82 A
Phyllograptus zone, Quebec rocks.	45, 47 K
Physical features, dependent on geological conditions	10, 16 F
of Rainy Lake	17, 18 F
Piagochi Lake and River, James Bay	41 J
Picea alba	186 B
Sitchensis	189 B
Pickerel Lake, Rainy L.	12 F
schist, described	76, 89 F
conglomerate, "	83 F
slates, "	94 F
granite, "	145 F
Pickwick Lake, Rainy L.	34 F
Pictou, N.S., coal field	96 A
Pictou county, N.S., iron ore	38 A
Pie Island, L. Superior, silver	53 H
mine, plan and section (plate)	40 H
Pigments, mineral, production	46 S
Pimimagachi Lake, James Bay	45 J
Pine Bay L. Superior galena	50 H
Pine Creek, Cariboo L., gold	124 R
Pine River Cañon, B.C., coal	150 R
Pine River, Rainy R.	20, 25 F
schist, described	79 F
post-glacial deposits	172 F
Pinus contorta	189 B
Murrayana	186 B
Pipestone, quarried, Rainy R.	40 F
Pipestone Lake, Rainy L.	31, 146 F
diabase, described	72, 159 F
schists, "	75 F
granite, "	129 F
Pipestone Lake route	19 F
glacial striæ	165 F
Plagioclase crystals, sundered (fig.)	63 F
shattered (fig.)	70 F
mörtel structur in	79 F
two forms of, in trap	156 F
in diabase (fig.)	160 F
Plain, alluvial, Rainy River	20 F
sandy, Great Whale River.	53 J
Plants, Canadian, catalogne published	114 A
list of, Yukon district	216-228 B
Stikine River	59 B
Tahltan River	65 B
E. of Cassiar Range	90 B
Upper Liard River	99 B
Frances River	103 B
Finlayson Lake	118 B
Pelly River	132 A
Lewes River	163, 168 B
list of, James Bay	63 J
Plaster, land, production	6, 30 S
of Paris, imports and production	7, 30 S
Plateau, Interior, of B.C.	8, 68 R
Platinum, statistics	5, 7, 48, 49 S
wire, imports	49 S
British Columbia	39, 104 R
Granite Creek	62 A, 104 R
Similkameen R.	62 A
Yukon district	28 B
Plumbago, statistics	6, 7, 28 S
British Columbia	161 R
Pohenegamook Lake, St. Francis River	38 R
Point à Pizeau, Q.	29, 44 K
Pointe au Platon, Q.	14, 26 K
Pointe aux Trembles, Portneuf, Q.	18 K
Pointe aux Trembles, L. Temiscouata	32 M
Poorman's Gulch, Cassiar, gold	140 R
Popcum, B.C., lime	159 R
Populus trichocarpa	186 B
Porcupine Bar, Liard R., gold	139 R
Porcupine Creek, B.C., gold	131 R
Porcupine silver mine, Rabbit Mtn	71, 126 H, 4, 88, 94 S
section (plate)	68 H
Porphyrite, Kishkutena Ridge	24 F
Porphyry	75 S
dyke, Grouse Creek	42 C
quartz-, Kishkutena L.	24 F
altered, Keewatin series	85-90 F
Pickerel Lake	52 F
Clear-water L., described	88 F

PAGE

Port Arthur, O., silver mining.21, 54 H, 89 S
Port Friedrick, Queen Charlotte Islands, copper ..... 153 R
Port Harvey, B.C., granite..... 158 R
Port Nelson, Hudson Bay..... 9 J
Port Simpson, B.C, copper ..... 153 R
Portage Lake, Maine..... 43 M
Porter's Ledge, Cariboo, (assay).. 43 C
Portland cement, imports..... 7, 105 S
Posey Bar, Fraser R., gold..... 116 R
Pospiskagami Lake, Great Whale River..... 51 J
Post-Archæan diabase traps, Rainy Lake..... 147 F
Post-glacial formations, Rainy L. 169 F
thickness of..... 171 F
northern limit of..... 174 F
value of..... 182 F
Post-pliocene deposits, James Bay 16 J
Post-Tertiary, Cariboo ..... 17 C
Potash, German mineral, imports. 7, 61 S
muriate and bichromate, imports ..... 7, 61 S
Potsdam formation near Quebec.. 35 K
supposed area of, Q..... 42 K
Pre-Cambrian, Eastern Townships 89-93 K
area, north-eastern N.B..... 7 N
soil on..... 31 N
Pre-glacial deposits, north-eastern N.B..... 10, 11, 17 N
Prehnite ..... 77 S
Presquile, Maine..... 46 M
Pressure, effects of, on schists, Rainy L. region..... 47 F
on diabase.....63, 65, 70 F
on hornblende in diabase (fig.) ..... 66 F
on trap (fig.) ..... 71 F
on quartz-porphyries (fig.). 86 F
on tourmaline (fig.) ..... 89 F
on quartz (fig.) ..... 93 F
on agglomerates ..... 96 F
on gneiss .....118, 128, 131, 138 F
on titanite in gneiss (fig.). 124 F
on igneous rocks..... 149 F
period of..... 140 F
northern N.B..... 24 M
"Primordials", lenticular . ..... 33 K
Prince's mine, L. Superior, silver. 51 H
Progress of work in B.C..... 4, 59 A
in Manitoba..... 14, 72 A
in Ontario..... 21, 77 A
on Hudson Bay ..... 19, 80 A
in Quebec..... 27, 82 A
in N.B..... 35 91 A
in N.S..... 38, 96 A
in laboratory ..... 42, 101 A
in museum.....44-53, 102-114 A
in botanical section ..... 53, 114 A

PAGE

Proserpine Ledge, Cariboo, silver (assays)..... 31 C, 45 T
Prospect Creek, B.C., gold..... 141 R
Publications of the Geological Survey..... 47, 105 A
Puget Sound, Washington T., coal (anal.)..... 92, 94 R
Pumice stone, imports..... 7, 9 S
Purcell Range, B.C..... 7 R
Pyrite, statistics ..... 5, 81 S
in quartz veins, Cariboo....33, 35, 36 C
iron, Copper Island..... 161 R
in silver veins, L. Superior.. 109 H
deposits in Ontario..... 85 S
in Eastern Townships .... 83-85 S
iron, Lanark, analysis ..... 55 T
Pyroxene ..... 76 S
rhombic, in diabase ..... 163 F
Pyrus rivularis..... 189 B

