GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

ANNUAL REPORT

(NEW SERIES)

VOLUME VIII

REPORTS A, D, J, L, R, S

1895

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1897

No. 617.

GEOLOGICAL SURVEY OF CANADA

REPORTS AND MAPS

OF

INVESTIGATIONS AND SURVEYS

The Publications of the Geological Survey of Canada may be ordered through :

WM. FOSTER BROWN & CO., Montreal, Que.
DURIE & SON, Ottawa, Ont.
WILLIAMSON & CO., Toronto, Ont.
J. A. KNIGHT, Halifax, N.S.
J. A. McMILLAN, St. John, N.B.
ALEX. TAYLOR, Winnipeg, Man.
THOMSON BROS., Calgary, Alta.
THOMSON STATIONERY CO., Vancouver, B.C.
T. N. HIBBEN & CO., Victoria, B.C.
EDWARD STANFORD, Cockspur St., Charing Cross, London.
SAMPSON, LOW & CO., 188 Fleet Street, London.
F. A. BROCKHAUS, Leipsic.
LEMCKE & BUECHNER, 812 Broadway, New York.
THE SCIENTIFIC PUBLISHING CO., 27 Park Place, New York.
Also directly from the Librarian, Geological Survey Offices, Ottawa.

Price of Volume VIII. and of the Separate Reports comprised in it :

Volume VIII. (with maps), \$1. *Part A*, 10 *cents*. *Part D (with map)*, 15 *cents*. *Part J (with map)*, 15 *cents*. *Part L (with maps)*, 30 *cents*. *Part R*, 10 *cents*. *Part S*, 10 *cents*.

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

ANNUAL REPORT

(NEW SERIES)

VOLUME VIII

REPORTS A, D, J, L, R, S

1895

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1897

No. 617.

To the Honourable

CLIFFORD SIFTON, M.P.,

Minister of the Interior.

SIR,—I have the honour to submit herewith Volume VIII. (New Series) of the Reports of the Geological Survey of Canada.

The volume comprises 998 pages. It is accompanied by six maps and illustrated by seventeen plates, besides a number of figures in the text.

The several parts composing the volume have been issued previously, as completed, and may be purchased separately at the prices noted on page ii.

I have the honour to be, Sir,

Your obedient servant,

GEORGE M. DAWSON,

Director.

OTTAWA, April, 1897.

Errata for Vol. VIII.

Annual Report Geol. Surv. Canada.

In Volume VIII (1895) *substitute* the single leaf inclosed herewith for the first leaf of Table of Contents.

In the same volume, *insert* Index of Part A, inclosed herewith, before the General Index at the end of the book.

TABLE OF CONTENTS.

REPORT A.

SUMMARY REPORT OF THE GEOLOGICAL SURVEY DEPARTMENT FOR THE YEAR 1896, BY THE DIRECTOR.

REPORT D.

REPORT ON THE COUNTRY BETWEEN ATHABASCA LAKE AND CHURCHILL RIVER, BY J. BURR TYRRELL AND D. B. DOWLING.

REPORT J.

REPORT ON THE GEOLOGY OF A PORTION OF THE LAURENTIAN AREA LYING TO THE NORTH OF THE ISLAND OF MONTREAL BY FRANK D. ADAMS.

TABLE OF CONTENTS.

REPORT A.

SUMMARY REPORT OF THE GEOLOGICAL SURVEY DEPARTMENT FOR THE YEAR 1896, BY THE DIRECTOR.

REPORT D.

REPORT ON THE COUNTRY BETWEEN ATHABASÇA LAKE AND CHURCHILL RIVER, BY J. BURR TYRRELL AND D. B. DOWLING.

REPORT J.

REPORT ON THE GEOLOGY OF A PORTION OF THE LAURENTIAN AREA LYING TO THE NORTH OF THE ISLAND OF MONTREAL BY FRANK D. ADAMS.

REPORT L.

REPORT ON EXPLORATIONS IN THE LABRADOR PENINSULA, ALONG THE EAST MAIN, KOKSOAK, HAMILTON, MANICUAGAN, AND PORTIONS OF OTHER RIVERS, IN 1892-93-94-95, BY A. P. LOW.

REPORT R.

REPORT OF THE SECTION OF CHEMISTRY AND MINERALOGY.
BY G. C. HOFFMAN.

REPORT S.

SECTION OF MINERAL STATISTICS AND MINES. ANNUAL REPORT FOR 1895. BY E. D. INGALL.

MAPS.

VOLUME VIII.

PLATES.

* *In* Portfolio.

GEOLOGICAL SURVEY DEPARTMENT
G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1895

BY

THE DIRECTOR

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1896

No. 582.

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1895.

OTTAWA, 1st January, 1896.

The Honourable T. MAYNE DALY, M.P.,

Minister of the Interior.

SIR,—In accordance with the provisions of the Act of Parliament relating to the Geological Survey, I have the honour to submit this Summary Report of the Department for the calendar year 1895. The reduced appropriation made by Parliament for the work of the Geological Survey during the fiscal year 1895-96, has rendered a strict economy necessary. This has particularly affected the nature and amount of the field-work undertaken, for the existence of a number of unpublished reports and maps resulting from the work of previous years, appeared to render it desirable that a considerable proportion of the money actually available should be devoted to printing. The members of the staff, without exception, have, however, exerted themselves to make the best possible use of the means placed at their disposal, and the progress made in 1895 has been satisfactory and important, as the succeeding pages of this report will, I believe, show.

Annua Reports.

During the year, volume VI. of the new series of Annual Reports of the Survey, has been completed and issued. The volume is a small one, of but 534 pages, but as the funds available for the fiscal year 1894-95 did not admit of further printing, it was deemed advisable to give to the public the matter already in type. The printing of volume VII. is now in progress, and it is hoped that this volume also may shortly be ready for publication.

Maps published during the year.

Twenty-six maps have been issued during the past year, including fourteen sheets of the geological map of Nova Scotia on the scale of one mile to an inch, and one sheet on the scale of four miles to an inch; nine plans and one section relating to the auriferous creeks of the Cariboo district in British Columbia; the north-east quarter-sheet of the "Eastern Townships" map, Quebec; the Rainy River and Seine River sheets in western Ontario. A number of the maps above mentioned had been engraved and printed previous to January 1st, 1895, but had not been distributed. Of the Seine River sheet, a small preliminary edition only has so far been printed, in advance of the forthcoming report on the district, and subject to correction in detail. This course was adopted in order to render the results of surveys immediately useful to prospectors and miners engaged in discovering and developing the gold-bearing veins of the district. This preliminary map has been available since October, although part of the field-work included by it was actually carried out during the past summer.

In addition to the maps above mentioned, two of the Kamloops district, one of the Omenica and Finlay region in British Columbia, and five relating to the surface geology of New Brunswick have been printed and are ready to appear with volume VII.

Other publications.

Other publications include part II. of volume III., Palæozoic Fossils, 84 pages, with 9 plates, and part I. of volume II., Contributions to Canadian Palæontology, 66 pages, with 5 plates. The latter had been printed in separate sheets at different times previous to 1895. A new list of the publications of the Geological Survey of Canada from the beginning of the work, in 1843, to date, making a pamphlet of 52 pages, has also been prepared and printed. This list has been very carefully revised throughout, and now includes no less than 479 official publications (including all maps, plans, etc.) besides a large number of scientific papers bearing upon the work of the Survey or the collections in the museum, of which copies are held on sale for the convenience of the public.

General index.

In order to facilitate reference to the various reports of the Survey, Mr. D. B. Dowling has now been for some months engaged in the preparation of a classified index to the reports published subsequent to the Geology of Canada (1863), which it is proposed to print when completed. The volume prepared by Sir William Logan, under the above title, forms a synopsis of the results of the Survey to the time of its publication; and the collective indexing of subsequent reports may be regarded as a first step towards the production of further synoptical reports.

Mineral specimens sent to Imperial Institute.

In pursuance of the policy of making known to purchasers and consumers, such special products of Canadian mines as find their market at a distance, letters were sent to the various producers of mica in the autumn of 1894, and at a later date to producers of asbestus in Canada, inviting them to send commercial samples and price-lists for transmission by the Geological Survey to the museum of the Imperial Institute in London. This invitation was well responded to in both instances, and the series of representative specimens obtained have during the year been placed on exhibition by the curator of the Canadian Section of the Institute, Mr. Harrison Watson. Brief descriptions of the character and mode of occurrence of the minerals were at the same time furnished for insertion in the technical journals, with special reference to the specimens shown, and many inquiries and requests for further particulars and addresses, have since been received both by the Geological Survey and the several exhibitors.

Photographic Exhibition.

In response to an invitation to participate in the special Exhibition of Photography in its application to the Arts, Sciences and Industries, in London, a number of large coloured and framed photographs of geological features and mines, illustrating the use of photography in connection with the work of the Survey, were prepared and transmitted. These photographs where taken and coloured after nature by Mr. H. Topley.

Geographical Congress.

To represent the work of the Geological Survey at the exhibition of the International Geographical Congress, also held in London during the past summer, a typical series of the various classes of maps published by the Survey was mounted and sent to that exhibition.

Both the photographs and maps above referred to, were at the close of the respective exhibitions handed over to the Canadian Section of the Imperial Institute, where they are now permanently displayed.

Educational collections minerals.

Another subsidiary, though not unimportant feature of the work, to which reference may be made, is that of the supply of small typical collections of Canadian minerals and rocks to educational institutions in Canada. This has grown up in consequence of requests received for such illustrative specimens. It was at first possible to make up a few collections from time to time from duplicate material in stock, but of late years it has become necessary to devote a large part of Mr. Willimott's time to the accumulation of suitable material, and the arrangement of such collections. During the year 1895, no less than fifty-nine collections of this kind, embracing 6665 specimens, have been furnished, without any charge beyond that of carriage, to educational institutions in the several provinces, from Nova Scotia to British Columbia. The increasing demand for such collections has rendered it necessary to restrict the supply pretty closely to institutions and schools in which some instruction in natural science is actually given. In most cases such collections are evidently highly appreciated, as shown by the acknowledgments received, and their value, from an educational point of view is, I believe, very great. It is scarcely possible to overestimate the importance in connection with the development of the resources of the country, of familiarizing the growing generation with even the commoner ores and rocks.

Correspondence.

A large and constantly increasing part of the official correspondence of the Survey, consists of answers to applications for special information on particular mineral products of the Dominion and cognate subjects. Attention is given, in this matter, to placing consumers and producers in connection, in so far as the information at disposal permits. Replies to such inquiries often involve considerable time and trouble, but this their direct importance fully justifies.

Inquiries relating to the geological structure of different parts of the country and the conditions of occurrence of minerals, are also numerous, and during the past year alone, have embraced questions respecting coal, petroleum, gas, salt, water-supply, mineral-waters, stone, clays, lime, cement, peat, fertilizers and many metallic ores. Another large class of applications for information must be made to include the most varied subjects connected with geographical features, heights of summits, or watersheds, elevations of lakes, practicable routes of travel, distribution of forest trees and character of timber, &c., &c. Many of these it is possible to answer to the satisfaction of the inquirers, from the facts included in previous reports, by means of reference to plans or surveys in the office, or from the experience of individual members of the staff.

Examination of specimens.

A very large number of specimens of every kind are also received for identification, determination or description. Many of these are transmitted to the laboratory for examination, and when this appears to be called for, they are there tested, assayed or analysed, the result being communicated to the sender.

It is necessary to mention briefly the work done in the offices under the above heads, as a considerable portion of the time of several members of the staff is thus occupied without any adequate record in the publications of the Survey, although, undoubtedly, to the great advantage of the public at large.

Necessity of a new building.

It is impossible to omit, in this report, a renewed allusion to the entirely insufficient accommodation afforded by the present building for the work of the Geological Survey. Not only are the offices inadequate and inconvenient, but the space available in the museum has become much too restricted, while both offices and museum with all their valuable accumulations, are subject to danger of loss by fire. The advantage to Canada of having an adequate display of the mineral wealth of the country can scarcely be exaggerated, and that the museum, even in its present state, possesses much interest to the general public, is evidenced by the fact that more than 26,000 visitors have been registered during the year.

Acknowledgments of assistance.

Scarcely a year passes, in which the Geological Survey is not indebted to specialists for important assistance, rendered gratuitously and in the interests of science. At the present time it is appropriate to acknowledge particularly our indebtedness to Professor Charles Lapworth, F.R.S., of Birmingham, who has devoted much time to a study of Canadian graptolites, a work now approaching completion; to Mr. S. H. Scudder of Cambridge, Massachusetts, to whose researches the work on fossil insects already mentioned is due, and to Professor A. Hyatt, of Boston, Massachusetts, for his critical notes on various fossils submitted to him. The acknowledged preëminence of each of these gentlemen in his particular lines of study, is such as to render their contributions of the utmost value.

Work of the Director.

My own time, during the year, has of necessity been employed chiefly in connection with the office and in the rearrangement of some parts of the executive work, as well as in supervising the printing and publication. A few days were, however, spent in the country near the Kingston and Pembroke railway, and about three weeks, in August and September, on a visit of inspection to Athabasca Landing in connection with the boring operations there.

Iron ores in Frontenac, Leeds and Lanark.

Considerable attention has lately been given by the civic authorities and Board of Trade of Kingston, to the possibility of establishing furnaces at that place for the smelting of iron ores found to the northward, chiefly in the counties of Frontenac, Leeds and Lanark. In June last, an influential deputation from Kingston waited upon you, for the purpose of urging that the Geological Survey should undertake at once such an investigation of the quantity and quality of the deposits of ore likely to become tributary to Kingston smelters, as might justify the necessary investment of capital there. It was pointed out, in replying to this request, that a good deal of work had been accomplished by the Geological Survey in the district in question some twenty years ago and at various times since, and I ventured to express the opinion that, taking the iron ore deposits in the aggregate, there could not be any reasonable doubt as to their great available quantity and excellent average quality. Many changes in connection with iron smelting have, however, occurred in late years, and it was thus considered advisable that such further investigation of the district as might be immediately possible should be undertaken. Mr. E. D. Ingall was consequently entrusted with this work, and with him I visited Kingston early in August, and subsequently looked over a number of the more important iron mines. Mr. Ingall continued and extended the examinations thus begun, with care and in considerable detail. A preliminary report upon his work is given on a later page, and it will be gratifying to those interested, to observe that the favourable conclusions flowing from the results of previous work by the Survey are fully borne out by this report.

Boring at Athabasca Landing.

Experimental boring for petroleum.

At the time of my visit to Athabasca Landing, the boring there had attained a depth of 1500 feet, which has since been increased to 1731 feet. The work of sinking this experimental well has been attended with unlooked-for difficulties and delay, in consequence of the unconsolidated character and the great thickness of Cretaceous shales which has had to be passed through, and the time consumed in communicating with, and meeting the requirements of the work, in a locality situated nearly one hundred miles beyond communication by railway or telegraph. Mr. W. A. Fraser has spared no effort in advancing the progress of the boring, and is entitled to much credit for the manner in which he has been able to overcome the various obstacles met with. A synopsis of his report on the work is given below.

Intention of the work.