Quilchena, B.C., lime..... 160 R
Qualicun, B.C., marble..... 158 R
Quartz..... 69 S
hyaline ..... 70 S
milky ..... 69 S
smoky..... 69 S
sundered by pressure (fig)... 93 F
vein-, between strata..... 106 F
origin of, in diabase dykes... 161 F
in silver veins, L. Superior.. 107 H
veins, Yukon district..... 35 B
Frances River .....113, 119 B
Pelly River..... 134 B
Cariboo ..... 23, 28 C
Jamieson Creek..... 64 A
L. of the Woods ..... 59 A
Quartz Creek, Columbia R., gold. 131 R
Quartz Creek, McDame Creek, gold..... 138 R
Quartzites, Yukon district..... 33 B
Stikine River..... 55 B
Lewes River..... 171 B
cherty, Cariboo ..... 17 C
Eastern Townships ....57, 63-66, 69 K
Quatawamkedgwick, origin of name ..... 25 M
Quatawamkedgwick R., N.B..... 20 M
valley..... 25 M
Quatsino Sound, V.Is., coal ..... 86, 146 R
Quebec city .....26, 58, 83 K
great fault .....31, 44, 55, 77 K
Quebec, province of, progress of work in..... 27, 82 A
report on Eastern Townships of..... 1-114 K
on portions of ..... 1-52 M
ores, assays..... 27 T
"Quebec group," history of..... 25-40 K

	PAGE
objections to the term	6 K
new views on	43 K
belt unaltered, S. of St. Lawrence R.	48 K
fossil fauna	47 K
Quebec diamonds	69 S
Queen's county, N.B., Silurian strata	48 M
Queen Charlotte Islands	10 R
discovery of gold	17 R
silver	74 R
coal	65 A, 85, 145 R
iron ore	101 R
gold veins	143 R
bitumen	112, 161 R
amber	111, 161 R
Quesnel Lake, Cariboo	18 C
crystalline series	16 C
Quesnel River, Cariboo	13 C
gold placers	17 C, 125 R
iron	152 R
native copper	155 R
ore, assay	37 T
North Fork, quartz ledges	47 C
South Fork, quartz boulders	48 C
Quesnel River beds	16, 17, 19 C
Quesnel Company location, auriferous veins (assays)	48 C
Quichena, B.C., coal	148 R
Quiet Lake, Big Salmon River	152 B
Quinze, Lac des, Q., ores, assays	28 T
R 48 location, Rabbit Mtn, silver vein	76 H
R 64 location, Silver Mtn.	95 H
chert, described	120 H
R 93 Ridge, Silver Mtn.	79 H
trap, described	121 H
R 119 Location, Whitefish L.	100 H
R 208 Location, "	100 H
Rabbit Mountain, Lake Superior, silver mining	68 H
mine, plan and section	70, 125 H, 88, 92 S
Jr. mine	71 H
ore, assay	32 T
Radisson (1668), voyages to Hudson Bay	8 J
Radnor Forges, Q	20, 34, 35 S
Raft River, James Bay	17 J
Railway terminus, position for, James Bay	21, 23 J
Rainy Lake, O	13, 16 F
region, work on	18, 76 A
report on	1-182 F
progress of survey	5 F
former surveys	8 F
plateau	11 F
glacial striæ	166-169 F
W. of, gneiss, described	129 F
gneiss, inclusions in	136 F
Rainy River, depth	21 F
Keewatin rocks	25, 40 F
gneiss, described	111, 137 F
trap dykes	152 F
glacial striæ	166 F
post-glacial formations	169 F
agricultural lands	176 F
Rancheria Bar, Fra er R., gold	117 R
Rapid River, Dease River	90 B
gold	139 R
coal	150 R
Rat Portage, O., ore, assay	36 T
Rat-root Bay, Rainy L.	38, 104 F
diabase, described	65, 162 F
conglomerate, "	82 F
Rawdon, N.S., antimony mine	10 S
gold district	26 S
Reaux Island, St. Lawrence R.	73 K
Red Deer River, N.W.T., lignite, analysis	9 T
Red Gulch, B.C., gold	121 R
Redgut Bay, Rainy L.	18, 35, 106 F
diabase, described	68 F
gneiss, "	114, 136 F
Red-pine Island, Rainy L.	37 F
schist, described	108 F
Reed, R., meteorological observations	254 B
Renard, A., referred to	155 F
Renfrew, N.S., gold district	26 S
Reserve colliery, N.S.	16 S
Rice Bay, Rainy L.	104 F
schist, described	110 F
Rice Bay Narrows, gabbro, described	68 F
Richardson, J., referred to	41 K, 89 R
quoted	26 A, 103 K
Richfield, B.C., quartz ledges	31 C
Richmond Gulf, Hudson Bay	55 J
Ridge, terrace-like, Rainy L.	171 F
gravel	171, 172 F
Riding Mountain, Ma.	14 A, 6, 13 E
Rimouski River, Q.	19, 22 M
Rink Rapid, Lewes River	144 B
River channel, ancient, Dease L.	69 B
change in, Clearwater R.	58 J
country, Rainy L. region	20 F
erosion, Big Sevogle R. (fig.)	19 N
flats, north-eastern N.B.	22 N
valley, formerly an inlet, Stikine River	49 B
valleys, Cariboo district	13 C
pre-glacial, gold in	30, 46 R
north-eastern N.B.	6-9 N
Rivers, Yukon district	11, 14 B
compared with other rivers	18 B
north-western Ma.	6 E
Rainy L. region	10 F
James Bay	17 J