It will be remembered, that the object of the experimental boring has been to reach and penetrate the basal sandstone of the Cretaceous formation, which, where it comes to the surface, about 130 miles further north on the Athabasca River, is known as the "tar sands" and is charged with bituminous matter.* In the last Summary, Mr. McConnell's Report on a Portion of the District of Athabasca, is quoted, to the effect that the top of the "tar sands" should be found at Athabasca Landing at a depth of from 1200 to 1500 feet. This statement was based upon the observed dip of the Cretaceous rocks and the relative heights of places along the natural section afforded by the banks of the Athabasca River, and depended upon an estimate, as close as the circumstances admitted, of these factors. It had necessarily to be assumed that the thickness and lithological character of the members of the Cretaceous series remain the same throughout. To a depth of 1090 feet, a continuous mass of shaly beds was penetrated in the

*Annual Report, Geol. Surv. Can., vol. V. (N.S.), Part D.

boring, and it began to appear possible, in consequence, that the Pelican and Grand Rapids sandstones of the observed exposures to the north, had given out where the boring was in progress. When, however, at the above-mentioned depth, a sandstone was encountered, it became probable that this represented one or other of the previously recognised sandstone formations; and before a depth of 1500 feet had been reached, it was clear that this represented the Pelican sandstone, that it was followed beneath by the Pelican shales, and that these in turn were underlain by the Grand Rapids sandstone, the two first-mentioned formations having very nearly the thickness and character presented by them at their natural outcrops.

Information gained as boring progressed.

It became apparent that the La Biche shales had a thickness somewhat exceeding that estimated for them at this place, but that notwithstanding this fact, the Cretaceous series as a whole remained perfectly regular, and that the volume of its underlying members was practically constant. There is thus much reason to believe that the thickness of the Clearwater shales, in which the well is for the present stopped, and that of the underlying "tar sands," will also prove here to vary little from that found at the natural outcrops; in which case the top of the "tar sands" should be reached at about 1800 feet, or less than 100 feet beyond the actual point now attained. Should it prove possible to do so, it is proposed to continue this boring to a depth of 2000 feet, a depth which it is anticipated will pass through the "tar sands" and penetrate, for some distance, the underlying rocks, presumed to be limestones of Devonian age. The bituminous matter with which the "tar sands" are saturated further down the river, has undoubtedly welled into them from the underlying limestones of that vicinity, and it is therefore advisable at this place, to seek for the existence of petroleum in both, if possible.

Regularity of the measures.

Depth to be attained in present boring.

It must be remembered, that the enormous accumulation of bitumen in the sands, where they are seen, has become possible only from the fact that these porous beds lie directly upon the limestones and are themselves covered by impervious shales. It is of course quite possible that impervious shaly layers may occur in the beds representing the "tar sands" beneath Athabasca Landing, and if so, any one of these might prevent the upward flow of petroleum if it exists there. For this reason, the possibly oil-bearing character of the lower beds of the Cretaceous, can not be considered to have been fully tested at the Landing until their whole thickness has been bored through.

It is also necessary to bear in mind that, even in the most productive oil-fields, the occurrence of valuable accumulations of petroleum

A single experiment insufficient.

is confined to certain limited areas or "pools," and that although there can scarcely be any reasonable doubt of the existence of an important oil-field in northern Alberta and Athabasca, the first experimental sinking in an entirely new region, may not prove to be successful as a source of oil. Whatever may be the ultimate result of the first experiment still in progress, it must be admitted that it has already demonstrated a most important fact in respect to the regularity, over a great area, of the members of the Cretaceous formation, and has rendered it possible to estimate within close limits of error, the depth at which the "tar sands" may be looked for along the Athabasca Valley for a distance of about 150 miles.

The great importance of the development of deposits of petroleum in this region, to which allusion is particularly made in my last Summary Report, should, I believe, not only encourage the completion of the present boring, but lead to an even more energetic system of prospecting, under which several experimental wells might be simultaneously progressing, in different parts of the great area which the geological conditions show to be favourable to the occurrence of petroleum in quantities of commercial value.

Plans proposed for further boring.

The depth attained, with the small diameter to which the present boring has now been of necessity reduced, cause its further prosecution to be attended with considerable difficulty, but should no further success be achieved in it, it is proposed in the spring to move the plant down the Athabasca River to the vicinity of the mouth of the Pelican. There, although still more remote from any base of supplies, it should be possible to reach the "tar sands," at the comparatively moderate depth of about 700 feet. If, on the other hand, any petroleum should yet be encountered in the present well, the importance of tracing its existence as far southward as possible, points to the advisability of making a second test somewhere in the North Saskatchewan valley. Should it, however, prove possible to do so, I would strongly advocate the simultaneous sinking of experimental borings at both these places, thereby effecting a saving of a year in the process of testing the great northern field.

Gas and salt water.

The natural gas, met with in quantity and under considerable pressure in the course of the boring at depths less than 1000 feet, and mentioned in the Report for last year, was, at a later stage, almost entirely shut off by the casing. When the Pelican sandstone was penetrated, the hole became filled with salt water, which overflowed at the top, but not in any great volume. When the casing passed this sandstone the flow was reduced, but the water still continued to flow around it into the hole, with, probably, at a later stage, some additions from the Grand Rapids sandstone. A five-gallon specimen of this water, collected by myself, has been subjected to analysis in the laboratory of the Survey, with results of some interest. They are reported as follows by Dr. Hoffmann :—

"The water contained a small quantity of suspended matter. This was removed by filtration. The filtered water, which was at first perfectly clear and colourless, became, after standing a short time, turbid, and deposited ferric hydrate, with ultimate complete separation of the iron previously contained in the water. Analysis of salt water.

"Agreeably with the results of an analysis, by Mr. F. G. Wait, an imperial gallon of the water would contain :—

	Grains.
Chloride of potassium	4·32
" sodium	2305·77
" calcium	131·91
" magnesium	79·98
Bicarbonate of lime	1·65
" iron	7·84
Silica	·57
Organic matter	traces
	2532·04
Carbonic acid, free	·65
	2532·69

"The carbonates are calculated as anhydrous bicarbonates and the salts without their water of crystallization.

"The water further contained a very distinct trace of lithium, faint traces of barium and strontium; also very distinct traces of bromine and a strong trace of iodine."

The geological section, as developed in the bore-hole up to the present time, with the addition of that shown in a natural exposure examined by me last summer, near the site of the bore, may I believe be summarized as follows, the zero datum being the top of the bore-hole, ten feet above low-water level of the Athabasca River, or about 1660 feet above sea-level :— Geological section developed.

Height.		Thickness of formation.
	Top of Bank.	
180 feet.	Yellowish sandstones, thin beds, with some ironstone: *Fox Hill* or *Laramie*	15 feet.
165 "	Probably all gray shales, with some thin sandstone layers; not well exposed.	

Depth.		Thickness of formation.
0 feet.	TOP OF BORE-HOLE.	
1090 "	Gray and blackish shales, often very soft, with occasional thin, hard, layers of sandstone or ironstone. Much gas at different levels between 245 feet and 780 feet: *La Biche shales*	1255 feet.
1130 "	Gray sandstone, with a flow of salt water: *Pelican sandstone*	40 "
1233 "	Dark shales, often soft; a little sandstone: *Pelican shales*	103 "
1461 "	Gray sandstones and gray reddish and blackish shales; the sandstone sometimes very hard and probably nodular, as in outcrop at Grand Rapids: *Grand Rapids sandstones.*	228 "
1731 "	Dark and light-gray shales, generally hard, with some sandstone layers, particularly toward the base: *Clearwater shales.*	270 " or more.
	Total	1911 feet.

Report on boring operations.

As recorded in the last Summary Report, the boring was suspended on the 26th of October, 1894, at a depth of 1011 feet, it being found impossible to go further without more casing. On the work done in 1895, Mr. Fraser has made a detailed report, from which the following account is extracted or summarized:—

I left Toronto for Athabasca Landing on the 10th April and work was resumed on the boring on the 27th of that month. The 300 feet of 5⅝-inch casing which had been sent up the previous fall, had not arrived in time to be driven however, so, as the first part of the work, we proceeded to try driving it. It was found that the 5⅝-inch casing had parted about 200 feet from the surface, so I deemed it unadvisable to try driving it—in fact it would have led only to disaster. It could not be determined at what exact depth it had parted, for it would not have been safe to attempt to draw it; the walls would have caved in and perhaps covered up the bottom lengths, so that the top lengths could not have been got into them again.

I then had the 4⅝-inch casing put down. We used the under-reamer from the former depth, 825 feet, to the full depth of the bore, 1011 feet.

At the depth of about 1000 feet, the 4⅝-inch casing would go no further, the bottom length became bent, and we could not work through it with safety. I did not consider it advisable to try to straighten it out, for fear it might become so badly damaged that no other smaller casing could be put through it.

Under the circumstances I proceeded to Ottawa for consultation on the 17th May. My suggestion that an additional string of 3⅝-inch casing be procured, and the boring proceeded with, was approved of, and 1500 feet of this sized casing was ordered. A full set of new tools of smaller size had also to be provided and the making of these caused considerable delay. Both casing and tools were, however, shipped on the 11th June from Petrolia, and arrived in Edmonton on the 24th of the same month. I got back to Edmonton by the same train, and immediately procured teams and had the casing and tools sent to the Landing, where I arrived on the 29th.

Report on boring operations—*Cont.*

One of the skilled men I had taken up from Petrolia, refused to work any longer, owing to a disagreement with the driller while I was away. This occasioned me some inconvenience, but I turned in myself and took his place, and the work proceeded from this time on very rapidly.

The first work was to put in the small casing (always spoken of as four inch) down through the 4⅝-inch. At 985 feet it struck hard cavings which had been driven up in the 4⅝-inch by the gas, and would not go any further. We drilled this out, and put it down to the bottom of the bore, 1012 feet.

Drilling was then recommenced, the shale being so soft that the casing followed the bit without any reaming for the next three or four feet. The materials passed through, with notes upon the work, are as follows, in descending order :—

1012–1015 feet, dark soft shale.

At 1015 feet this changed to a hard light-coloured shale.

At 1017 we struck a mud-vein which ran in as fast as we could take it out with the sand-pump. The shale, though hard, still caved badly.

1017–37, still caving. In reaming found it quite hard at 1020 feet.

1037–69, formation dark shale and caving badly. Struck gas at 1055 feet.

1069–84, formation dark shale, caving badly.

1084–90, formation dark shale.

1090, struck sandstone (afterwards proved to be Pelican sandstone) which carried water that flowed over the top of the casing and was strongly saline.

1090–94, sandstone. Put down the casing, but it did not shut off the water, which continued to flow over the top.

1094–1130, still sandstone, water present but in less volume. When the tools were left out of the hole at night, and the water was allowed to find its own hydrostatic level, it stood at about 60 feet below the surface.

1130, reached shale, pretty clearly the Pelican shale of Mr. McConnell.

1130–60, shale, dark in colour and caving badly. The sandstone and shale here mixed in the hole to the consistency of cement, which made the drilling difficult.

1160–70, dark shale—soft.

1170–1207, dark shale with layers of sandstone.

1217–33, dull reddish shale and sandstone.

1233–37, dark gray shale—soft.

1237–42, light gray shale—very hard.

1242–47, light gray shale—soft.

1247–55, dark shale—soft.

1255–60, sandstone—very hard.

1260–67, dark shale—soft.

Up to this time we had been able to pull the casing up and down in the hole, and it worked rather freely. We had moved it up and down almost every day to prevent it becoming fast. At 1267 feet, the bore was caving very badly and the casting became fast. In trying to move it we pulled the derrick down and narrowly escaped a serious accident, particularly to the driller, who was buried underneath the ruins, but unhurt.

Report on boring operations—*Cont.*

Lumber had to be sawn out by hand to rebuild the derrick, and about a week was lost by this mishap. When the repairs had been completed, we were obliged to have recourse to driving. We screwed an iron cap, which had been provided for such a contingency, into the top length and drove on it. From this depth to the bottom the casing required more or less driving.

1267–85, dark shale—soft.
1285–95, sandstone—very hard.
1295–1300, sandstone—hard.
1300–10, sandstone—very hard.
1210–1323, dull reddish shale and sandstone—soft.
1323–38, reddish shale.
1338–50, sandstone and dark shale.
1350–63, dull reddish shale with a little sandstone.
1363–79, dull reddish shale and sandstone.
1379–91, dull reddish shale and a little sandstone.
1391–1425, sandstone, with some layers of dark gray shale.
1425–35, sandstone, medium hardness, shale dark.
1435–48, sandstone, hard with soft streaks.
1448–61, sandstone and dark shale interstratified.
1461–73, dark shale. (Thin streaks of lignite about here.
1473–91, dark shale.
1491–1531, hard shale, light gray colour.
1531–40, shale; not quite so hard.
1540–66.
1566–70, hard sandstone.
1570–76, very hard sandstone.
1576–89, hard shale, drilling very like limestone.
1589–1601, hard shale, light gray in colour.
1601–13, similar, with streaks of soft shale.
1613–26, hard shale.
1626–33, very hard. Iron-stone boulder.
1633–43, hard shale.
1643–55, hard shale, a little gas.
1655–82, hard shale.
1682–89, hard and soft shale alternating.
1689–95, shale and sandstone alternating.
1695–1722, shale and sandstone alternating. Shale very soft and caving in badly.
1722–31, shale with a little sandstone.

At this depth (on October 10th) further drilling became impossible, because of caving-in of the sides of the hole, until the casing should be put down to the full depth. The casing stood at the time at 1473 feet. The under-reamer, which had been gotten new in June, was completely worn out; so I proceeded to Calgary and had a new one made there. I returned on the 25th October, when work was resumed again, and the hole was subsequently enlarged and the casing carried down to a depth of 1668 feet. When this had been accomplished, it became necessary to close operations for the season, owing to the onset of very cold weather.

When it became fully established that the formations were in regular order, as observed by Mr. McConnell on the lower reaches of the Athabasca, it was evident that the "tar sands" would be encountered at a greater depth than anticipatep, consequently the 1500 feet of 4-inch casing would be insufficient. An additional 300 feet was ordered, and forwarded by the department. No delay was met with, for this casing arrived before it was actually needed, thanks to the prompt manner in which it was forwarded. The quantity of casing on the ground should be sufficient to carry the bore down to 2000 feet. Report on boring operations—*Cont.*

The sinking of the bore during the season of 1895, has been a difficult undertaking. The formation is the very worst that can be encountered, on account of the constant caving, requiring to be cased all the way, and to this the sandstone strata proved a serious obstacle, as they required to be reamed off before the casing could be put down. The under-reamer got for this purpose was quite inadequate to the work, as made in the shops; but, as the result of much experience on this bore, it is now a first-class tool and does its work very satisfactorily.

The price of success has been eternal vigilance. An instance of this may be given which occurred during the reaming, at 1285 feet. We were six days reaming three feet, and when the casing was put down it had only *one-quarter inch clearance.* This was through a very hard sandstone, which wore off the steel as though it were being held on a grindstone driven by steam power. We could not pull up the casing had we let it down, and if it did not go through all work on the bore would have ended there. We made sure of our measurements, and then put the casing down successfully.

Although operations were commenced over a year and a half ago, the drill being first started on August 15th, 1894, only eight months of actual work has been done on the bore, divided as follows:—1894, two months; 1895, six months. The balance of the time had been lost for actual work, owing to the great distance by which the locality is removed from the base of supplies.

The work is of such a nature that machinery and tools cannot be made so that breaks will not occur. Neither would the duplicating of parts overcome this evil, for one particular part may break two, three, or five times, whilst the parts are so numerous, bulky and expensive that one would be forced to spend a small fortune on freight in moving the plant about in such an out-of-the-way place, to say nothing of the first expense of purchase. All that can be done has been done in the past to provide against such delays, having a due consideration for the fact that economy has been carefully and at all times impressed upon me by the department.