	PAGE
northern N.B	6 M
north-eastern N.B	8 N
Rivers Inlet, B.C, iron ore	151 R
Roads, natural, through swamps, Ma	10 E
Robert, J. A., work by	38 A
Robinson's Bar, Fraser R., gold	117 R
Robson, J. (1752), visit to Hudson Bay	12 J
Roches moutonnées, Rainy L	25, 155, 164 F
Rock crystal	69 S
Rock Creek, B.C., gold placer	64 A, 38, 129 R
silver ore	68 R
gold ore	144 R
coal	148 R
copper	154 R
lead	155 R
Rock River, Kettle R., gold placers	129 R
Rocks, fragmental, Rainy L	91 F
Rocky lake country "	20 F
Rocky Islet Bay, "	104 F
rock, described	66 F
trap, "	67 F
schist, "	77 F
Rocky Mountains, B.C	6 R
N. W. extremity	12 B
Rocky Mountain House, coal, analysis	9 T
Rosella Creek, Cassiar, gold	138 R
Rosenbusch, H, referred to	58, 95, 108, 157 F
Rosier, Cape, Q., graptolite zone	45 K
Ross River, Pelly River	18, 122 B
gold	140 R
Ross Seam, N. Saskatchewan R., lignite, analysis	6 T
Rothsay Point, Stikine River	54 B
Rouchon Creek, B.C., gold	122 R
Round Top Mountain, Cariboo	20, 23 C
quartz ledges	43 C
Routes of travel, Yukon district	12, 71 A, 19, 183 B
Cassiar Trail	64, 74 B
Liard River	12 A, 141 B
Lewes River	173 B
Chilkoot Pass	174 B
White Pass	177 B
see also Navigable waters.	
Big R. to Bishop Roggan R	40 J
S. Branch of Bishop Roggan River	43 J
Big River	45 J
Big River to Great Whale R.	48 J
Richmond Gulf to Clearwater Lake	55 J
Rubellite	67 S
Rupert, Prince (1668), sends expedition to Hudson Bay.	8 D
Rupert Bay, James Bay	15 J
Rupert River, James Bay	19 J
first fort on	10 J
mouth of	22 J
Saal Lake, James Bay	57 J
Saanich, V.Is., lime	150 R
Saanich Inlet, V.Is., coal	146 R
Sabaskong Bay, L. of the Woods.	22, 132 F
schist, described	132 F
Sabaskong Laurentian area	41, 117 F
Sadou Ledge, Cariboo (assay)	36 C
Sagenite	70 S
Saginaw Bay, Rainy L	18 F
Sailor Bar, Fraser R., gold	116 R
Salix conjuncta, n. sp	225 B
Salmon Arm, Jarvis Inlet, copper	152 R
Salmon Creek, B.C., gold	133 R
molybdenite	157 R
Salmon River, N.S., gold district.	26 S
Salt, statistics	5, 6, 7, 86 S
Salt Spring Island, B.C., sandstone	157 R
Sam Crane's Old Store, Cariboo, auriferous vein	34 C
Sam Montgomery's Ledge, Cariboo	39 C
ore, assay	47 T
San Juan River, V.Is., gold	142 R
Sand and gravel, statistics	6, 7, 105 S
north-eastern N.B	32 N
Sand barrier, L. of the Woods	173 F
ridge, Wiachtiwan River	58 J
dunes, north-eastern N.B	26 N
Sands and gravels, Dease Lake	77 B
Frances River	118 B
Pelly River	130 B
Lewes River	147, 151 B
Rainy River	172 F
Charleton Island	25 J
and c ays, James Bay	16 J
Big River	47 J
Great Whale River	53 J
north-eas rn N.B	17-22 N
Sand Bay, Rainy L	15 F
gneiss, described	126 F
Sand Island River route, Rainy L.	11 F
Sand Point Lake, Rainy L	100 F
Sandstone as building stone, B.C.	107, 157 R
Sandstones, Lewes River	145 R
red, N. of L. Superior	9 H
Eastern Townships, Cambro-Silurian	13-19 K
"Sillery."	51, 55-58, 64-74 K
"Hudson River"	58, 78 K
Lake Metapedia	13 M
Bois Brulé Mtn	17 M
Quatawamkedgwick R	20 M
Sansome Narrows, B.C., copper	152 R
Saponite, in silver veins	105 H
Sapphire	66 S
Sardonyx	71 S
Saskatchewan River, Al., gold	28 S
Sault Ste. Marie ship canal	16 H
Saunders gold placer, Cariboo, quartz ledge	37 C
ore, assay	44 T
Saxicava sand, north-eastern N.B.	20 N

PAGE

Sayyea Creek, Liard R., g ld. 81, 100 B, 140 R
Sa-ze-oo-ti-na Indians, B.C. ..... 199 B
Scapolite ..... 77 S
Scenery, Frances River ..... 109 B
Lewes River ..... 165 B
Temiscouata and Madawaska. 7 M
Schist, Great Whale River ..... 54 J
group, crystalline, Q ..... 44 K
eastern extension of ..... 89 K
Schists, Yukon district ..... 32 B
Dease River ..... 94 B
Lower Cañon, Liard River ... 99 B
Pelly River ..... 125, 130 132 B
Lewes River ..... 170 B
Cariboo gold belt ..... 22 C
Schists of Keewatin series, Rainy L. region ..... 22, 73 F
contact of, with gneiss ..... 22-43 F
penetrated by gneiss ..... 23, 32 F
by gabbro ..... 51 F
by granite ..... 53 F
hornblende ..... 22, 30, 52-54 F
thickness of ..... 48 F
agglomerate ..... 44, 48, 50, 53 F
felsitic ..... 46, 52 F
green ..... 50, 55 F
Schists, Keewatin, described .... 73-90 F
hornblende, Crow Portage ... 74 F
Pipestone L ..... 75 F
First-quill L ..... 75 F
Cedar Narrows ..... 76 F
L. Along-the-Hill ..... 76 F
Three Island L ..... 76 F
Big Turtle R ..... 77 F
Rocky Islet Bay ..... 77 F
Grassy Is ..... 77 F
Otukamamoan L ..... 78 F
green, Swell Bay ..... 80 F
Grassy L ..... 81 F
Bad Vermilion L ..... 81 F
Seine Bay ..... 81 F
sericite, Line Bay (fig.) ..... 86 F
Off Lake ..... 89 F
crypto-crystalline, Clear-water Lake ..... 90 F
Swell Bay ..... 90 F
aphanitic, Swell Bay ..... 90 F
porphyroid, Sturgeon Falls .. 90 F
Schists of Coutchiching series, bedded ..... 99 F
mica-, Bear's Passage belt ... 102 F
altered at contact ..... 104, 108 F
penetrated by Laurentian. 106, 130, 132 F
described, mica-, Coutchiching Rapids ..... 107 F
Open-water Narrows .... 107 F
Red-pine Is ..... 108 F
Bleak Bay ..... 109 F
Cranberry Bay ..... 109 F
grey, Lob-stick Is ..... 109 F
Rice Bay ..... 110 F

PAGE

Schist Lake ..... 48, 50 F
conglomerate, described ..... 83 F
Schistosity, degrees of, in trap .... 59 F
Schwatka, Lieut., surveys in Yukon district ..... 16, 143 B
Scotty's Creek, B.C., gold ..... 119 R
Scripture vein, Silver Mountain .. 93 H
Scripture vein, Whitefish Lake .. 101 H
Scud River, Stikine River ..... 50 B
Sebastopol Creek, Skeena, gold ore 144 R
Sections, vol anic ash and drift, Lewes River ..... 45 B
basalt overlying gravels, etc., Stikine River ..... 72 B
(fig.) ..... 47 R
Lightning Creek valley (fig.) 32 R
Mission Creek (fig.) ..... 48 R
gold-bearing conglomerate, Dakota (fig.) ..... 49 R
Cretaceous, V.Is., (coal) ..... 89 R
Snowshoe Plateau ..... 26 C
Keewatin series ..... 43-57 F
Clear-water L ..... 44 F
Kahtimiagamak L ..... 46 F
Kaiarskons L. to Bluff L .. 49 F
Pickerel L. to Missus L ... 51 F
Manitou L ..... 53 F
Seine R. belt ..... 55 F
Animikie, Silver Islet Mine (plate) ..... 28 H
Pie and McKellar Islands (plate) ..... 40 H
Spar Island mine (plate) .. 42 H
Jarvis Island mine " .. 44 H
Duncan mine (plates) .... 56, 58 H
Porcupine mine (plate) ... 68 H
Beaver mine " ... 72 H
Silver Mtn. and Crown Point mines (plate) ..... 88 H
Laplante's Trail ..... 98 H
Sunset Lake Vein ..... 99 H
Wiacht wan River ..... 59 J
N. W. coast, Newfoundland .. 38 K
Cape Gaspé ..... 12 M
Quatawamkedgwick River .. 21 M
Mount Wissick ..... 29 M
Long Lake ..... 42 M
surface beds, near Black R ... 10 N
near Nelson and Bathurst. containing striated boulder (fig.) ..... 13 N
Tracadie River ..... 21 N
sand and peat ..... 24 N
Indian camp site (fig.) ..... 32 N
Sedgwick or Square Lake, Maine. 40 M
Seine Bay, Rainy L ..... 17 F
diabase, described ..... 61, 64 F
schist, " ..... 81 F
Seine River, Rainy L ..... 18, 37 F
Keewatin belt ..... 55 F
Coutchiching rocks ..... 55 F