The boring at the Landing has been put down as cheaply as possible, and if it had been done by day labour, it is safe to say that it would have cost double the sum it has.

At present the amount of casing in the bore-hole is as follows:—

37 feet of 6⅝-inch diameter; 625 feet of 5⅝-inch diameter; 1000 feet of 4⅝-inch diameter; 1070 feet of 3⅝-inch diameter (probable estimate). Much of this can be recovered for use next year in another bore.

There is above ground:—30 feet of 6⅝-inch diameter; 400 feet of 5⅝-inch diameter; 500 feet of 4⅝-inch diameter.

During the summer, two large boats capable of carrying ten or twelve tons of plant, have been constructed to take the boring outfit down to the Pelican River, Report on boring operations—*Cont.*

if this should be decided upon. These boats were built by the men while work was interrupted on the boring, as above described.

In conclusion, I beg to call your attention strongly to the value of the information obtained, with regard to the continuance of the rock-formations observed near the outcrop of the "tar sands," at this great distance from the said outcrop. It means that the forecast that they did so extend is now an absolute certainty, and is one of the strongest arguments against the popular fallacy that geological knowledge is of no practical value in determining the extent of a petroleum deposit. We now know that the formations overlying the petroleum-saturated sandstone, extend with almost unvarying regularity at least one hundred and fifty miles to the south and west. That they have been found at a greater depth than anticipated matters very little—in fact, in my opinion, this is rather favourable to the existence of a greater natural reservoir for oil, should it still be there.

The total expenditure in connection with the above operations, during the calendar year 1895, has been $7838.66, of which $6125.50 was paid to the contractor as the work progressed, $1504.31 was paid for casing and transporting the same, and $208.85 represents travelling and minor expenses.

Gold-washing on the Saskatchewan.

While at Edmonton, in connection with my visit to Athabasca Landing, some facts of interest in connection with gold-washing on the North Saskatchewan were learned. This industry has been prosecuted in an irregular manner, at low-water stages of the river, for many years. The principal paying bars are found along the river within a distance of about sixty miles above and a similar distance below Edmonton, but of late, ground has been worked even as far down as Battleford, some 250 miles below Edmonton. A larger number of men than usual were in 1895 engaged in this work on the Saskatchewan, probably about 300 in all, while it was estimated that gold to the value of $30,000 had already been purchased at Edmonton, before the end of August. Simple mechanical appliances of various kinds, worked by hand, are now employed successfully in raising gravel from the submerged bars, a sand-pump has been tried without much success, but this year a large dredge has been constructed for the work. This was about ready for operation at the time of my visit, but no particulars are available respecting its work since.

Distribution of gold.

The occurrence of gold is not, however, limited to the North Saskatchewan. As may be gathered from previous Reports of the Survey, it is found in greater or less abundance, in a similar manner, on portions of the courses of all the rivers east of the Rocky Mountains from the 49th parallel northward. Good returns obtained by individual miners on the corresponding part of the Athabasca River, led last summer to the outfitting of many parties for that river. The results were on the whole disappointing, but it must be added that most of the adventurers were not even skilled in the work, or likely to be able to save the gold, which is always very fine.

To the south of the Peace River, at least, the gold thus found in the beds of the rivers of the Great Plains, does not appear to be derived directly from the Rocky Mountain region. The question of its origin has been discussed in several previous Reports, but further investigations appear to be required to settle this definitely.

On my return journey, a couple of days were spent on the Lake of the Woods, with the purpose of seeing something of the progress of the gold mines there in course of development. Acknowledgments are due to Mr. R. H. Ahn, for his kindness in assisting me in this endeavour; and I had also the pleasure of meeting, at Rat Portage, Mr. A. Blue, Director of the Ontario Bureau of Mines. In company with Mr. Blue, visits were made to several of the locations. The *Sultana* is the only one of these which can be said to have, at the time, passed the experimental stage. The shaft is there down about 200 feet, with levels run out on the vein to the north and south, while a considerable amount of ore has also been taken taken out from the outcrops of the veins. A ten-stamp mill with Frue vanners is in constant operation, the free gold only being obtained at present. Pyritous "concentrates" which amount to about one-hundredth of the whole weight of quartz, and are said to carry $50 to $60 worth of gold to the ton, are put aside for future treatment. Through the kindness of Mr. J. F. Caldwell, the owner of the Sultana, I am able to state that the total yield of gold from this mine to date, has been of the value of about $90,000.

Gold mines on Lake of the Woods.

At the *Gold Hill* mine, a ten-stamp mill had been put in place and was nearly ready for operation at the time of my visit, while work was actively in progress on the lodes. The *Regina* mine was not visited, but another ten-stamp mill is now at work there, and very excellent specimens of auriferous quartz from the mine were shown to me by General Wilkinson. Projects are on foot for the installation of milling machinery on other properties around the lake, and, generally speaking, an encouraging amount of well-directed activity is being shown, such as to lead to the belief that the gold mining industry is likely to be pursued in future in a business-like manner and with good results.

Taken in connection with the later developments about Rainy Lake, the Seine River and in the Manitou district, of which some particulars will be found in Mr. McInnes's report on a later page, the circumstances are such as to show, more clearly than ever, the auriferous character of the Huronian rocks. Already the prospectors and miners have become

Auriferous belts.

accustomed to recognize this fact, over the whole region, and the geological maps prepared by this department are valued by them as most important guides, while urgent demands are made for the further extension of the work of the Survey.

Metalliferous character of Huronian rocks generally.

From a still wider point of view, embracing the nickel, copper and gold deposits of the vicinity of Sudbury and Sault Ste. Marie, as well as those above particularly referred to, the economic importance and metalliferous character of the rocks of the Huronian system become even more apparent. This fact was recognized and the importance of the geological conditions insisted upon by Sir William Logan, in reports of the Survey made nearly forty years ago, and it is gratifying to observe that the practical miner is now beginning to appreciate the value of a large amount of geological work carried out in the country to the north of the Great Lakes, which, a few years ago, it might have appeared difficult to justify in the light of any economic results up to that time achieved. There can now be very little doubt, that every square mile of the Huronian formation of Canada will sooner or later become an object of interest to the prospector, and that industries of considerable importance may yet be planted upon this formation in districts far to the north, or for other reasons at present regarded as barren and useless.

Distribution of field-parties.

Turning to the operations of the regular field parties of the Geological Survey, the following synopsis of their distribution, by provinces, may in the first place be given :—

British Columbia	2
North-west Territories (boring operations)	1
Manitoba and Keewatin	1
Ontario	4
Quebec	4
Nova Scotia	2
Total	14

Special examinations in the field.

In addition to the above parties, which were engaged in continuous field-work during a great part of the season, several members of the staff were occupied for shorter periods with special investigations in the field. Mr. J. F. Whiteaves, spent a few days in palæontological researches on the Island of Montreal and in its vicinity, and Dr. H. M. Ami was occupied for nearly a month in similar work in Nova Scotia; both in connection with the definition for mapping of the geological formations. Mr. W. F. Ferrier was authorized to visit and examine several localities where ores and minerals of interest had been reported. Mr. J. White spent two weeks in running a line of survey, found to be necessary for the laying out of one of the Ontario map-sheets. Mr. Willimott also, as noted in the sequel, made a number of short journeys for the purpose of collecting duplicate material to be employed in making up collections for educational institutions. Of the gentlemen not regularly attached to the staff of the Survey, who have in former years carried out geological work, Professor L. W. Bailey of Fredericton, alone was entrusted with any such work during the year, and the funds available restricted his operations to a short period.

Before entering with such details as are appropriate repeating the field-work of the season, the following additional general observations may be given, which, in conjunction with the foregoing notes, will serve as a brief outline of the scope and results of the explorations and surveys of the year:—

Synopsis of field-work.

The work done in British Columbia has been confined to two districts in that extentive province. Its results, given at greater length below, are therefore insufficient to indicate the great general development of mining there is in progress. The facts detailed by Mr. McConnell, however, show the wonderful expansion of mining enterprises taking place in the West Kootanie district and the extent and richness of the deposits carrying silver and gold there. One of the most notable points brought out, is the occurrence, lately ascertained, of ores of exceptional value in parts of the granitic area, which has heretofore been almost disregarded by the miners.

Most of the facts relating to the structural geology and actual survey of the district, are reserved for a detailed report and map, for which much further work is still needed. Ten years ago this district was almost an untrodden wilderness, but it is difficult now, with the means at the disposal of the Geological Survey, to keep pace with the march of discovery. Mr. McEvoy's work in the Shuswap region, has been given principally to obtaining additional data for the map, now approaching completion. The recent discovery of a large deposit of gypsum in this region is noteworthy, as being the first of the kind found in British Columbia.

Mr. Tyrrell's exploration of the country to the east of Lake Winnipeg, has afforded the means of representing that region correctly upon the maps. Although found to be underlain almost exclusively by Archæan gneisses and granites, an unexpected development of superficial silty deposits was met with, such as to afford a large tract of probable agricultural value.

In the Rainy Lake and Thunder Bay districts of Western Ontario, the surveys carried out by Mr. McInnes, of which an interesting

Synopsis of field-work—*Cont.*

summary is given, have been in close connection with the development and definition of the auriferous quartz-veins and the iron ores. The rocks characterizing this country are divisible, in a general way, into Laurentian and Huronian, the former term being applied to the granitoid gneisses and granites of similar composition inclusively, in the absence of criteria such as to enable any distinct line to be drawn between these two classes of rocks, and without necessarily implying the existence of any rocks preserving their originally bedded character, like those of the Grenville series. The Huronian rocks include the Keewatin and Coutchiching of Dr. Lawson, and of these the relations will be more fully explained in Mr. McInnes's forthcoming report. It is in this series that minerals of value are found to occur, and it may be added, that some assays lately made in the laboratory, of quartz from the Manitou and Seine River regions, prove the existence of quartz-veins exceptionally rich in gold, of which it only remains to prove the extent and continuance in depth.

Rocks very similar in character to those above referred to, but even more closely akin lithologically to those of the Sudbury region, of which they are in fact the continuation, characterize the area covered by the Nipissing and Temiscaming sheets. These two maps, with a report relating to their united area, are in process of compilation by Mr. Barlow. Frequent inquiries are already being made for maps of this region, by prospectors anxious to pursue their explorations in it, and it will be endeavoured to publish the sheets referred to as soon as possible. Upon Lake Temiscaming is one of the typical Huronian areas first discovered and named by Sir William Logan, and its close examination has produced results of considerable value from a geological standpoint.

The country in the vicinity of the Ottawa River, from the vicinity of Ste. Scholastique to that of Pembroke, now being laid down in detail for the first time by Dr. Ells, comprises extensive areas of the Grenville series of the Laurentian, with its great crystalline limestones and other characteristic rocks. These, it is hoped, it may be possible to trace into some clear connection with the representatives of the Hastings series of Vennor, of which the relations have remained more or less in doubt. The economic minerals of the region covered by this work comprise iron-ores, mica, graphite, apatite, asbestus, as well as marble and other structural materials.

The map-sheet extending to the south-east of Ottawa and including Cornwall, upon which Mr. Giroux has been engaged, is underlain by little-disturbed Cambro-Silurian rocks. The areas occupied by the various formations comprised within this period are being carefully defined.

No metalliferous deposits are known to occur, but questions relating to building-stones, brick-clays, peat, marl and the existence or otherwise of porous beds capable of yielding potable water, are involved. Synopsis of field-work—*Cont.*

The survey of the Noddaway River in Northern Quebec, by Dr. Bell, and the establishment of the fact that the stream previously known to exist to the north of Grand Lake, on the Ottawa, is one of its principal sources, makes a substantial contribution to the geography of the province. The most important geological discovery made, and one which promises to have results of economic value, appears to be the existence of a great area of the Huronian system to the north of the main watershed. The occurrence of a wide expanse of country characterized by good soil and bearing a considerable growth of forest, is also notable.

Mr. Low's expedition up the Manicuagan River and in the country about the height-of-land between this river and those draining to the northward, had also in part a geographical object. Its geological results are, however, not without importance in connection with the accumulation of material for a more complete map of the rocks of the Dominion. The supposition that the region traversed is in general one of Laurentian rocks has been confirmed, but it has been proved that the Upper Laurentian, or Granville series, is present there, as well as important masses of anorthosite rocks. A remarkable bed of magnetic iron-ore was also discovered, although this is too far from means of transportation to be of any immediate utility.

In the 'Eastern Townships' of Quebec, Mr. Chalmers has begun a critical reëxamination of the auriferous gravels, bringing to bear upon this problem his long experience of the superficial deposits of the neighbouring parts of New Brunswick, and of the events of the glacial period generally. The wide spread of the auriferous drifts beneath the boulder-clay has been demonstrated, while various facts of scientific value have also been noted; such as the probable twofold division of the boulder-clay, the height and continuity of old sea-beaches and the various directions in which the ice flowed over the district during different stages of the glacial period. The discovery of an auriferous conglomerate among the ancient metamorphic rocks of the region, at Dudswell, is also a matter of interest and possibly of importance.

Mr. Fletcher's work, in Cape Breton, has been directed to a reinvestigation of the Sydney coal-field, preparatory to a new issue of the geological map-sheets, of which the previous edition has become exhausted. Since the surveys of Mr. Robb, many years ago, great progress has been made in the working of these coal-fields, rendering

Synopsis of field-work—*Cont.*

necessary such a reconsideration of structural facts as that now in progress. In the counties of Halifax and Hants, Nova Scotia, Mr. Faribault has continued his careful survey of the Cambrian gold-bearing rocks. The facts discovered in regard to the relation of the auriferous veins to the various well-marked anticlines, have rendered necessary a close study of these folded strata, together with their associated granitic masses and the various faults and fractures affecting them. All these features are being laid down with accuracy upon maps on the scale of a mile to the inch, and the interest of the mining population in the work is freely expressed.

The work done by Professor Bailey, of Fredericton, during a few weeks, in the south-west part of Nova Scotia, had reference to a revision of the general geology of that portion of the province, which has not yet been mapped in detail.

Arrangement of following summaries.

In presenting the subjoined preliminary reports on work done in the field, they are arranged, in conformity with previous practice, in order by provinces and districts from west to east. In respect to detail, greater prominence is, as a rule, given to the results of explorations and surveys which are as yet incomplete, and of which it will not be possible to present final reports and maps for some time to come, and greater space is given to those aspects of the work of the year which appear to have immediate importance from an economic point of view.

BRITISH COLUMBIA.

British Columbia.

During the early part of the year, much of Mr. R. G. McConnell's time was occupied in completing for publication a report and map of his exploration on the Finlay River, made in 1893. Work was also in progress on the surveys made in West Kootanie during 1894, and on the rocks and minerals obtained from this district and from the Finlay.

West Kootanie. Work by Mr. McConnell.

On the 11th of June, Mr. McConnell resumed field-work in West Kootanie, assisted, as before, by Mr. H. Y. Russel. The work was brought to a close on October 5th.

The season available for effective geological work on the high mountain ranges of the Kootanie district, judging from the experience of the last two seasons, is practically limited to the two months of July and August, with the first two weeks of September, and even during this short period, operations are often seriously hindered by forest fires and the dense smoke arising from them. The snow seldom disappears from the high summits before the end of June, and usually re-appears on the mountain tops before the middle of September. The shortness of the season, taken in conjunction with the rough, wooded, pathless character of most of the region, necessarily cause its geological examination to be a lengthy undertaking.