	PAGE
trap, described	64 F
iron ore	180 F
Seine River route, glacial striæ	167 F
Selinum Dawsoni, n. sp	220 B
Selkirk, Fort, Pelly River	135, 138 B
distances from	17 B
Selkirk Range, B.C	7 B
ores, assays	52 T
Selkirk Mining and Smelting Co., Illecillewaet	49 S
Selwyn, Dr. A. R. C., report by	1-117 A
work by	1, 58 A
on Quebec group	43 K
referred to	10 N
quoted	63 R
Semi-opal	72 S
Seminow Mountains, Lewes River	150, 154 B
Sergeant Lindsay Ledge, Cariboo, ores (assays)	33 C, 45 T
Serpentine, production	5, 97 S
Yukon district	78, 118, 125 B
Rainy L. region	45, 50, 180 F
Crow Lake, described	97 F
Clear-water L. "	98 F
Lake Despair "	98 F
Eastern Townships	87, 91 A, 87, 94 K
Sewer pipes, imports	7, 108 S
Seymour Creek, B.C., gold	141 R
Seymour Narrows, B.C., iron	151 R
Shales, Dease River	93 B
Pelly River	126 B
clay-, Cariboo	16 C
Eastern Townships, Cambro-Silurian	15-24 K
Trenton-Utica	16, 21, 44, 47, 64, 72, 84 K
Hudson River	58, 58, 71, 77 K
Sillery	49-76, 81-84 K
Lévis	44, 59, 64 K
Shaler, Prof. N. S., referred to	47 M
Shanty Point, Crow Lake	47 F
diabase, described	72 F
agglomerate, "	92 F
Sharp's Diggings, Cariboo, quartz ledge (assay)	44 C
"Shasta group," Cariboo	18 C
Shatachiwan Lake, Big R	44, 45, 47 J
Shearing in sericite schists (fig.)	86 F
Sheep Mountain, Dease R	90 B
Shells, fresh-water, Rainy R	172 F
Sherbrooke, Q., silver ore, assay	27 T
Sherbrooke, N.S, gold district	26 S
Shickshock Mountains	12 M
Ship Hole, Moose River	21 J
Shippegan Island, N.B	12 N
peat bog	23 N
Shoal Lake, Seine R	56 F
conglomerate, described	82 F
Shoals, James Bay	15, 23, 27, 30 J
Shoe Bay, Rainy L., trap dykes	151 F

	PAGE
Shore line and strike of rocks, parallelism of, Rainy L	17, 27 F
E. of James Bay	50 J
Short Creek, Valley River	15 E
Shuniah silver mine, *see* Duncan.	
Shuswap Lakes, B.C., ores, assays	79 R
lime	160 R
asbestus	161 R
spring	163 R
Shuswap Lake, Little, bismuth	161 R
Siegas River, N.B	36 M
Silica, interstitial, Silver Mtn	82 H
"cone in cone," R 64 location	95 H
Silicified wood	72 S
Sillery, Q	64 K
Sillery group, Eastern Townships	6, 25, 32, 43, 60-84 K
thickness and character	34, 64 K
altered, characters	37 K
shales	49-76, 81-84 K
sandstones	51, 55-58, 64-74 K
and Lévis group, relations of	86 A, 62, 82 K
Cambrian age of	83 K
Silurian limestone pebbles, Rainy River	175 F
E. of James Bay	16 J
Eastern Townships	11, 43 K
northern N.B	92 A, 10, 25 M
thickness of	12 M
on Metapedia River	15 M
system of southern and northern N.B	47 M
of northern N.B., Q., and Maine	51 M
Silver, production	5, 88 S
in galena, McDame Creek	82 B
mining, Cariboo	31-38, 48 C
British Columbia	59-74 R
ores, B.C	62 A, 55-79, 145 R
N. of L. Superior	40 A, 8, 13, 26 H
mining	26-114 H
native	28, 33, 52, 90, 106, 110 H
veins, general characteristics	104 H
probable mode of deposition	112 H
and gold assays	26-55 T
Silver Bluff, Silver Mtn	78, 84 H
trap, described	118 H
chert, "	120 H
Silver Creek, B.C., gold	136 R
Silver Creek mine, Rabbit Mtn	74 H
Silver Falls Vein, Silver Mtn	94 H
trap	80 H
Silver Harbour mine	63 H
Silver Hill Vein, Silver Mtn	93 H
Silver Islet, L. Superior, mine	26, 106 H
plan and section (plate)	26 H
yield of silver	34 H
milling	124 H
Silver King claim, Kootanie	60 R