British Columbia—*Cont*

Mr. McConnell reports as follows on the progress made in his work, and the condition of mining in the district.—*

Operations of the season.

"Field-work was commenced with an examination of Slocan Lake and the surrounding country, which occupied about a month. After completing this, work was continued eastward to Kootanie Lake, and southward to Balfour, along the zone of shales and schists bordering the great granite area of the district. A trip from Kootanie Arm to Slocan Lake and back by the Slocan River was contemplated, but had to be abandoned owing to the early appearance of the snow. The work included a rough topographical survey as well as geological survey of the district, the former being conducted by Mr. H. Y. Russel, the latter by myself.

Slocan Lake.

"Slocan Lake is one of those long, narrow bodies of water which occur so frequently throughout the mountainous districts of British Columbia. It occupies part of a great valley, hewn out of the mountains long before the present drainage-system was inaugurated, extending from Nakusp on the Upper Arrow Lake, to Kootanie River.

"The lake has a length of twenty-three miles, and an average width of about a mile. Its depth increases, going southward, from 750 feet near the mouth of Wilson Creek, to 930 feet off Cape Horn. Marginal flats are absent, except at the mouths of the principal feeders; and the high mountains which surround it on all sides, rise either gradually, or in precipitous cliffs, from the water's edge. The slopes of the mountains are covered with a dense coniferous forest, except where forest fires have passed, up to a height of 3000 feet above the lake, and with a scattered growth of pine, spruce and fir, up to a further height, dependant on local conditions, of from 1000 to 2000 feet.

Region between Slocan and Kootanie Lakes.

"The region between Slocan Lake and River and Kootanie Lake, partially examined during the season, is covered mainly by granite, fringed on the north and east by a border of slates and schists, and is everywhere of a mountainous character. The granite-mass, originally dome-shaped, has been carved by the drainage-system of the region into bold craggy mountains and mountain ranges, which culminate in a rugged mass of snow-clad peaks, situated between the south-end of

* NOTE.—The bearings given throughout this and the succeeding reports are referred to the true meridian unless otherwise specially stated.

British Columbia—*Cont.*

Slocan Lake and Ainsworth, the highest summits of which approach 9000 feet in height above the sea. The principal streams of the district, including Lemon Creek, Ten-mile Creek (Slocan Lake), the south fork of Kaslo Creek, Woodberry Creek and Coffee Creek, radiate from this group and descend rapidly through deep, steep-sided valleys to the main waterways. A second range of prominent peaks, scarcely inferior in height to the central group, occurs north of the Kaslo-Slocan wagon-road. The Whitewater, Lyell Creek, and other tributaries of Kaslo Creek, head in glaciers which descend from this range.

Boundaries of the granite.

"The principal geological boundary in the district between Slocan Lake and River and Kootanie Lake, is the sinuous line separating the granite area from the bordering slates. Starting from Four-mile Creek on Slocan Lake, this line follows that stream in an easterly direction for ten miles, then bends to the north across the range separating Four-mile Creek from Cody Creek and following the latter stream in a northerly direction for a couple of miles. From Cody Creek, the granite border runs almost directly east to Twelve-mile Creek. After crossing this creek the line becomes more irregular, as several spurs leave the granite area and penetrate for varying distances the group of mountains lying between Ten-mile Creek and the South Fork of Kaslo Creek. At the latter stream, the granite recedes a couple of miles, then bends around a deep embayment of slates, and continues on in an easterly direction towards Kootanie Lake. Four miles from the lake, the line of junction turns abruptly southward, and continues in this direction until near Balfour, where it bends more to the west and crosses the outlet of Kootanie Lake about four miles below its head. Inliers of slate in the granite, occur at the head of Eight-mile Creek (Slocan Lake), on Four-mile Creek and at other places, while bosses of granite, separated from the main area, break through the slates at Paddy's Peak, Reco Mountain, and north-east of New Denver.

Rock-series developed.

"The stratified rocks bordering the granite area are everywhere tilted at high angles, broken by numerous faults, and frequently overturned. They may be divided into four main groups, as follows, in descending order:—A series of dark shales and slates associated with limestones and calcareous quartzites, which may be provisionally named the Slocan slates; a series of greenish, probably mostly diabase-schists, interbedded with some slates (Kaslo schists); a series of dark calc-schists holding occasional bands of limestone and green schists (Nisconlith series); and a basement series of mica-schists, calc-schists, crystalline limestones and gneisses (Shuswap series).*

*Compare Annual Report, Geological Survey of Canada, vol. IV. (N.S.), part B. The Slocan slates are probably the equivalents of the Adams Lake series, but it may be an advantage for the present, at least, to refer to them by a local name.

"The Slocan slates occur all around the northern end of Slocan Lake and extend eastward, striking in a north-westerly and south-easterly direction, along the Kaslo-Slocan wagon-road to the Forks of Kaslo Creek. The slates of this group strike into the granite area, and with the exception of a narrow strip which skirts the eastern edge of the granites south to near Balfour, are cut off by it. The Kaslo schists were traced from Balfour north to Kaslo Creek, and then in a north-westerly direction to the edge of the map. These schists are altered in places into serpentine. The Shuswap series occurs in a band of varying width along the shores of Kootanie Lake, and was also found on the western side of Slocan Lake near Saw-mill Creek, where it is inclosed in granite.

British Columbia—*Cont.* Distribution of rocks.

"The classification of the rocks of the district as given above, is based entirely on differences in lithological character, as no fossils were found, nor were any unconformities worked out. The three systems appear in places to graduate into each other, and the lines separating them must be drawn, so far as present evidence goes, in a more or less arbitrary manner. The stratified rocks are traversed by two systems of dykes, one apparently contemporaneous with the granites and the other much younger. The former is cut by the fissures holding the mineral lodes of the district, while the latter, in some cases at least, cuts these fissures.

Metalliferous veins.

"Mineral veins occur to some extent in all the formations represented in the district, irrespective of age or origin, but are more numerous and better defined in the Slocan slates than in the older stratified rocks or in the granites. The famous Slocan Star occurs in this formation, and also the Alamo, Idaho, Mountain Chief, Noble Five, Reco, Alpha, Wellington, Payne, Washington, No. 1, Skyline, and dozens of other promising leads. The Eureka and the great Silver King vein, occur in the Kaslo schists, and the Bluebell and Highland in the Shuswap series. As examples of those occurring in the granite, may be mentioned the Fisher-maiden, Enterprise and Arlington.

Rich veins in granite.

"A number of mines and prospects in the district were visited during the progress of the work and brief notes were taken, some of which may be of interest here. The granite area south of the main Slocan mining camp, hitherto somewhat neglected, was prospected pretty thoroughly during the past season, and a large number of claims—some of considerable promise—were staked out. Among those visited in this section were the Arlington, celebrated for the richness of its ore, the Nancy Hanks, Tamarac, Dayton and Enterprise.

"The Arlington, on Springer Creek, located in 1894 by C. E. Fielding, follows a zone of shattered rock, which as shown in the single

British Columbia—*Cont.*

opening so far made, has a width of from six to eight feet. The ore occurs mostly in siliceous stringers, ranging in width up to four or eight inches, which run in an irregular manner through the fissured and altered granite, but is also found disseminated through, or in small bunches, in the granite itself. It consists principally of native silver, galena, gray copper and argentite. The lead strikes in a north-easterly direction and is reported to be traceable all the way to Ten-mile Creek, a distance of over ten miles. Claims have been staked on it for this distance.

"A large boulder of altered granite, holding stringers of ore resembling that of the Arlington, occurs on the Speculator, the third claim north of the Arlington. The Tamarac is situated on Whittaker Creek, a branch of Springer Creek The workings here have exposed a quartz-seam, from twelve to eighteen inches in width, holding grains and bunches of galena, argentite, and ores of copper. The seam is very regular and has been uncovered for a distance of 250 feet. The Dayton and Nancy Hanks are somewhat similar in character.

"The Enterprise, situated on the northern slope of the ridge separating Springer from Ten-mile Creek, was located in 1894 by R. Kirkwood. This claim is crossed by a well-defined fault-fissure, running in a north-easterly direction and dipping to the south-east at an angle of 80°. The fissure has a width of twelve to eighteen inches and is filled partly with ore and partly with a quartz gangue. The ore consists mostly of galena with some gray copper, and in common with other ores in the granite belt is high grade in silver. A large number of claims have been staked out in the vicinity of the Enterprise, but little development work has so far been done on them.

Claims on Eight-mile Creek.

"The claims on Eight-mile Creek, north of Ten-mile Creek, occur mostly in an inlier of hard, rusty slate or schist, several square miles in extent, inclosed in the granite. The L. H., Baby Ruth, Los Vegas, Mountain View, Granite Mountain, Daisy, and a number of others are situated on this strip. The L. H., is a gold claim of a somewhat peculiar character. The slates are fissured along an east-and-west line, and the schistose country-rock adjoining the line of fracture on the south has been altered, silicified, and impregnated in places with ore, along a zone varying in width from 20 to 40 feet. The alteration varies greatly in intensity, in some places being scarcely noticeable, while in others the rock has lost all traces of its original character. The ore appears to consist mostly of native arsenic, mispickel, pyrite, and pyrrhotite, distributed through the vein in an irregular manner. Assays from samples taken at intervals across the whole width of the lead (40 feet) are stated to have averaged $23 in gold to the ton, and others taken across a selected band seven feet in width, to have averaged $125 to the ton. British Columbia—*Cont.*

"The Baby Ruth, situated on a branch of Eight-mile Creek, about half a mile below the L. H., shows a well defined fault-fissure a couple of feet in width, filled with a quartzose gangue and bands of residual clay. The Granite Mountain and Mountain View leads, appear to consist of narrow tongues of slate penetrating the granite. The slate is partly altered, and mineralized to some extent with pyrite, blende, and galena. The Los Vegas and Daisy, both reported to be valuable claims, were not examined.

"Small inliers of slate occur in the granite in what is known as the Galena Farm, a plateau south-east of Silverton, so called on account of the numerous galena boulders scattered over it. The principal claims examined here were the Noonday and Currie. The workings on the Currie consist of a small shaft and a short tunnel, both inaccessible at the time of my visit, on account of water. The lead where uncovered, has a width at the surface of ten to fifteen feet, and consists of a brecciated mass of quartz and angular fragments of slate, mingled with galena, blende, and pyrite. It appears capable of yielding a large quantity of concentrating ore. The Noonday, situated near the junction of the slate inlier with the granite, is somewhat similar in character. Galena Farm

"The known area of the mineralized granite belt, was greatly enlarged during the latter part of the season, and now includes all the country drained by the various branches of Lemon and Cedar creeks, and probably extends even farther to the south and east. The rough character of the country, and the almost total absence of trails, has prevented much development work being done on the various lodes, beyond that required for assessment work, and it is highly desirable that readier means of access to this promising region should be opened up.

"A short account of some of the principal mines in the main Slocan mining camp, was given in my summary of last year's work. A number of others were visited during the past season, but it will be impossible here to make more than the briefest mention of these. Slocan mining camp.

"This camp has passed the doubtful stage, and is now in a thoroughly prosperous condition. The workings on the older mines have proved the continuity in depth of the lodes in most cases, and new ore-bodies are constantly being opened up. Several tramways and concentrators are in course of construction, and two lines of railway will this winter compete for the rapidly increasing output of ore.

British Columbia—*Cont.*

"The principal mines in the Slocan district, are situated on the slopes of the long irregular ridge separating Four-mile Creek from the South Fork of Carpenter Creek, and on the ridge separating the South Fork of Carpenter Creek from Seaton Creek, or the Middle Fork of Carpenter Creek. The former ridge is known as Silver Mountain, and around it are grouped the Alpha, the Reed and Robertson groups, the Canadian group, the Mountain Chief, the Alamo, Idaho, Cumberland, Yakima, Wonderful, Ruth, Slocan Star, Ivanhoe and many others.

The Alpha.

"The Alpha is situated on the Four-mile slope of the mountain, about two miles east, and 2500 feet above Slocan Lake. The steep slope near the mine, is overcome by a gravity tramway 1600 feet in length, from the foot of which a good wagon-road leads to the lake. The Alpha lead has the character of a crushed zone, 20 to 40 feet in width, running through shales and limestones. The strike is N. 24° E., and the dip is south-easterly at an angle, near the surface, of 35°. The ore occurs mostly in large pockets, one of which yielded 800 tons, and two others about 200 tons each. It consists principally of rich galena, with some blende, and gray copper. Considerable tunnelling has been done at this mine, and at the time of my visit an incline, following the dip of the lead, was being sunk. Farther to the south-east on the same slope, are the Reed and Robertson claims, situated on a strong lead 20 to 30 feet in width, which is stated to be traceable from Four-mile Creek to the summit of the ridge, a distance of over two miles. Still farther east, on the crest of the ridge, are the Chamblet and Britomarte claims.

"Among the more important mines on the northern slope of Silver Mountain, are the Mountain Chief, from which 1000 tons of ore has already been shipped, and the Alamo, Idaho, and Cumberland, on the head of Hauser Creek. The Idaho was idle at the time of my visit, but good forces of men were engaged on both the Alamo and the Cumberland.

The Alamo.

"The Alamo affords a good type of the leads in this vicinity. It shows a well-defined fissured zone from five to ten feet in width, traversing the slates in an easterly direction and filled with crushed and brecciated slate, calc-spar, spathic iron, quartz, and ore. The dip is southerly, at an angle of 75° in the upper levels, but lower down it becomes nearly vertical. The lead is situated on a steep slope, and, like most of the mines in the Slocan district, offers especial facilities for being mined by tunnels, four of which have been driven into it at levels about 100 feet apart, in all of which important bodies of pure and concentrating ore have been exposed. The ore consists principally of galena, with some blende, gray copper, pyrargyrite and pyrite.

"A concentrator of 100 tons capacity, was erected by the Slocan Mining Company at the mouth of Hauser Creek during the past summer, to treat the concentrating ores from the Alamo and other mines in the vicinity. A tramway a mile and a quarter in length, has also been built up Hauser Creek, from the end of which wagon-roads lead to the different mines.

British Columbia—*Cont.*

"On the north slope of Silver Mountain ridge, are the Slocan Star, Ruth, Ivanhoe, Wonderful, and other claims. A description of the Slocan Star was given in last year's summary. The fourth tunnel, which was incomplete at the time of my former visit, reached the ledge at a distance of 500 feet. Drifts—mostly in ore—are now being driven along the lead, and an upraise to connect with No. 3 level, 300 feet above, is being made. A concentrator of 100 tons capacity, connected with the workings by a tramway 1900 feet in length, is also in course of construction in connection with this mine.

Mines on north slope of Silver Mtn.

"The Ruth lead, has a width of from four to ten feet, and strikes S. 70° W., with a dip to the south of 65°. The workings consist of a tunnel 300 feet in length, from near the end of which an upraise has been made to the surface. One hundred and fifty tons of ore, principally galena, stated to carry 120 ounces of silver to the ton, has been shipped from this mine, and considerable bodies of ore are in sight.

"The Ivanhoe, situated high up on the slope of the mountain, shows several nearly parallel veins. Two cross-cut tunnels—the upper 50 feet and the lower 90 feet in length, connected by an upraise of 70 feet—have been driven, and drifts have been extended along the lead from the ends of both tunnels for varying distances. The workings have exposed an ore-chute sixty to seventy feet in length, with a maximum width of five feet of pure and concentrating ore. A contract for a third cross-cut tunnel, 150 feet below No. 2, had been let at the time of my visit.