	PAGE
Silver Ledge, Cariboo (assay)	39 C
Silver Mountain, L. Superior, silver mining	77 H
silver vein	15, 87 H
mine	88 H, 88, 94 S
plan and section (plate)	88 H
work, East End	129 H
work, West End	131 H
ores, assays	23 T
Silver Mountain, Q., serpentine	94 K
Silver Peak, B.C., mercury	157 R
Similkameen River, B.C., gold	62 A, 20, 38, 126 R
platinum	39, 104, 156 R
silver	145 R
coal	61 A, 148 R
iron	152 R
copper	153 R
Simpson Lake, Frances River	104 B
Simpson Mountain, Frances River	103 B
Sinclair Pass, B.C., hot spring	162 R
Singleton silver mine, Port Arthur	65 H
Siwash Bar, Fraser R., gold	116 R
Siwash Creek, B.C., gold	127 R
Sixty-mile Creek, Yukon, gold	141 R
Skagit River, B.C., gold	127 R
Skeena River, B.C., gold	44, 141 R
coal	93, 156 R
hot spring	163 R
Skeleton Creek, B.C., gold	130 R
Skidegate Inlet, Queen Charlotte Islands, anthracite	85, 145 R
anthracite, analysis	86 R
iron ore	151 R
tuff	160 R
Skincuttle Inlet, Queen Charlotte Islands, magnetite	151 R
copper	153 R
Skon-un Point, Queen Charlotte Islands, lignite	146 R
Skree Range, Dease River	88, 92 R
Slalets Mountain, B.C., coal	147 R
Slate, statistics	5, 6, 7, 98, 99 S
"Slate belt," Cariboo	20 C
Slates, clastic, Pickerel Lake, described	94 F
Manitou L, described	95 F
Lake Superior, "	58 H
Cambro-Silurian, Eastern Townships	13-15 K
Cambrian, Eastern Townships	87 K
Quatawamkedgwick River	20 M
Slate Creek, Tulameen, gold	129 R
Slocan River, Tulameen, gold	133 R
Slough Creek, B.C., gold	121 R
Slude or East Main River, James Bay	19 J
Smith, Dr. A. C., referred to	31 N
Smith, W. H., work by	18, 76 A, 5-7 F
Smith Creek, B.C., gold	134 R
Smithfield, N.S., silver and lead	98 A
Smoky River, B.C., gold	126 R
Smooth-rock Lake, Rainy L.	33, 43 F
Snider, O., ores, assays	32, 35 T
Snow, perennial, Cariboo	14 C
Snow Creek, B.C., gold	138 R
Snowdon, O., iron mines	63 S
Snowshoe Creek, Cariboo, quartz veins	44 C
ores, assays	40 T
gold placers	124 R
Snowshoe Plateau, Cariboo	13, 29 C
section	26 C
auriferous quartz, galena	44 C
Soapstone, production	5, 48 S
Eastern Townships	113 K
Soda salts, imports	7 R
Sodaco Ledge, Cariboo, gold, assay	37 C
Sodalite	77 S
British Columbia	111 R
Soils, Rainy River	178 F
northern N.B	10 M
north-eastern N.B	28 N
Solomon's Temple Island, James Bay	30 J
Somer's Creek, Cassiar, gold	139 R
Somerset, Q.	63 K
Sooke, V.Is., iron ore, assays	100, 151 R
coal	147 R
Sooke Harbour, V.Is., copper	102, 153 R
River, V.Is., gold	142 R
Soundings of Lakes, Rainy L. region	14 F
South Sherbrooke, O., iron ore (anal.)	24 T
Spallumsheen arm, Shuswap L., spring	163 R
Spanish Bar, Fraser R., gold	118 R
Spanish Creek, Cariboo, quartz ledges	47 C
gold placers	125 R
Spar Island, L. Superior	14, 42 H
silver mine, plan and section (plate)	42 H
Spelter, imports	7 S
Spence's Bridge, B.C., lime	160 R
hematite (anal.)	26 T
Spencer, Miles, zoological notes	76 J
Spencer Island, James Bay	35 J
Sphene	77 S
Sphene Lake, gneiss and syenite, described	123 F
Spiegel	39 S
Spilimichine River, B.C., silver ore	67 R
Spindulum Flat, Fraser R., gold	117 R
Spinel	66 S
Spring Creek, Cassiar, gold	139 R
Spring Hill colliery, N.S.	16 S
Springs, mineral and thermal, B.C.	112 R

	PAGE
salt, Nanaimo (anal.)	112 R
perennial, James Bay	27, 28 J
Sproat, G. M., quoted	65 R
Spuzzum, B.C., gold placers	116 R
Spuzzum Creek, Fraser R., molybdenum	157 R
Squall Point, Rainy L	18 F
diabase, described	68 F
granite, "	143 F
Square or Sedgewick Lake, Maine	40 M
Squatook Lakes, Temiscouata region	9 M
Squirrel Cove, Cortez Is., granite	158 R
Ste. Agathe, Q	62 K
St. Alphonse, Q., gold	85 A
Ste. Anne de Beaupré, Q	24 K
Ste. Anne de la Pérade, Q	32 A
Ste. Anne de la Pocatière, Q	70 K
Ste. Anne de Montmorency, Q., mineral paint	113 K
Ste. Anne des Monts, Q., graptolite zone	45 K
St. Ann's, N.S., gypsum	31 S
ore, assay	26 T
St. Anselme, Q	69 K
St. Antoine de Tilly, Q	16 K
St. Aubert, Q	69 K
Ste. Blandine, Q	18 M
Ste. Catherine, Q., serpentine	97 K
St. Charles, Q	68 K
St. Clara Bar, Fraser R., gold	116 R
Ste. Croix, Q	16 K
Ste. Foye, Q., fault	45 K
St. Francis, Beauce	15 K
gold	86 A, 101 K
marble	114 K
St. Francis, Little Lake, Q., serpentine	96 K
asbestus mining	109 K
St. Francis, N.S., ore, assay	28 T
St. Francis River, St. John R	6, 33 M
St. Gabriel, Métis R	17 M
St. George, Q., synclinal basin	10 K
St. Gervais, Q	68 K
St. Grégoire, Q., gas well	33 A
St. Gilles, Q., copper ore	105 K
St. Henry de Lévis, Q	60 K
St. Jean, Rivière, Q	27 M
St. John, Little Lake, Q., agriculture	14 K
St. John, N.B., graphite	28 S
St. John River, Q. and N.B., upper	13 K, 6, 37 M
valley	8 M
St. Joseph, Q	53, 64, 81 K
St. Lawrence River, lower, islands of	70 K
St. Martin Lake, Ma., gypsum	74 A
St. Maurice River, Q	31 A
St. Michel de Bellechasse, Q	66 K
St. Nicholas, Q., fault	15, 57 K
St. Raphael, Q	69 K
St. Roch des Aulnets, Q	67 K
St. Simon, N.B., peat bog	23 N
Ste. Sophie, Q	63 K
St. Sylvester, Q	62, 92 K
St. Thomas, Q	66 K
St. Tite, Q., limestone	31 A
Standing-stone Point, Rainy L	19 F
gneiss, described	127 K
Standon, Q	92 K
Stanjikoming Bay, Rainy L	114, 151 F
gneiss, described	127, 128 F
Stanjikoming Laurentian area	41, 112 F
Statistics, mineral, work on	39 A
report on	1-110 S
Staurolite	76 S
Stave River, B.C., coal	147 R
Steadman Ledge, Cariboo (assay)	31 C
Stelzner, A., referred to	149 F
Stephen, Mount, B.C., argentiferous galena	64 A, 66, 155 R
ores, assays	77 R
Stephenson Ledge, Cariboo	47 C
Stevenson, Mount, Cariboo	25 C
Stewart River, Pelly River, gold placers	182 B, 140 R
asbestus	27 B, 161 R
Stibnite, Foster's Bar, assay	58 T
Stikine River, B.C	19, 46-64 B
gold, discovery of	62, 79 B
sections of basalt and gravels	27 B, 47 R
diabase, described	235 B
granite "	238 B
gold placers	43, 137 R
hot spring	163 R
Stone, building, statistics	5, 7, 100 S
British Columbia	106, 157 R
N. of L. Superior	9 R
Eastern Townships	114 K
quarries, Pictou	98 A
Stones, ornamental	7 S
British Columbia	108 R
precious	7, 65 S
British Columbia	110 R
"Stone house," Chilkoot Pass	175, 177 B
Stone-dam Lake, Rainy L	31 F
gneiss, described	120 F
Stormont, N.S., gold district	26 S
Stout's Gulch, Cariboo, quartz ledge (assay)	32 C
gold placers	120 R
Strawberry Lake, Rainy L	19, 50 F
Strike of rocks and mountain relief, concordant, Cariboo	23, 26 C
and shore line, parallel, Rainy L	17, 27 F
E. of James Bay	50 J
circular, of gneiss foliation	19, 113 F
Stromness Harbour, James Bay	22 J

	PAGE
Structural materials	97 S
Strutton Islands, James Bay	29 J
Stump Lake, Nicola valley, opaline silica	61 A
gold	63 A
silver mines	63 A, 69 B
silver ores, assays	79 B, 38 T
copper	154 B
lime	160 B
Sturgeon Bay, L. Superior, silver	51 H
Sturgeon Falls, Seine R., schist, described	90 F
Sturgeon River, O., survey of	78 A
Submergence, Eastern Townships	101 K
Subsidence of James Bay, disproved	32 J
E. of Hudson Bay	62 J
north-eastern N.B.	7, 20, 25 N
Sucker Lake, Rainy L.	50 F
Sudbury, O., nickel, copper and gold	2, 58, 78 A
copper min s	21 S
ore, assay	36 T
Sugar Creek, Cariboo, auriferous veins	40 C
res, assays	43 T
Sullivan, Mount, Dease Lake	77 B
Sulphate of ammonia	61 S
Sulphur, crude, imports	7, 83 S
Sulphurets, relation of, to gold	58 B
Sulphuric acid, statistics	5, 7, 81, 82 S
Sunset Lake, Whitefish L.	101 H
Sunstone	75 S
Superior Lake, mines and mining on	1-131 H
Suquash, V.Js., coal area	80, 146 K
coal, analyses	87 B, 18 T
Surface geology, Eastern Townships	98 K
north-eastern N.B.	1-33 N
Survey operations, Cariboo district	6 C
north-western Ma	5 E
Rainy L. region	5 F
James Bay	5 J
Eastern Townships	5, 49 K
Sutton, Q., schist (anal.)	23 T
Sutton Mountain, Q., anticlinal	5, 89 K
former views on	35 K
Swamp River, Cariboo	20 C
Swan River, Ma.	12, 15 E
Swell Bay, Rainy L.	17, 36 F
gabbro, described	60-63 F
schists, described	80, 90 F
granite, "	82 F
Swift River, Cariboo	48 C
gold	125 B
Sydney colliery, N.S.	16 S
Syenite, hornblende, Foot-print L., described	122 F
Sphene L., described (fig.)	123 F
Cedar Narrows, described	125 F
augite-, McKellar's Point, described	115 H
Syenitic rock, red, L. Superior	45 H
Sylva. *see* Trees.	
Sylvester's Landing, Dease River.	89 B
Sylvester Peak, Dease River	89 B
Table-land, E. of James Bay	16, 20 D
Tabusintac River, N.B., peat bog.	23 N
section (fig.)	32 N
Taché road, Q, Cambrian on	86 K
Tagish Indians, B.C.	203 B
vocabulary	208 B
Tagish Lake, Lewes River	165, 169 B
felsite, described	237 B
ore, assay	37 T
Tahk-keena River, Lewes River	160 B
Tahltan Indians, B.C.	192 B
vocabulary	208 B
Tahltan River, Stikine River	64 B
gold	80 B, 137 B
silver	145 B
lignite	150 B
Taiya or Chilkoot Pass, B.C.	174 B
Taiya River, Taiya Inlet, B.C.	176 B
Tako Arm of Tagish Lake	168 B
Taku Indians, B.C.	193 B
Taku River, Taku Inlet, B.C.	19 B
Talcose rock, Rabbit Mtn.	71, 73 H
Tangiers, N.S., gold district	26 S
Tanzilla River, Stikine River	68 B
Tar Island, Queen Charlotte Islands, bitumen	161 K
Tatshun River, Lewes River	144 B
Tchia an's Vein, Silver Mtn.	96 H
Teall, J. J. H., referred to	118, 155, 157 F
Tehema Bar, Fraser R., gold	117 B
Telegraph exploration, Stikine R.	62 B
Telegraph Creek, Stikine R.	51, 57, 60 B
trail from, to Dease Lake	64 B
meteorological observations at	248 B
Temagami Lake and River, O., surveys of	77 A
ore, assay	32 T
Temiscaming, Lake	78 A
lead mine	49 S
Temiscouata Lake	29 M
Temperature, affected by cultivation	9 E
Tenny Cape, N.S., manganese	44 S
Tent Peak, Tootsho Range	106 B
Terra cotta clay, Nassagaweya, O.	57 T
Terraces, Stikine River	58, 73 B
Tanzilla River	68 B
Dease River	88, 91, 96 B
Frances River	109 B
Finlayson River	118 B

PAGE

Pelly River ..... 131 B
Lewes River ..... 144 C
Cariboo district ..... 14 C
Fraser River ..... 25 R
Charleton Island ..... 26 J
Twin Islands ..... 34 J
Big River ..... 47 J
Great Whale River ..... 53 J
marine, Clearwater River .... 58 J
Wiachtiwan River ..... 59 J
north-eastern N.B ..... 18 N
Terry Creek, B C., gold ..... 126 R
Tertiary, Yukon district ..... 37 B
Dease River ..... 95 B
Frances River ..... 103 B
Cariboo district ..... 17 C
deposits and gold placers .... 47 R
fuels, B.C .....61, 66 A, 84, 94 R
Tes-lin Lake, Tes-lin-too River .. 155 B
Tes-lin-too River, Lewes River ... 16, 153 E
Tetragraptus zone, Lévis ..... 51 K
Texada Island, B.C., gold ..... 74, 144 R
iron mine ..... 34 S
iron ore (anal.) ..... 99, 151 R
copper and silver ore .....102, 152 R
molybdenite ..... 157 R
marble ..... 158 R
lime ..... 159 R
ores, assays ..... 55 T
Texan Bar, Fraser R., gold ..... 116 R
Thetford, Q., Pre-Cambrian ..... 91 K
granite ..... 93 K
serpentine ..... 95, 111 K
copper ore ..... 105 K
chromic iron ..... 106 K
examined ..... 56 T
asbestus mining .....87 A, 107 K, 12 S
Thibert, H. (1872), discovers gold in Cassiar district ..... 84, 111 R
Thibert Creek, Cassiar, gold placers .....80 B, 138 R
native copper .....82 B, 155 R
asbestus ..... 161 R
Thirteen B Silver Vein, Pie Is... 53 H
Thlinkit Indians, B.C .... 190 B
Thomas River, Frances Lake .... 111 B
Thompson, D. (1790), voyages in the N.W ..... 13 J
Thomson River, Fraser R., discovery of gold ..... 18 R
Main, coarse gold on ..... 29 R
gold placers ..... 118 R
copper ore ..... 154 R
North, silver and gold ore (assays) .....64 A, 71 R, 49 T
gold placers ..... 135 R
coal .... 149 R
lime ..... 160 R
South, gole placers ..... 135 R
granite ..... 159 R
lime ..... 160 R