"The leads on the ridge separating the South from the Middle Fork of Carpenter Creek, are crowded even closer together than those on Silver Mountain ridge. On the south slope, among others, are the Noble Five group, Last Chance, Goodenough, Reco, Deadman and Bluebird, and on the north slope the Best, Antelope, Rambler, Surprise, Antoine, R. E. Lee and Washington. The Payne, the first mine staked in the district, is situated on the crest of a spur of the same ridge.

Mines on Reco Mtn. ridge.

"The Noble Five group, consists of a string of five claims, located on the same lead. The strike is N. 60° E., and the dip is to the north-west at an angle of 45°. The lead has in places the character of a true

Noble Five Group.

British Columbia—*Cont.*

fissure, and in others that of a crushed and fissured zone filled with masses of the slaty country-rock, quartz, calc-spar and spathic iron. It varies in width from a few inches to ten feet or more.

"The Bonanza King and World's Fair, two members of this group, have been worked continuously since the spring of 1892. The workings consist of five tunnels, following the lead at various depths, with a number of upraises and intermediate drifts. The three upper tunnels, which have lengths respectively of 120, 240 and 400 feet, pierce an important ore-chute from 60 to 100 feet in length, and from a few inches to six feet in width. The ore-body widens from No. 1 to No. 2 tunnel and narrows somewhat at No. 3. A fourth tunnel, at a further depth of 350 feet, is now heading towards the chute, but has not yet reached it. The ore consists mostly of galena and blende, with their decomposition-products, classed locally as carbonates, and some gray copper, native silver and a dark earthy mineral which has not yet been examined, but probably consists largely of argentite. A band of the latter in No. 2 tunnel, three to four inches in width, is stated to have averaged 1500 ounces of silver to the ton. A thousand tons of ore stated to have averaged 135 ounces in silver to the ton, has already been shipped from this mine, and the owners expect to ship a second thousand during the coming winter.

The Deadman.

"The Deadman, a parallel lead situated 400 feet east of the Noble Five group, has a somewhat similar character. The ore-body has here a length of 40 to 50 feet and a maximum width of five feet. It has been opened up by two tunnels, each about 200 feet in length, and a third tunnel 135 feet lower down has been started towards it. The ore is very high grade in character. The output of shipping ore up to the present, is stated to have amounted to about 300 tons.

The Goodenough.

"East of the Deadman, on the same slope, are the Reco and the Bluebird, accounts of which were given in last year's Summary. The Goodenough, a small but exceedingly rich lead, adjoins the Reco on the south. The ore-chute, varying in width from traces up to six or seven inches, has been followed for a considerable distance on the neighbouring Reco claim. The ore consists mainly of galena and carbonates with some ruby silver and gray copper. A shipment of ten tons of the undecomposed ore from this mine, is stated to have averaged 776 ounces, and another shipment of five tons 817 ounces of silver to the ton.

The Last Chance.

"The Last Chance, is situated above the Noble Five mine. The surface appearance of this lead was somewhat unpromising, but an incline run down on it to a distance of 80 feet, resulted in the discovery of a chute of ore showing from one to three feet and a half of pure high-grade galena, bordered by several feet of carbonates and concentrating ore. The chute was followed for 40 feet, when work was stopped by water, and a tunnel is now being driven toward it at a lower level.

British Columbia—*Cont*

"The claims on the northern slope, occur mostly near the heads of the various tributaries of McGuigan's Creek. The R. E. Lee, is situated above McGuigan's Lake near the crest of the ridge. This lead has a width of about three feet and follows a well-defined fissure which cuts sharply through the hardened quartzose slates and granitic dykes which form the country-rock. The vein-filling is principally broken slate with some quartz. A tunnel has been driven along the lead for a distance of 100 feet. The first 20 feet proved barren, but beyond that, a layer of ore from three to six inches in thickness resting on the foot-wall, was followed all the way. At the breast of the tunnel, ore occurs on both walls. The ore is principally a high-grade galena, shipments averaging 133 ounces to the ton in silver and 75 per cent lead.

Claims on north slope of Reco Mtn. ridge.

"North-west of the R. E. Lee is the Washington. This mine has been idle for some time, but will be worked during the present season. The principal openings consist of a tunnel 300 feet in length, from which an upraise of 180 feet leads to a short tunnel above. An ore-body was struck 140 feet in from the mouth of the tunnel, and followed for 120 feet, from which 1500 tons of shipping ore and about 5000 tons of concentrating ore have already been taken. A third tunnel, 146 feet lower down, has been driven in 300 feet, and will be continued to the ore-chute and connected with No. 2 by an upraise, during the present season. A tramway 1500 feet in length and a concentrator of 50 tons capacity are also projected in connection with this mine.

The Washington.

"East of the Washington is the Surprise basin, occupied by the Surprise and the Antoine claims, neither of which was examined; and still further east are the Best and Dardanelles basins. The ridge between the last two basins, is formed by a fine-grained granitic boss about half a mile in diameter, on which are situated the Best, Rambler, Antelope and Caribou claims. The granite is traversed by numerous small faults and seamed with irregular quartz-veins of all sizes, which often carry considerable quantities of tetrahedrite rich in silver. A specimen from the Antelope, assayed in the laboratory of the Survey, ran over 3000 ounces of silver to the ton. Besides the tetrahedrite, some galena, iron- and copper-pyrites and blende are also usually present. A number of the ledges in this group have been

Best Basin.

British Columbia—*Cont.*

opened up by short tunnels and shafts, but no extensive development work has yet been undertaken.

Dry-ore belt.

"The North Fork of Carpenter Creek runs through what is known as the 'dry-ore' belt. The leads in this district are usually siliceous in character and carry bodies of highly argentiferous tetrahedrite, galena and other silver ores. Most of the claims are situated north of the area examined during the past year. At the Miner Boy, a fairly regular quartz-vein, from a few inches to a couple of feet in width, has been followed over 100 feet by a tunnel, and has also been traced west from the face of the tunnel for an equal distance. Some shipments of rich ore have been made from this mine, but I was unable to obtain statistics of these, as the mine was idle at the time of my visit.

"At the London group, north of the Miner Boy, the slates and associated quartzites are cut by several ore-bearing quartz-seams, ranging in size from stringers up to a foot or more in thickness. The seams have been opened up by a couple of short tunnels, and a long tunnel is now being driven in to intersect them in depth.

Claims east of main Slocan camp.

"East of the main Slocan mining camp, numerous claims have been located, both north and south of Kaslo Creek, all the way to Kootanie Lake, but only a few of these were examined. South-west from Bear Lake, is the Lucky Jim, situated on what appears to be a faulted line of contact between the slates and a brecciated band of limestone. The ore occurs in large pockets and side fissures penetrating the limestone. About fifty tons have been shipped.

Claims on South Fork of Kalso Creek.

"North of Kaslo Creek and east of Murray Creek, is the Wellington. This lead resembles somewhat that of the Alpha, and may be described as a wide crushed zone, traversing the slates in an east-and-west direction and dipping to the north. The crushed slates hold stringers and pockets of quartz, spathic iron and calc-spar. A shaft was sunk near the lead to a depth of seventy-seven feet, but was abandoned on account of the water, and the mine is now worked by tunnels. The upper tunnel cross-cuts the slates for 170 feet, and a drift then follows the lead for 100 feet. The drift has exposed an ore-chute sixty to seventy feet in length, stated to average two feet in width at the bottom of the tunnel. It was covered at the time of my visit. A second cross-cut tunnel from the surface to the lead, 700 feet in length and 160 feet below No. 1, has just been completed. The Wellington ore consists of a fine-grained galena, with blende and gray copper. One hundred and fifty tons, stated to average 250 ounces in silver to the ton, have been shipped.

"Farther east, near the head of Lyell Creek, is the Eureka, situated on a well-defined fissure cutting the green schists of the Kaslo series. The workings consist of a cross-cut tunnel 150 feet or so in length, from the end of which a drift follows the lead for 300 feet. An ore-chute twenty feet in length, from which some shipments have been made, was passed through, eighty feet from the end of the tunnel. British Columbia—*Cont.*

"On the South Fork of Kaslo Creek are the Montezuma, Daisy and Ben Hur, the first on a tributary and the two latter near the main stream. The Montezuma lead strikes about N. 30° E. At the main showing, the lead divides, one branch continuing on in nearly the same direction, while the other bends more to the south. The southern branch has a width of ten feet. The south-western one is somewhat smaller and soon narrows in. A tunnel, following ore all the way, has been driven in for a distance of about 100 feet. The ore consists principally of argentiferous galena and blende, with their decomposition-products. On the Daisy, two leads are exposed, about 100 feet apart. They strike N. 60° E. with a dip of 80° to the S. E., and are each from seven to eight feet in width. On the upper lead a shaft, following a short ore-chute adjoining the hanging-wall, has been sunk to a depth of twenty-five feet. The ore consists of argentiferous galena, blende, iron- and copper-pyrites, and some native copper. Gold assays up to $4.40 a ton have also been obtained.

"The Ben Hur, situated north-east from the Daisy, shows two leads each eight to ten feet in width, which are supposed to be a continuation of those on the latter claim.

Ainsworth District.

"In the Ainsworth district, the principal mines being worked are the Highland, No. 1 and Skyline. A short description of the Highland mine, which is situated on a well-defined fissure cutting the schists of the Shushap series, was given in last year's summary. The lower tunnel mentioned there, has since been driven in to a distance of 480 feet. Ore was met with 330 feet from the face of the tunnel, and has been followed continuously for 150 feet. An upraise to the surface, along the lead, was also nearly completed at the time of my visit. A large quantity of shipping and concentrating ore is now in sight in the mine.

Character of Skyline and No. 1.

"The Skyline, and No. 1, occur in limestone bands associated with the Slocan slates, and are situated, the former about 200 yards and the latter about half a mile east of the granite area. The deposits worked in these mines are of a somewhat puzzling character, and would require extended study before conclusions of value could be arrived at concerning them. They appear to occupy fractured zones of con-

British Columbia—*Cont.*

siderable but unknown width, traversing the limestones and slates in a nearly north-and-south direction, and dipping to the west. The zones have been silicified, and impregnated with ore in a selective manner, by ascending solutions.

"The ore occurs in flattened ore-bodies, occasionally ten to twelve feet in thickness, which, in the case of the Skyline, according to Mr. Scott MacDonald, the manager, often cross nearly horizontally from the foot- to the hanging-wall. The workings on the Skyline include an incline eighty-seven feet deep sunk on the lead, and a shaft farther to the west, 200 feet deep, from the bottom of which a drift 120 feet in length and an upraise of forty feet lead to the incline, and the chambers of ore at present being worked. The Skyline ore consists of a porous siliceous rock, carrying a dark mineral, probably mostly argentite, native silver and galena, along with some gray copper and iron- and copper-pyrites. It averages from forty-five to fifty ounces in silver per ton. The present output of from ten to fifteen tons per day, is shipped directly to the Pilot Bay smelter, its siliceous character rendering it valuable as a flux for the more basic ores of the district.

"The workings on No. 1, are somewhat irregular, owing to the different managements under which they have been carried out. The ore consists of a siliceous matrix, holding argentiferous iron-pyrites, native silver, galena and several other minerals which have not yet been identified. The pyrite, when separated from the gangue is stated to assay 700 to 800 ounces in silver per ton, and the galena 200 to 300 ounces. A concentrator of seventy-five tons capacity has been built at this mine, and the output, amounting to about fifteen tons daily, is mostly concentrated before shipment.

"Besides the mines mentioned above, some work is also being done in the district on the Highlander, the Lady of the Lake, the claims of the Canadian Pacific Mining and Milling Company at the mouth of Woodberry Creek and at other places.

Hendryx.

"At Hendryx, the Bluebell is in active operation. This mine is situated on a band of crystalline limestone interbedded with the Shuswap schists, which has been fractured in various directions. The ore, consisting mostly of low-grade galena and pyrrhotite with some blende, iron- and copper-pyrites, and their decomposition-products, occurs either pure or disseminated through a calcareous and occasionally a siliceous matrix. It occupies irregular chambers in the limestone, some of which are of huge dimensions. The ore-body being worked at present, including some large horses of limestone, measures approximately 70 feet in width by 200 feet in length and 150 feet in height. Forty thousand tons of pure and concentrated ores have been shipped from this mine during the year, and prodigious quantities remain in sight. British Columbia—*Cont.*

"The Toad Mountain district was not visited during the season. A Halliday wire-rope tramway, four miles and a half in length, leading from the Silver King mine to a flat near Nelson, has been constructed here by the Hall Mines Company, and a Fraser & Chalmers 100-ton blast furnace will be completed, so I was informed by Mr. Croasdaille, by the end of the present year. (1895.) Toad Mountain.

"Before returning east, a brief visit was made to Trail Creek. A short account of the geology and principal mines in this district was given in last year's report, but since then great progress has been made. The number of working mines has been largely increased, the known area of the mineral belt extended in all directions, a well-built town of 2000 or more inhabitants has sprung up near the mines and a second town is being built near the mouth of Trail Creek. Cursory examinations of some of the working mines were made, but of too general a character to add much to previous knowledge, and as part of the coming season will probably be spent in this district, it would be injudicious here to enter into much detail. The greater part of the mines are situated on an eruptive area, which appears to consist largely of diorites and uralite porphyrites cut by numerous dykes. The eruptive area is traversed, in an approximately east-and-west direction, by lines of fracture dipping to the north and holding ore-bodies ranging in size from mere stringers up to great lodes 30 feet or more in width and from 100 to 200 feet in length. The ore consists mostly of gold-bearing pyrrhotite and chalcopyrite, but mispickel, galena, blende, pyrite and other minerals also occur. Trail Creek.

"Work on the Leroy and War Eagle, the two principal mines of the camp, has been actively prosecuted during the year with highly satisfactory results. The shaft on the Leroy is now down over 380 feet, and the lode followed appears to be strengthening with depth. At the 350-foot level, the ore-chute has a length of 168 feet and a width, at one point, of over 40 feet. The result of the workings on the Leroy, the pioneer mine of the camp, has inspired confidence in the permanency of the numerous other less developed lodes in the district. Principal claims.

"At the War Eagle, which is worked by tunnels, the great yield of the past season, amounting to many thousands of tons of rich ore, has been taken mostly from a stope on the main ore-body between the first level and the surface. A second tunnel over 800 feet in length and about 100 feet below No. 1, is now nearly completed to the chute, and a third one, which when finished will have a length of 1800 feet, British Columbia—*Cont*

has been started. At the Josie, a tunnel following the lead has been driven in to a distance of 330 feet, and three ore-bodies have been opened up, the further one of which has a length, to the breast of the tunnel, of 128 feet. Considerable work has also been done in this vicinity on the Cliff, the Nickle Plate and the Centre Star, and farther to the east important ore-bodies have been developed on the Iron Horse, the Kootanie, the Columbia and numerous other points.

"South of Trail Creek, development work is being pushed, among other claims, on the Crown Point, where a wide body of rich ore has been followed to a depth of 65 feet, and on the R. E. Lee. West of these are the Homestake, the Deer Park and a number of other important claims.

Machinery employed.

"The large amount of work being done, or in contemplation, in this district, is illustrated to some extent by the following list of machinery, part of which is in active operation and the remainder ordered. This has been kindly furnished me by Mr. J. D. Sword, agent at Rossland for the Ingersoll Rock Drill Company.