PAGE

Thomson's Island, L. Superior .. 41 H
Thomsonite ..... 78 S
Thorburn, Dr. J., reports by ..... 56, 116 A
Three A Silver Mine, Thunder Bay .... 66 H
Three Island Lake, Rainy L ..... 16 F
schist, described ..... 73 F
Thunder Bay, L. Superior, silver. 22 H
Thunder Bay Silver Mine ..... 54 H
Thuya excelsa ..... 189 R
gigantea ..... 189 B
Tide in James Bay .....15, 32, 35 J
in Gulf Lake ..... 55 J
Ti-le-i-tsho Lake, Thomas River. 111 B
Till, *see* Boulder-clay.
Tilting of Keewatin rocks ..... 47 F
Timber, *see* Trees.
Timber-line, Yukon district .....116, 188 B
E. of James Bay ..... 45 D
Tin, imports .....7, 50, 51 S
Tinné Indians, B.C ..... 192 B
Titanite ..... 77 S
Titanite crystal, twinned, in gneiss (fig.) ..... 124 F
Ti-tsho-ti-na Indians B.C. ..... 200 B
vocabulary ..... 208 B
Toad Mountain, Kootanie, silver ore ..... 65 A, 60 R
gold ..... 60, 144 R
copper .....60, 102, 154 R
ores, assays ..... 76 R
Toby Creek, B.C., gold ..... 131 R
Too-tshi-too-a River, Frances R.. 105 B
Too-tsho Range, Frances R. .....106, 113 B
outline of (fig.) ..... 110 B
Tooya River, Stikine River ..... 66 B
gold ..... 137 R
Topaz ..... 66 S
Törnebohm, A. E., referred to .... 79 F
Tourmaline ..... 67 S
sundered, in quartz-porphyry (fig.) ..... 89 F
Tourmente, Cape, Q ..... 25 K
Tracadie River, N.B., section .... 20 N
peat bog ..... 23 N
Trachyte, Stump Lake ..... 61 A
Tranquille River, B.C., gold ..... 135 R
platinum ..... 156 R
Trap, altered, Rainy L. region. 44, 47, 54, 57 F
Berry Island, described ... 65 F
Back Point, " ... 66 E
Bear's Passage ..... 68 F
Manitou L ..... 70 F
Kishkutena L .... 72 F
flow, on argillites, L. Superior, (fig.) ..... 24 H
dykes, on lake coast ..... 26 H
sheets, " " ..... 25 H
sheets, columnar, Outpost Hills ..... 24, 80 H
Spar Island ..... 42 H

PAGE

Caldwell Point ..... 45-49 H
Rabbit Mtn. mine, dyke .. 69 H
Silver Mtn..... 78 H
Whitefish Lake..... 97 H
Sunset Lake Vein..... 99 H
supposed influence on presence of silver.....26, 35, 112 H
microscopical examination.. 118 H
dyke, Big River..... 40 J
Eastern Townships..... 94 K
Trass, B.C.....109, 160 R
Treadwell gold mine, Alaska.... 54 R
Tree distribution, Yukon district. 185 B
Tree limit (ash), James Bay..... 45 J
Tree trunk, burnt in peat..... 24 N
Trees, affecting climate., Ma.... 8 E
Trees, Yukon district..... 24, 185 B
E. of Cassiar Range ..... 90 B
Lower Dease River..... 91 B
Upper Liard River..... 99 B
Frances River ..... 103 B
Frances Lake..... 112 B
Finlayson River ..... 116 B
Pelly River..... ...121, 125, 134 B
Chilkoot Pass..... 177 B
Rainy L. region.....177, 179 F
N. of L. Superior..... 23 H
Hudson Bay..... 82 A
James Bay ..... 24, 42 J
Charleton Island..... 28 J
Little Charleton Island..... 31 J
Big River .....39, 44, 47 J
Bishop Roggan River..... 49 J
Great Whale River..... 51, 54 J
Gulf Lake..... 55 J
Clearwater River..... 58 J
north-eastern N.B..... 29 N
Trenton, on St Lawrence River.. 32, 34 A, 18-25 K
Trenton-Utica, N. of St. Lawrence River ..... 64, 83 K
Trentonian fauna, Q ..... 47 K
Tretheway, R., quoted..... 37 H
Triangulation, Cariboo (diagram) 11 C
Triassic, Stikine River..... 33, 56 B
plateau, upper Liard River.. 102 B
Tring, Q., Cambro-Silurian..... 14 K
lime ..... 113 K
Tripolite, B.C..... 112 R
Trodiley or Little Charleson Is.. 31 J
Trois Pistoles River..... ... 26 M
Truro, N.S., ore, assay ..... 26 T
Trutch, J. W., map of B.C..... 6 C
Tschermak, G., referred to..... 155 F
Tses-i-uh Range, Liard River.... 102 B
Tsuga Pattoniana ..... 189 B
Tuck, S. P., work by ..... 7 C
Tuladi Lake, Tuladi R..... 34 M
Tuladi River, Q..... 28, 33 M

PAGE

Tulameen River, B.C., gold placers ..... 62 A, 127 R
silver..... 71 R
platinum.....104, 156 R
coal ..... 148 R
copper..... 153 R
Turnagain or Black River, Liard River, gold.....81 B, 139 R
Turner, W., surveys by ..... 13 J
Turtle Lake, Rainy L., Laurentian area..... 118 F
Turtle Portage, L. of the Woods, schist, described ..... 75 F
Turtle River route, Rainy L., glacial striæ ..... 167 F
Tus-tles-to Lake, Thomas River.. 111 B
Twin Islands, James Bay ..... 33 D
Two Head Island, St. Lawrence R..... 74 K
Two Sisters Mountains, Cariboo.. 20 C
Tyrrell, J. B., work by ..... 14, 72 A
report by..... 1-16 E

Uniacke, N.S., gold district..... 26 S
Union Bar, Fraser R., gold..... 116 R
Union colliery, Nanaimo ..... 83 A
Upham, W., work by..... 18 A
referred to..... 175 F
Upheaval, E. of Hudson Bay..... 59 J
Upper Mormon Bar, Fraser River, gold..... 117 R
Uraninite..... 43 A
Us-tas-a-tsho Lake, Yus-sez-uh R. 111 B
Utica, on St. Lawrence R..... 16-25 K
Point Lévis ..... 46, 59 K
not clearly identified..... 47 K

Valley, N.S., gypsum ..... 98 A
manganese..... 99 A
Valley River, Ma..... 6, 12 E
Vallier Point, Q..... 66 K
Van Hise, C. A., referred to..... 60 F
Van Winkle gold mine, Cariboo.. 33, 122 R
Vancouver Island, gold..... 45, 141 R
silver..... 74 R
ores, assays..... 79 R
building stone..... 106 R
coal.....67 A, 146 R
Vaucouver Range, V.Is... ..... 9 R
Vegetable mould, north-eastern N.B..... 25 N
Venus' hair stone..... 70 S
Vermilion gold mine, O..... 59 A
Vermilion Lake, Minn., iron..... 12 H, 34 S
Vermilion River, B.C., chalybeate springs ..... 163 R
Vermilion River, Ma., boring.... 72 A

	PAGE
Victoria, V.Is., lime	159 R
Victoria colliery, N.S.	16 S
Victoria county, N.B., gypsum	31 S
Victoria Creek, B.C, gold	123 R
Victoria Island, L Superior, silver	45 H
Victoria Peak, V.Is.	10 R
Victoria Shaft Ledge, Cariboo	34 C
Views, Tanzilla River	67 B
Too-tsho Range	110 B
Bennett Lake	167 B
Villeneuve, Q., muscovite, examined	58 T
Visitors to museum	56, 116 A
Vista Lake, Rainy L., schists	54 F
Vital Creek, Omenica, arquerite	73, 145 R
gold	136 R
copper	154 R
Volcanic rocks, gold ores in	63 A
ash deposits, Yukon district	43 B
rocks altered, Stikine River	55 B
Lewes River	171 B
materials, Cariboo	16 C
rocks, Keewatin series	29, 105, 135 F
agglomerates or tuffs	91 F
rocks, N. of L. Superior	8 H
Cambrian rocks, Eastern Townships	85, 87 K
Volcano, Archæan, Rainy L.	57, 141 F
Voligny, L., R., work by	7 C
Vologda, Russia, compared with Yukon district	30 B
Vowell, A. W., referred to.	59, 65 R
Wadsworth, M. E., referred to.	126, 155, 156 F
Walbridge Silver Mine, L. Superior	65 H
Walker Creek, Cassiar, gold	129 R
Walker Islands, B.C., magnetite	151 R
Walker Ledge, Cariboo, gold	35 C
Walker's Gulch, Cariboo, gold	120 R
Walrus bones in sand dunes, N.B.	27 N
Walsh Cove, Redonda Is., granite.	158 R
Walter Island, James Bay	35 J
Waltham, Q., plumbago	28 S
Walton, N.S., gypsum	31 S
Wapta valley, B.C., mercury	156 R
Warnock Creek, B.C., coal	147 R
Warren, Gen., referred to	9 E
Washington Bar, Fraser R., gold.	116 R
Water, mineral, imports	7 S
in silver veins, L. Superior	28, 106 H
analysed	29 H
natural, analysed, Banff	21 T
Ascot	22 T
see also Springs.	
Watershed, between Arctic and Pacific oceans, Yukon district	11 B
Waterton River, B.C., ore, assay	49 T
Watkinson's, Fraser R., iron	152 R
copper	154 R
antimony	156 R
Watson Creek, Fraser R., arsenic.	161 R
Watson Island, James Bay	20 A
Watsonkwa River, B.C., coal	93, 150 R
Wawechotochis Lake, James Bay.	41 J
Weaver Creek, B.C., gold	132 R
Webster, A., referred to.	13 K
quoted	100 K
Well, N. side of Rainy R.	172 F
Wellington Bar, Fraser R., gold	116 R
Wellington colliery, Nanaimo	83 R, 17 S
Wernerite	77 S
Westminster, B.C.	66 A
Weston, T. C., work by	48, 107 A
fossils collected	60 K
Weston Islands, James Bay	33 J
Whale Rivers, Great and Little, Hudson Bay	23 J
Whip-saw Creek, Willow R., gold	121 R
Whip-saw Creak, Similkameen, gold	127 R
White, J., work by	84 A, 4 H
White, Mount, Lake Marsh	164 B
White Pass, Yukon district	177 B
White River, Pelly River	13 B
White Cliff Island, B.C., marble	151 R
White Horse Rapid, Lewes River.	161 R
Whiteaves, J. F., work by	47, 74, 105 A
fossils determined	146, 158 B
shells determined	172 F
referred to	49 M
Whiteburn, N.S., gold district	26 S
Whitefish Lake, Whitefish R.	85 H
silver mining	96, 131 H
ores, assays	33 T
Whitefish Lake Mining Co., veins	97 H
Whitefish Lake, Q., ores, assays	29 T
Whitefish River, L. Superior, drift	87 H
ore, assay	33 T
Whiting, statistics	5, 7, 46, 47 S
Whitney, Prof., referred to	49 R
Whitton, Q., ore, assay	28, 56 T
Whymper, F., referred to	15, 179 B
Wiachtiwan River, Gulf Lake	55, 59 J
Wild Horse Creek, B.C., gold placers	21, 40, 130 R
Wiley's Cabin, Cariboo, quartz ledge (assay)	41 C
Wiley's Old Diggings, Cariboo, ore, assay	40 C
Williams, Dr. G. H., referred to	124, 126 F
Williams Creek, Cariboo, quartz ledges	31 C
gold placers	30, 34, 120 R
silver ore	67 R
Willimott, C. W., work by	46, 104 A
Willow Bank, Fraser R., gold placer	117 R

	PAGE
Willow River, B.C., gold placers.	121 R
Wilsonite	79 S
Wind, bedding in sand due to.	173 F
Windsor, N.S., gypsum	31 S
Windy Point, L. of the Woods	28, 173 F
Winnipegosis, Lake, Ma., survey.	74 A
Wissick, Mount, L. Temiscouata.	8, 31 M
section	29 M
beds	35 M
Witherite, Rabbit Mountain	71 H
Wolf Creek, B.C., gold	127 R
copper	153 R
Wolf's Cove, Q., fault	44, 57 K
Wolfestown, Q., asbestus mining.	87 A
Wollaston, O., iron ore, analysis.	24 T
Woods, Lake of the, gold	59 A
work on	76 A
Keewatin rocks	22, 27 F
S.-E. of, Keewatin trough	28 F
trap dykes	150, 152 F
agricultural lands	177 F
Woodside's Vein, Silver Mtn.	96 A
granite, described	119 H
Wrangle Island, B.C.	23, 64 B
biotite-granite, described	237 B
Wright, G. B., referred to	59 R
Wright Ledge, Cariboo, gold (assays)	36 C
Wyandotte, O., smelting	39 H
Ya-kan Point, Queen Charlotte Islands, lignite	146 B
Ya-koun River, Queen Charlotte Islands, coal (anal.)	86, 145 B
Yale, B.C., silver	73 R
ores, assays	79 R
gold placers	116 R, 24 S
Yank's Peak, Cariboo, "Big Ledge"	46 C
Yankee Bar, Fraser R., gold	117 R
Yellow metal, imports	7 S
Yoke Lake, Rainy L., agglomerates	51 F
Yukon district, area of	5 B
exploration of	4, 69 A, 7 B
former explorations of	14 B
routes to	20 B
gold mining	26 R, 21, 44, 140 R, 28 S
economic importance	26, 29 B
silver ores	74 R
ores, assays	78 R
coal	150 R
platinum	156 R
Yukon, Fort, Yukon River	138, 140 B
Yukon River, confused nomenclature of	14 B
tributaries	17 B
and Pelly River, identity of.	138 B
Yus-sez-uh River, Frances Lake.	111 B
Zinc, imports	7 S
British Columbia	103 R
Zinc-blende, N. of L. Superior	8, 13, 62 H
mode of occurrence	108 H
Calumet, assay	57 T
Zircon	66 S
Zonochlorite	77 S
Zoological collection, additions to	50-53, 107-113 A
work, progress of	47, 105 A
collections from Yukon district	229 B
notes breeding habits of certain mammals	76 J