"At the Leroy, one 7-drill compressor and eight Ingersoll drills, two hoisting engines, three boilers (100 h.p., 80 h.p. and 40 h.p.) One diamond drill.

"At the War Eagle, one 20-drill compressor, ten Ingersoll drills, two 100-h.p. boilers.

"At the Josie, one 7-drill Ingersoll compressor and drills, also diamond drill and hoisting engine.

"At the Centre Star, one 7-drill Ingersoll compressor and drills, 80-h.p. boiler.

"At the R. E. Lee, one 30-h.p. boiler, Ingersoll hoisting engine and steam drills.

"At the Iron Horse, one 5-drill Ingersoll compressor, drill and pump.

"At the Columbia and Kootanie, one 30-drill Ingersoll compressor and drills.

"At the Nickle Plate, one hoist and Knowles pump.

"Sampling works of 200 tons capacity, and a matting plant of 125 tons capacity, are also being erected by the British Columbia Smelting Company near the mouth of Trail Creek.

Metallic minerals found.

"The following is a list of the metallic minerals which have been recognized so far in the West Kootanie district:—Native gold, native silver, native copper, native arsenic, galena, cerrusite, anglesite, altaite, argentite, pyrargyrite, proustite, chalcopyrite, chalcocite, bornite, tetrahedrite, malachite, hæmatite, limonite, siderite, blende greenokite, stibnite, jamesonite, mispickel. British Columbia—*Cont.*

"In conclusion, I must express my thanks to the various mine owners and managers in the district for permission to visit the different mines, for information, and for many other courtesies."

Work by Mr. McEvoy.

In the early part of the year, Mr. J. McEvoy was chiefly occupied in the compilation of parts of the Shuswap map-sheet, British Columbia, employing for that purpose data obtained during the previous summer. Before leaving for the field, about one-half of the area of this sheet had thus been laid down. The field-work of the season was devoted to the area of the same map, in which further surveys and examinations were carried out, such as to nearly complete the required data. There remains, however, some rugged mountain country in the north-east corner of the map, and a geologically complicated tract in the south-west corner, both of which it may be desirable to investigate further before the publication of the sheet.

Mr. McEvoy left Ottawa for the field on the 6th of June and returned on the 21st of October. The work accomplished is described by him as follows :—

Examination of Shuswap sheet.

"Leaving Kamloops with pack-horses and supplies, my first work was the examination of Louis Creek valley and adjacent mountains, where the distribution of the Cambrian rocks was investigated. A squeezed serpentinous agglomerate was noticed capping the mountains north of Fadear Creek, which will probably prove to be a local variation of the Tod Mountain rocks.

"Proceeding to Shuswap and thence northward, the region north of Shuswap Lake was visited and the boundaries of the granite area on Scotch Creek were traced out. The examination of this country was carried on as far as Lee Creek, the next creek above Ross Creek, beyond which the rocks are exposed on the lake shore and were seen by Dr. Dawson last season.

"Salmon River country was next visited, the return being made by way of Shuswap. Some outlying areas of Tertiary volcanic rocks were traced out and the granite boundaries were ascertained.

Gypsum deposit.

"On the hillside north of the middle crossing of Salmon River, there is a fine deposit of gypsum, associated with gray schists and white crystalline limestone. The principal deposit, in which a tunnel twenty-five feet long has been made, is one hundred feet and over in thickness. The exact thickness could not be ascertained on account of the heavy cover-

British Columbia—*Cont.*

ing of drift on the hillside. Above this is another deposit, with a thickness of thirty feet or more, still higher up are two more small deposits, one of which shows bedding. The large deposit is massive and perfectly white in some places, showing slight traces of anhydrite. The general strike of the deposits is east-and-west, true, with vertical or high northerly dip.

"At Salmon Arm, the boundaries of the granite composing Granite Mountain and its extension eastward were traced out, and at Canoe Creek a considerable extent of Cambrian rocks was found, running eastward as far as the Spallumcheen Valley.

Region north-east of Vernon.

"Proceeding toward Vernon, a few points were visited to define granite boundaries on the west side of the valley, where the granite is in contact with black argillite. From Vernon, the B. X. Creek was ascended and the mountains crossed over to Trinity Valley. A great thickness of argillites and grauwackes is developed here. The descent to Trinity Valley was through a wind-fall of heavy larch timber necessitating much chopping and making progress slow. Trinity Valley lies north-and-south and is situated, roughly speaking, midway between the valley of Mabel Lake and the Spallumcheen Valley, and approximately parallel to these valleys. The valley is quite wide, over three miles in the widest part, and a number of settlers have lately taken up land in it.

"A trip was made into the foot-hills of the Gold Range on the east side of Mabel Lake, following the watershed between Mabel Lake and the Upper Shuswap River (above Sugar Lake). These mountains proved to be composed of rocks of the Shuswap series.

"The North Fork of Cherry Creek and vicinity was next visited and further evidence as to the extent of the argillite area in that neighbourhood obtained. Harry's Creek and some other points in White Valley were also examined.

Shuswap River.

"Returning to Enderby, the survey of Spallumcheen or Shuswap River from 'the islands' up to Mabel Lake was completed, by means of a canoe. The river is quite shallow in places, being divided by bars and islands. At low water an ordinary log canoe touches bottom on some of the 'riffles.' Two miles below the lake, a portage-route one and a quarter mile long begins. At the head of this a large stream flows into the river from the north.

"Between the northern end of Trinity Valley and Mabel Lake, a new area of Tertiary volcanic rocks, underlain by shales and sandstones, was found and traced out.

British Columbia—*Cont.*

"On the return journey to Kamloops, some work was done near Round Lake and Monté Lake. At Campbell's Creek a day was spent in ascertaining the boundaries of the Tertiary rocks and the granite and argillites of that vicinity.

Agricultural lands.

"The amount of agricultural land still unclaimed has frequently been mentioned in previous reports. Much still remains, notably, along the north shore of Shuswap Lake at Lee Creek and Ross Creek. This land has mostly been burned over more than once, and could easily be cleared for cultivation. Irrigation would not be necessary on the greater part of it. Between Enderby and Salmon Arm also there is still unclaimed land which is suitable for settlement.

Placer mining.

"The Chinese are still engaged on a small scale in placer mining on Scotch Creek and Cherry Creek. During the summer hydraulic mining was commenced on a small stream a mile and a half south of the lower crossing of Salmon River."

MANITOBA AND KEEWATIN.

Work by Mr. Tyrrell.

Mr. J. B. Tyrrell reached Ottawa on 16th January, 1895, after completing a second traverse of the "Barren Grounds," as briefly mentioned in last Summary Report. He was occupied during the remainder of the winter, and until July, in preparing a report on the whole expedition and a map of the route followed.

Country east of Lake Winnipeg.

On the 5th July, Mr. Tyrrell left Ottawa for the purpose of examining that portion of Manitoba and Keewatin lying east and north-east of Lake Winnipeg and drained by streams flowing into that lake or into the upper part of the Nelson River. It was considered advisable to ascertain the geographical and geological features of this tract of country, as it is comprised within the area of a map-sheet in course of preparation. This sheet embraces Lake Winnipeg and its vicinity, already geologically surveyed by Mr. Tyrrell and Mr. D. B. Dowling. Mr. Tyrrell returned to the office on the 19th October.

He reports on the work done as follows:—

Journey north from Winnipeg.

"On Saturday, 13th July, I arrived in West Selkirk, and shortly afterwards engaged as canoemen Roderick Thomas, and John Harper, two of the men who had accompanied me in 1894, down Kazan River, through the Barren Grounds, to the west coast of Hudson Bay. A cedar canoe, ordered from the Peterborough Canoe Company, had not yet arrived, but Sir John Schultz, then Lieutenant-Governor of Manitoba, kindly placed a large bass-wood canoe at my disposal. The

Manitoba and Keewatin—*Cont.*

remainder of that day and Monday, were spent repairing and painting this canoe, and obtaining necessary supplies for the season. On Monday evening, however, word came from Winnipeg that my cedar canoe had reached there, and would be in Selkirk by the next train on Wednesday morning. Fortunately, the steamer 'City of Selkirk' was leaving for the north on the same day. On Wednesday afternoon we left the wharf and started down the Red River, and at five o'clock the next evening, after a quick and pleasant run over Lake Winnipeg, we reached Selkirk Island, twelve miles north-east of the mouth of the Saskatchewan River. On Friday evening, July 19th, we were towed north-west for about twenty miles, after which we paddled our canoe around the north shore of Lake Winnipeg, reaching its outlet into Nelson River, where the exploratory work of the season was to begin, late on Saturday evening.

Great Playgreen Lake.

"During the first half of the following week, a survey of Great Playgreen Lake was made with a boat-log and compass. The north-eastern shore is entirely underlain by Archæan granites and gneisses, while the south-western shore is composed of the stratified post-glacial clays, which form the long, narrow point separating that lake from Lake Winnipeg. Nelson River issues from Great Playgreen Lake in several channels. The most eastern channel we descended and surveyed past the mouth of Gunisao River to Rossville Mission on the latter lake.

Gunisao River.

"Here an Indian was engaged to accompany us up Gunisao River. Near its mouth, it winds without perceptible current through an extensive marsh, with a width of from fifty to one hundred yards. The water is of a dark brown colour and slightly murky. Up to the Forks, a distance of about eighteen miles, the banks are low and but scantily wooded, with a few rounded bosses of gray gneiss rising here and there. The stream is interrupted by four rapids, past two of which are portages, respectively 100 and 185 yards in length.

"Above the Forks, the south branch is the larger. This was in the first place ascended, for six days, through Gunisao Lake, to a small lake above. Many rapids obstruct the stream, up some of which the canoe was hauled with a line, while past twenty-two of the most serious it was necessary to carry the canoe. For about fifty miles above the Forks, the river flows through a clay-covered country sloping gently towards the north-west, and has cut a channel or valley varying in depth from six to twenty-five feet. In places it has cut down to the underlying granite or gneiss, which then usually forms a barrier over which is a fall or rapid. Between these rocky rapids is slack water, and rock-exposures are infrequent, and where seen are constantly of gray or reddish-gray granite.

"The banks are wooded with beautiful, tall, white spruce, apparently forming a magnificent coniferous forest, but how far back from the river this forest extends, was not determined. There is certainly here a large quantity of valuable timber, much more than was seen anywhere else in the country immediately east of Lake Winnipeg, for most of the surface further south has been swept by extensive forest fires within the last decade.

Manitoba and Keewatin—*Cont.*

"In the upper half of the river, the banks are low and much less clearly defined. Deep bays, filled with wild rice, extend between the rocky knolls back to swamps, wooded with tamarack and small black spruce, generally killed by fire.

Gunisao Lake.

"Gunisao Lake was reached on the first of August. This is a lake of clear cold water, with irregular contour, about thirty-two miles in length, and with steep, almost bare rocky shore of gray granite. The rowan bush was seen growing on some of its many rocky islands.

"On descending the south branch again to the Forks, the Indian hired at Rossville mission refused to accompany us up the north branch, so he was put ashore among some of his friends who happened to be passing, and the river was ascended without his assistance.

"The channel is almost as large as that of the south branch and carries about two-thirds as much water, but the banks, in the lower part at least, are rather more rocky and barren, and almost all the timber has been destroyed by fire.

North Branch of Gunisao River.

"The north branch was ascended for three days and a half, to its source in a narrow lake ten miles long, from which there is said to be a good canoe-route across the height-of-land eastward to Island Lake. There are but ten portages on this river, but for long distances the current is very swift, and the river has not yet cut for itself a channel of any considerable depth. Throughout its whole course from the long narrow lake to its mouth, the river flows through a level, clay-covered country, the rock merely rising here and there in knolls and ridges above the general level.

"After the survey of this river was completed, we paddled down the stream to its mouth, and then to Norway House, where we were delayed for several days by heavy winds, but the time was spent in refitting the sail-boat 'Pterodactyl' that had been brought out last year to await our arrival from the north, and was now to be used in travelling southward down the east shore of Lake Winnipeg.

Little Playgreen Lake.

"On the 20th and 21st August, accompanied by Mr. R. Strath, of Rossville mission, we made a survey of Little Playgreen Lake. The

Manitoba and Keewatin—*Cont.*

rock is generally a very uniform gray granite, although at one place, near the south end, it is associated with a dark rather coarse-grained massive diorite, and near the north end of the lake, it is cut by veins of red pegmatite containing crystalline aggregates of molybdenite.

Black River.

"From Norway House, where we had been kindly welcomed by Mr. J. K. Macdonald, we sailed southward to the mouth of Little Black River. Here, leaving the sail-boat at anchor, and taking a week's provisions in the canoe, we began the ascent and survey of Little Black River. For twelve miles, up to the first portage, the river is from sixty to one hundred yards wide, with clay banks six to fifteen feet high, wooded with white poplar and small black spruce. A low outcrop of gray granite may be seen here and there. The water is dark-coloured and muddy. Above this portage, the river has a width of from thirty to fifty yards.

"We continued our journey up the river for three days, during which time we made twenty-one portages past as many rapids, besides ascending numerous other rapids with line or paddle. The river was found to rise not far from Gunisao Lake, and there is said to be a practicable canoe-route in high water from it to the lake, but the water was now so low that it was impossible to ascend so far with our canoe. The current was often swift, and the channel crooked and overhung with willows. The banks are everywhere composed of stratified clay or silt, and much of the country had been well wooded, but unfortunately nearly all of the timber has been destroyed by fire in comparatively recent years. Some small trees of Manitoba maple *(Negundo aceroides)* were growing by one of the lower rapids. The rock, wherever seen, was a uniform gray granite.

"From the mouth of Little Black River, we sailed southward to Berens River, but a heavy storm drove us in to Poplar River, and detained us there for several days. At Berens River, we engaged an Indian as steersman, and on Monday, 9th September, we paddled southward to the mouth of Pigeon River, and began the ascent and survey of that river.

Pigeon River.

Pigeon River flows into the lake in a deep channel, a hundred yards wide, between sandy points, above which it opens into a shallow weedy lake. Around the sides of this lake were beds of wild rice, then almost ripe, on which great flocks of wild ducks were feeding. The channel gradually narrows and becomes well defined at a little rapid, where it is about forty yards wide, above which it again expands to a width of from sixty to a hundred yards, with even clay banks, six to ten feet high, wooded with tall white poplars. Low bosses of gray gneiss outcrop here and there, on which are growing small groves of oak.

"The ascent of the stream was continued for six days, and on Saturday evening we reached the Hudson's Bay Company's trading-post at Grand Rapids. The work of ascending the stream had been rather slow and difficult, for the Indians rarely travel on the river, and the twenty-nine portages that we were obliged to make were often through dense burnt forest and over innumerable fallen trees. In its lower part, the banks are chiefly composed of stratified clay or sand, and the channel is even and well defined, but higher up the banks are of gneiss or pebbly till. Manitoba and Keewatin—*Cont.*

"From Grand Rapids Lake, Pigeon and Berens rivers, two streams of about equal size, flow westward towards Lake Winnipeg, the former discharging from the south, and the latter from the west side of the lake. Large pot-holes.

"On Monday morning the return journey to Lake Winnipeg was begun down the Berens River. Just below a little rapid with a drop of thirty inches, at the west end of Long Lake, is a granite hill, on the south-east side of which, facing up the river, is a group of seven large pot-holes, besides several smaller ones. The most perfect is thirty-three inches in diameter and ten feet deep, with the top of the rim eight feet above the water at its base, or five feet and a half above the water of Long Lake. Some of the others have been partly cut away, and the smooth rock faces are strongly scored by glacial marking, showing that the pot-holes are of pre-glacial or inter-glacial age, when the water flowed in a direction more or less opposite to the course of the present river.

"A short distance below Pot-hole Portage, a small sluggish brook flows into Berens River from the north. This brook was ascended to a little shallow lake, almost choked with luxuriant beds of wild rice. Near the east end of this lakelet, we entered a small crooked brook which winds through marsh and willow swamp for about three miles to a rocky barrier eight feet high, over which the water flows in its higher stages earlier in the season. Crossing this rock by a portage fifty yards long, we begin the descent of what is now the Etow'-imā'-mi River. At the next portage, the water runs in a rill a few inches in width. The narrow, winding, but constantly increasing stream was then descended for about thirteen miles, between banks of rock and light gray pebbly till, to a series of heavy rapids, just below which is a well-defined sandy terrace, marking the highest shore-line of the glacial Lake Agassiz seen on the east side of Lake Winnipeg, and the eastern limit of the lacustral deposits. This limit had been determined on several of the other streams flowing into the lake, but nowhere was it so distinctly marked as here. Below this sandy terrace, the Etow'-imā'-mi River.

Manitoba and Keewatin—*Cont.*

river was followed downward for two days, between wooded banks of stratified lacustral sand and clay, to the point where it empties into Berens River seven miles above its mouth. The rocky bosses seen here and there were everywhere of uniform granite and granitoid gneiss.

Blood River.

At the mouth of Berens River, the sail-boat was sold to Mr. William Flett, and we proceeded southward in our canoe to the mouth of Miskowow or Blood River, where an Indian was engaged to accompany us up the river. The ascent of the stream was begun on September 28th. Miskowow River, near its mouth, averages from forty to fifty yards in width, with water of a slight brownish tinge but not dark-brown like most of the other rivers east of Lake Winnipeg, indicating that it is derived chiefly from lakes of considerable size, in which the water has been cleared of its dark colouring matter. The banks are not very high, but are usually rocky, and the water often seems to flow in a preëxisting rocky channel. Between the rocky knolls and ridges, the blue, stratified, lacustral clay that is seen everywhere in the lower country east of Lake Winnipeg, forms well-defined level land, thickly wooded with white poplar, while the rocky knolls are thickly wooded with Banksian pine and oak.

"At the fourth portage up the river, three pot-holes, similar to those on Berens River, occur on the summit and south-west side of a granite knoll, and further up the river, above the ninth portage, and about half-way between the mouths of Mine'go and Little Miskowow rivers, a large pot-hole has been bored in the steep eastern side of a granite hill, the surface of which is now strongly scored by glacial markings. the river was ascended to Kowtinagan (or perch-dish) Lake, and then descended again for a short distance and the north branch ascended to Sasaginigak Lake, an irregular body of clear water lying in the midst of low hills of gray granite. From this lake there is said to be an easy canoe-route northward to Grand Rapids on Berens River.

Return to Selkirk.

"After the survey of this lake was completed, the river was again descended to Lake Winnipeg, which was reached on the 4th of October. On the following day we were taken on board one of the steamers running on the lake and carried to Selkirk, where we arrived on the evening of October 6th, just as a heavy snowstorm set in. The canoe and outfit were stored at the Government fish-hatchery, the men were paid off, and on Tuesday, October 8th, I started for Winnipeg and the east.

General character of country.

"The country explored was found to be almost entirely underlain by granites and granitoid gneisses of Laurentian type. A very interesting feature is the occurrence over a very large area, of massive granites characterized by plagioclase felspars. These granites and gneisses are generally overlain by stratified clays and silts up to a height of about a hundred and fifty feet above the present level of Lake Winnipeg. Much of this area will undoubtedly prove to be excellent farming land, more especially since the nearness of the great body of water in Lake Winnipeg will largely prevent the occurrence of summer frosts. Much of the timber that once covered the country has, unfortunately, been destroyed by forest fires, but there is still some excellent white spruce on the banks of Gunisao River." Manitoba and Keewatin—*Cont.*

ONTARIO.

(With adjacent parts of Quebec.)

Work by Mr. McInnes.

Mr. W. McInnes, after writing a preliminary report on the Lake Nepigon region, explored the previous season, devoted the winter of 1894–95 to getting together the materials for a report on the region covered by the Shebandowan and Seine River sheets, of the series of geological maps now being prepared of Western Algoma. For the geological colouring of a large part of the last-mentioned sheet, the notes and specimens collected by the late W. H. C. Smith, who had the work in hand at the time of his death, had to be carefully gone over, and the report on this section must to a certain extent be based upon these.

On May 24th, or as early in the season as appeared practicable, Mr. McInnes proceeded to the Rainy River and Thunder Bay districts of Ontario, for the purpose of continuing work upon the map-sheets above mentioned, and in other neighbouring areas, to which much attention has lately been attracted in connection with gold mining. He was assisted, as in former years, by Mr. W. Lawson, who attended to a great part of the surveying work. The following preliminary report on the results obtained is given by Mr. McInnes :—

Region east of Rainy Lake.

"The early part of the season, until the 10th of July, was spent in the region lying to the east of Rainy Lake. Calm or Nonwatin Lake, on the lower part of the Seine River, was first visited, and the country about it geologically examined for the purpose principally of defining more closely the Keewatin (Huronian) areas in that region. With this object in view, the smaller lakes and streams in the vicinity were surveyed, and additional information was gained of the distribution of the gold-bearing Keewatin rocks. This information has been incorporated in the geological map, of which a preliminary edition has since been published.

Ontario—*Cont.*

"With the same object in view, a track-survey was made of the Little Turtle River to Dovetail Lake and thence to the Seine River. Many gold locations have been taken up in the district, particularly in the region lying immediately to the east of Bad Vermilion Lake, which is included in the Rainy Lake geological sheet, already published. In this neighbourhood two stamp-mills have been erected, but attention was wisely being directed chiefly to sinking on the properties to prove the extent and value of the veins. At Harold Lake, a five-stamp mill was in operation, and the owners report satisfactory results in free gold, with promise of further profits from treatment of the tailings, for the handling of which they are not yet provided with machinery. Development work was being carried on upon a number of veins on this property.

Stamp-mills.

Manitou region.

"The Manitou region was then visited, and surveys were made there which occupied the time until early in September. The eastern shores of Manitou Lake and a number of small lakes adjoining were first surveyed. Rocks of the Keewatin were found to occupy the whole of the immediate shores of the lake, consisting of green chloritic and other schists with areas of massive diorites, etc. A great thickness of conglomerates and agglomerates, with a schistose, felspathic matrix and well-rounded pebbles of quartzite, felsite, banded chert, impure magnetite, quartz and occasionally of gneiss, occupies the eastern shore of of the main lake from Beaver Narrows to the head. Irregular belts of the same conglomerates are interbedded with the schists on many of the islands in the lake. Near the north end of the lake, the gneisses approach within a mile of the eastern shore, trending away from the shore southwards, being distant about four miles opposite the Narrows and approaching the lake again to within two miles opposite Sand Point. A route from Manitou Lake southerly to Rainy Lake by way of Crooked and Round lakes was then surveyed. The north-east branch of Kahopskikamak River was ascended to its headwaters, and surveys made of Eagle Rock, Narrow and Small Trout lakes. Hornblende gneisses were found to occur all along this route. This is the gneiss area above referred to, which comes close to the eastern shore of Manitou Lake near the head.

"A route was next surveyed west of Manitou Lake, from Pipestone Lake northward through Yoke, Route, Arm, Lawrence, Hill and Rowan lakes and back to Pipestone by Bass Lake and a number of smaller lakes. The Keewatin area of Crow and Pipestone lakes was found to extend northwards to the western arms of Lawrence Lake. Rowan and Hill lakes were found to lie entirely within this Keewatin belt. The biotite-gneiss belt which approaches the western shore of

Manitou Lake, occupies almost the whole of the shores of Lawrence Lake, the contact trending north-easterly near its western end. Ontario—*Cont.*

"The remainder of the season was devoted to sheet No. 9 (Lake Shebandowan sheet), where surveys were made of short routes north and south-east of Dog Lake, for the purpose of adding to the topographical details of that region and of gaining a closer knowledge of the structure of the gneisses which occur everywhere about Dog Lake

Surveys on Shebandowan sheet.

"Short trips were made by Mr. Lawson from Buda, Kaministiquia, Murillo, and Kakabeka stations, and the line of the Canadian Pacific railway was examined between Carlstad and English River.

"The gold in the region explored seems to be confined, or at least its occurrence in commercial quantities, to the belts of Keewatin (Huronian) rocks, which, with many minor deflections and diverging arms, extend eastward and north-eastward in broad bands inclosed in the Laurentian gneiss. The areas of these rocks open to the prospector, though limited on the United States side to the southern margin of Rainy Lake, are very extensive on the Canadian side of the boundary, extending from Rainy Lake easterly through the districts of Rainy River and Thunder Bay. The occurrence of gold throughout this whole area is now established, and during the past season a discovery of promise was made in rocks of the same class at Jack-fish Bay on the north shore of Lake Superior. The greater part of the actual development and mining work, has been so far confined to the region lying about Bad Vermilion Lake, near the mouth of the Seine River, where the first finds were made on the Canadian side. In this neighbourhood, almost all the land lying between Shoal and Bad Vermilion lakes has been taken up in gold locations. Two mills have been erected in this area, at Hillyer's and at Weigand's, and testing shafts have been sunk on a number of the properties. Work in this direction is still going on and the prospects for the establishment of permanent mines seem good.

Gold mining in progress.

"At Rainy Lake, two mills of ten stamps have been built on the United States side, one at the Little American Mine on the outlet of Back Bay and the other at the Lyle Mine on Dryweed Island just south of the boundary line. Neither of these mills were being worked at the time of my visit, but the power was being used for operating drills in the shafts. At the Lyle, a shaft was down 75 feet at that time. It was sunk in a belt of quartz-schist, chloritic and sericitic in layers, and with irregular, small veins, stringers and lenses of quartz, the whole pretty thoroughly impregnated with iron-pyrites and stated to carry gold in good quantity. Nearly opposite, on the Canadian side, a small amount of work had been done on Sand Point Island, on a well

Mines and mills near Rainy Lake.

Ontario—*Cont.*

mineralized vein about four feet in thickness, in chloritic schist, cut by a dyke or mass of diorite. The vein was not traced on the strike for any distance.

"The Little Canada, on a small island near by, is a contact deposit, where a coarse diabase with blebs of opalescent quartz cuts chloritic schists. Stringers and lenses of quartz occur near the contact and the general mass of the rock for several feet is well impregnated with iron-and copper-pyrites. Assays giving good returns in gold are reported by the owners of these properties.

Prospecting on Seine River.

"Prospecting work has extended for some distance up the Seine River, though only in a rambling sort of way, indeed the immediate shores of Rainy Lake and the lower Seine River, with the area already referred to about Bad Vermilion Lake, are the only areas which have yet been gone over with any thoroughness. In the vicinity of Sturgeon Falls, on the Seine River, a number of properties have been taken up, as well as further on at Nonwatin or Calm Lake and in the region surrounding it. On most of these properties some preliminary stripping work has been done. Still further to the eastward, prospecting work of an even more scattered character has been carried on, and gold properties have been taken up as far in that direction, on the Seine River belt, as Star Island and Partridge Lake.

"On an arm of this Keewatin belt, stretching north-easterly towards the Canadian Pacific railway and reaching it at Carlstad station, properties have also been taken up at Lynx Falls and Saw-bill Lake, lying to the east of Clearwater Lake. These properties show free gold, and good assays have been obtained from surface specimens. Only preliminary surface stripping has been done on them.

Huronian mine and vicinity.

"On another belt of similar Keewatin rocks, further to the east and south, and separated from the Seine River belt by a band of gneiss about ten miles in width, is situated the Huronian mine and neighbouring properties on the same vein. This was equipped with the necessary buildings and machinery, but operations have been suspended since 1885. Following the opening up of the Huronian mine, upwards of one hundred gold locations were taken up on the belt extending north-easterly from the mine, along the strike of the schists and along both shores of Upper Lake Shebandowan. With the exception of the Huronian, little work has been done on any of the properties recorded at that time. Recently renewed attention has been given to this area, and gold properties have been located as far east as Gold Brook, a tributary of the Matawin River.

"In the region about the easterly end of Rainy Lake and extending up the Seine River, more than five hundred locations had been taken up. Ontario—*Cont.*

Iron ores.

"Though extensive deposits of magnetic iron-ore of high percentage have been recorded along the Atikokan River, beyond testing with the diamond drill and some preliminary stripping, no mining work has been done.

"Further east, south of Finmark station on the Canadian Pacific railway and near the Matawin River, are other deposits of iron, which have been stripped and tested pretty thoroughly by the diamond drill, but although the deposits are promising enough, actual mining has not yet begun. Further deposits of iron have been located at various points along the different Keewatin belts, but nowhere else has any considerable work been accomplished.

General distribution of gold.

"The occurrence of gold has now been established over practically the whole district lying between Lake of the Woods and Lake Superior, confined, however, as far as our present experience goes, to the belts of Keewatin (Huronian) rocks. It occurs throughout these belts in impregnations of bands of the country rock, in parallel sets of bedded or interfoliated segregation veins, and in well-defined fissure-veins which cut the containing rocks without regard to the direction of their foliation. Any of these forms of occurrence might under proper conditions constitute good paying properties.

"The discovery during the past summer of a gold-bearing vein which promises well, at Jack-fish Bay, on the north shore of Lake Superior, is interesting, as it occurs in rocks which we believe to be practically a continuation of those of the district under consideration."

Work by Mr. Ingall.

Mr. E. D. Ingall spent a considerable part of the summer in the investigation in the field of the deposits of iron-ores in the country traversed by the Kingston and Pembroke railway. The circumstances under which this work was taken up have already been explained. In company with Mr. Ingall, I visited Kingston for the purpose of conferring with the gentlemen interesting themselves in the initiation of iron-smelting in that vicinity. We then together visited some of the best known mines, and subsequently Mr. Ingall (on August 13th) began a more detailed examination of the points already visited, as well as of many other known deposits of ore, which was continued until October 28th. On the work accomplished, Mr. Ingall reports as follows:—

Questions to be answered.

"The main questions upon which it was desired to obtain further information were as follows:—

Ontario—*Cont.*

"The quantity of available ore from immediately accessible localities?

"The quality of the same?

"The first question, for its solution requires a correct understanding of the nature of the deposits of the district, and, therefore, of their reliability as to continuity in length, depth and thickness. This is more particularly the case owing to there being no mines at present working from which to judge of the behaviour of the deposits in depth. At a number of places extensive openings have been made, but work has been discontinued throughout the district for several years, and, the excavations being now filled with water, nothing but the surface features remain available for the study of the question.

"It is thus evident that, using the term 'ore in sight' in its proper sense, at none of the places visited were the conditions such as to allow of measurements being made of the cubic contents, and therefore of the tonnage of any block of ore, unless one assumed or imagined, at least one of the three dimensions necessary to be ascertained. At some places there was found to be a stock-pile of ore selected from the material mined; but, apart from that, the question of available ore becomes one of judging, in a general way, the possibilities of the supply from deposits already discovered and worked, and of the probability of discovering yet other deposits throughout the district in the future.

Ore deposits visited.

"In order to form an opinion on these points, visits were made to as many as possible of the reported deposits of iron-ore, to the number of over forty, where, besides examining all openings, measuring all ore exposures and collecting illustrative specimens, both of area and rocks, surface surveys were in many places made, as well as readings with the dip-needle. The points visited, including many reported hæmatite occurrences, were as follows:—The Bluff Point and Calabogie mines of the Calabogie Mining Company; the Coe Mine; the Martel, or Wilson; the Culhane; the Williams or Black Bay, and the Lerond mines, all in Bagot township, and within a radius of three miles of Madawaska station on the Kingston and Pembroke railway; the Radenhurst and Caldwell properties in Lavant township and near Flower station, and in the same township the Wilbur mine; the Robertson and Mary mines near Mississippi station in Palmerston township, all situated near the line of the Kingston and Pembroke railway north of Sharbot Lake. Between this point and Kingston, the mines of the Zanesville group were visited, namely, the Zanesville or Glendower mine; the Howe mine and the Black Lake mine. Of the district tributary to Kingston, by way of the Rideau Canal, time only permitted visits to the two chief places, viz., the Chaffey and Yankee mines near Newboro'.

Frontenac county.

"In the south-western corner of Lanark county, the mines visited were the old Foley mine openings with those adjacent to it, and several reported hæmatite occurrences in Bathurst township. In Dalhousie township visits were made to the old Playfair hæmatite mine and to a number of reported indications of the same mineral in that vicinity, as well as to one on the eastern shore of Dalhousie Lake.

Ontario—*Cont.*

Lanark county.

"In the township of South Sherbrooke, the mines visited were the Christie's Lake; the Bygrove; the Fournier (with the adjacent Allen mine in North Crosby); the Silver Lake and others near Christie's Lake, whilst near Maberly on the Canadian Pacific railway, in the northern part of the township, examination was made of the range of properties, taken up for iron, extending from near the station westward to the property of Mr. Rudd in Ose township. Although somewhat distant from the present railway communications, a trip was made to the Yuill mine near the eastern end of White Lake in Darling township. The above, together with reported hæmatite occurrences in Storrington township on Dog Lake, which connects with the waters of the Rideau canal, on Birch Lake in Bedford township, and some other points of lesser importance, constitute the examples it was found possible to visit in the time at disposal.

South Sherbrooke.

"The geology of this part of Ontario has already been reported upon by the Geological Survey. In the Geology of Canada, 1863, and in the Reports of Progress for 1870-71, 1871-72, 1872-73 and 1874-75 particulars will be found of the results of the investigations made by former officers of the staff.

"In a general way the rocks of the district can be described as a series of schistose and gneissic beds with interspersed belts of crystalline limestones, which latter often persist for miles. The schistose rocks may be roughly classed as micaceous and hornblendic, whilst more basic rocks, probably dioritic in nature, are also frequent. A definite opinion as to the relationships of these more basic rocks to the rest of the series could not of course be based upon the present work, so that nothing further can be said as to whether they are merely basic members of the series or intrusive masses in it. The series seems to have a very general dip southward over the parts visited, often at quite low angles. To the south it is overlain unconformably by the basal beds of the Cambro-Silurian formation, represented by the basal conglomerates and false-bedded sandstones of the Potsdam with the overlying limestones at Kingston.

Rocks of the region examined.

"Although the ores mined in this district so far, have been almost altogether magnetites, in the past the Dalhousie or Playfair mine

Ontario—*Cont.*

shipped hæmatite for several years, and at many points in the district similar ore is reported as occurring, although it has nowhere else been developed to any extent.

Nature of ore-deposits.

"*Magnetite.* It would be premature to pass any final opinion upon the exact nature of the deposits, previous to the thorough examination and working out of the specimens and other data collected, but in speaking of the district in general and its probable future ore-producing capacity, a correct judgment could not be formed if one ignored the fact that the deposits are irregular in their nature. It would seem as if, so far, this feature had hardly been recognized sufficiently, and thus we find most observers in the past assuming that the ore occurs in beds and therefrom erroneously inferring the continuity of the ore-bodies between widely separated outcrops, and in some cases forming thus most exaggerated estimates of the amount of ore which could be taken as proved to exist.

Erroneous ideas concerning these.

"Then also in using the dip-needle, this same error would appear to have been frequent. If, for instance, on a given run of rock or direction across country, a few high dip-readings were obtained in a distance of several miles, it would be assumed as proved that a continuous bed of ore exists, only requiring sinking on it to open it up for extraction. In travelling through the country it was pointed out, that by so using the dip-needle comparatively little can be proved when, as in most cases, the observations have not been taken sufficiently close together to justify definite conclusions. Also, that all such conclusions must be modified and interpreted in the light of knowledge acquired by a study of the worked deposits of the nature and habits of the same. For example, it was found that many of the worked deposits consisted of masses of magnetite in compact, dark, basic (dioritic?) rocks, and many of the dips-readings obtained where no outcrops of ore showed were along the strike of similar basic members of the series, leaving one, in the absence of anything to the contrary, to fairly conclude that these isolated dip-readings might be taken as showing the existence of separated masses of magnetite of greater or less extent, rather than of a continuous bed of ore.

"Another feature which has led to misapprehension in many cases, has been the prevalence of outcroppings of rusty rock which have quite generally been taken as indicating the existence of iron-ore below. As a matter of fact, the colour of these rusty parts seems to be almost always due to the decomposition of pyrites plentifully disseminated through the rock.

Aggregate importance.

"Whilst, however, all these points must be taken into account in judging individual deposits, the wide-spread occurrences of ore-bodies throughout the district as a whole, and the great likelihood of further discovery leading to a large addition to the list of deposits already known, would seem to assure its future as an ore-producer for any smelter of reasonable size that might be erected; just as in the case of the phosphate mining district of the Rivière du Lièvre in Quebec, where, whilst the deposits of that mineral show similar irregularity, the output of the district was considerable and steady for over seventeen years and ceased only because of low prices and in no way because of any failure with regard to its capabilities for yielding the mineral.

Ontario—*Cont.*

"Speaking still of the magnetite deposits, their mode of occurrence may be briefly summarized as follows:—

Classes of magnetite deposits.

"The chief worked deposits may be classified under three heads, viz.:—First, ore-bodies occurring at the actual contacts of belts of crystalline limestone with the harder gneissic and schistose members of the series. Second, ore-bodies where the magnetite occurs in ribs, or impregnating schistose or gneissic belts, in most of which cases limestone is either absent from the vicinity altogether or only occurs at some little distance from the ore-body. Third, ore-bodies occurring entirely in areas of basic rocks, very much after the manner of the apatite deposits of Ottawa county, Quebec, where these are found in the pyroxenites.

"In the first and second classes, there is a tendency for the ore-bodies to follow along the strike of the formation, either entirely isolated from each other or separated by intervening stretches of rocks either free from magnetite or too poor to pay for extraction. In the third case, the ore shows in detached, irregular occurrences, the rocks being, as at some points opened, reticulated by numerous veins, seams, &c., of magnetite, showing at times vuggy or drusy cavities with crystals of calcite, hornblende and other minerals. The magnetite will thus vary in its occurrence from places where there is a considerable admixture of foreign matter to those where the ore is in considerable mass and comparatively free from admixture.

"Where the ore occurs in the schistose rocks, the magnetite frequently shows as detached grains plentifully disseminated through the substance of the schist, varying in proportion between the extremes of a magnetite-bearing schist, and ore with a small intermixture of bisilicate minerals. In places, in immediate association with the ore, a chloritic schist occurs which probably results from the local alteration of the materials of the inclosing schistose rocks.

Mining developments

"The developments made in the district in the way of proving the deposits, have been comparatively shallow in most instances, being

Ontario—*Cont.*

limited to depths under 100 feet; although, in a few cases, by pits and diamond-drill holes the ore has been proved to a depth of 300 feet. Longitudinally, the distance between the extremes of any range of pits would come well within 2000 feet for the most extensive mine in the district, whilst in most instances the known extent in length of any string of ore bodies is covered by a few hundred feet, and frequently the whole development consists of one more or less circular pit.

"As to the width of the ore-deposits, it is extremely variable, even in the more regular belt-like masses. At the same mine it is found to vary from one or two feet to thirty or forty feet; whilst, with regard to the more irregular deposits in the basic rocks, it would be impossible to actually say which dimension of the pit to take as width. At Robertsville, the large pit has surface dimensions of 40x60 feet, with a reported depth of 250 feet, and at the old Chaffey mine are three large pits, separated only by narrow walls of rock, which are said to be about fifty feet deep and would measure, in the case of the two larger, fifty feet by one hundred and fifty feet, and for the smaller about thirty feet by one hundred and fifty feet. At the Yuill mine, is a pit about one hundred by thirty feet, reported sixty feet deep, and this, with the two previous examples, will illustrate the dimensions of some of the largest of the irregular ore-bodies of the district. It is stated that the Robertsville mine shipped over 60,000 tons, which further indicates the size attained by such ore-bodies, and as it is stated that the three diamond-drill holes put down on the hanging-wall side here, went through twenty feet of ore at a depth of 550 feet, the body of ore evidently extends a considerable distance below where work was abandoned.

Characte of the ores.

"The magnetite ore of this district presents the following features. The shipping ore of course represents the best as selected from the general run of the ore mined, and is in general pretty free from sulphur as far as visible pyrites is concerned. The various piles of ore also, with very few exceptions, showed no visible apatite. Beyond this no further statement can be made as to the percentage of sulphur and phosphorus which might be expected in the ores of the district taken as a whole and in large shipments, short of spending considerable time and money in really sampling large piles. That the percentage of these deleterious ingredients does not prevent the use of these ores in the blast furnace under proper conditions, is evidenced by the fact that as long as the prices permitted their exportation, the United States smelters were quite willing to buy and use them.

"The ore-bodies do carry pyrite and often in considerable quantity, but in most cases in such a way that the pyritous parts can be rejected by hand picking. At some points visited, however, the pyrite was so finely and evenly distributed throughout the ore as to render its elimination by this simple process impossible, and this has also been found to be the case in portions of some of the larger and better known deposits which have elsewhere yielded large quantities of clean shipping ore. Ontario—*Cont.*

"In some cases, nearly the whole of the material taken out has been shipping ore, as evidenced by the smallness of the waste-pile relatively to the size of the excavation, though in most instances the amount of waste has been considerable. In the case especially of some of the isolated occurrences in the basic rocks, apatite occurs associated with the ore.

"As shown by the ore-piles, the foreign matter which would have to be dealt with in smelting would be mostly of a fusible nature, consisting of hornblendic, micaceous, and chloritic material distributed through the mass, as well as in the seams in the ore. Calcite is also a common ingredient, with more rarely quartz. These minerals by proper selection should make a good slagging mixture.

"In grain, the ores at different points show varying characters. Those of the ore-bodies in the basic areas are apt to show a peculiarly vitreous fracture, vuggy structure, and interferent crystalline aggregation of the magnetite; whilst at other points the structure of the ore is schistose, platy or granular, with a coarse or finely crystalline cross-fracture.

Ore in stock.

"The ore already mined and available, is represented by the stock-piles at some fifteen places, and amounts to about 17,000 tons. It is stated that in the past the total shipments from this district have amounted to some 220,000 tons of magnetite, to which must be added about 30,000 tons from the Dalhousie and McNab hæmatite deposits.

Analyses of ores.

"The available analyses of these ores are those of hand specimens, which cannot be taken as representing the actual composition or character of bulk lots, such as can be shipped. The examination made of the ore-piles of the district showed a visible admixture of foreign materials, already mentioned, of from five to fifteen per cent, estimated by the eye. This would, of course, bring down the theoretical percentage of iron in magnetite (72·37 per cent) to from 60 to 65 per cent.

"A table has been prepared of the several analyses of the ores of the district, made at various times in the laboratory of the Geological Survey and published in the Reports. This it is proposed to publish in connection with a more detailed account of the mines, together with

Ontario—
Cont.

such additional analyses as may be made of specimens recently collected. Meanwhile, the following general statement, based upon the existing information, may be given :—

"Of the 31 determinations of metallic iron, 22 were of magnetites and 9 of hæmatites, the average of the former being 59·20 per cent, of the latter 59·58 per cent. Of the 15 determinations of phosphorus in the ore, the proportions in 10 magnetites varied from a trace to 0·110, whilst in one specimen small crystals of apatite were visible to the eye, although the proportion of phosphorus was not actually determined in this case. In 5 hæmatites, the phosphorus ranged from 0·010 to 0·235 per cent.

"In 9 magnetites the sulphur ranged from a trace to 1·75 per cent, while in 5 examples of hæmatite it ranged from 0·004 to 0·070 per cent.

"Titanic acid was looked for in two of the hæmatites, but not found. Of 21 magnetites examined for this substance, 11 were free from it, in four other cases it ranged from 1·03 to 5·92 per cent, whilst in the ore from the Yankee and Chaffey mines, it was found in four analyses to range between 5·70 and 16·45 per cent.

General character of ores.

"Thus it may be stated that, in so far as these analyses represent the general character of the ores, the percentage of phosphorus is low, the sulphur is in some cases rather high, while the titanium, with a few exceptions, is inconsiderable in amount. Should it be found advantageous in some cases to do so, the amount of sulphur might no doubt be reduced by roasting.

"It will be observed that the percentage of titanium is high in some cases, but where it is in large proportion, as at the Chaffey and Yankee mines, it is only what one would expect of such irregular bunches of ore in a coarse diabase rock.

"In the absence of determinations based on carefully sampled lots representing large quantities of the ore, it is not possible accurately to determine what proportions of phosphorous, sulphur or titanium would have to be dealt with in furnace charges, or to what extent it might be advantageous to mix these with other ores. The ores of the district have been used already by managers of smelters in the United States, presumably in this way, and lately also the Drummondville smelter in Quebec has purchased these ores for admixture with their own bog ores.

Improvement in steel-making methods.

"The constant improvement in methods of smelting in late years, has of course rendered it possible to utilize more impure ores than formerly, and even in making the best grades of steel a much lower grade of pig can be used. In this connection it may be useful to quote an article by Mr. H. H. Campbell, on 'Open Hearth Work at Steelton,' in The *Mineral Industry* for 1893, p. 378.* Ontario—*Cont.*

"Speaking of the large open-hearth furnaces, with tilting hearths in use there, with either basic or acid lining, he says:—

"'The ability to remove the slag in such a furnace renders possible the use of an impure stock [pig], and charges have been successfully handled which contained 0·28 per cent sulphur, whilst others have had 3 per cent of phosphorus. For the most common work it may suffice if the phosphorus and sulphur are both brought below 0·10 per cent; but this by no means represents the regular practice. The charges in the basic furnaces generally average from 0·25 to 0·50 per cent in phosphorus and from 0·07 to 0·12 in sulphur. This is reduced to a content of from 0·005 to 0·04 phosphorus, according to requirements, and from 0·015 to 0·06 sulphur in the steel.

"'The large steel castings are made from one of these tilting furnaces, and by careful selection acid metal of 0·015 phosphorus has been produced. The smaller castings are made from a five-ton acid furnace and contain from 0·025 to 0·04 per cent phosphorus. This pure metal gives steel which will compare with the products of any of the celebrated foreign manufactories.'

"*Hæmatite.*—A number of points were examined where deposits of hæmatite were reported to occur, with a view to ascertaining the possibilities of obtaining supplies of this class of ore. Apart, however, from the old Dalhousie or Playfair mine in Dalhousie township, nothing was seen that could be properly described as a hæmatite deposit. In some cases the only indications consisted of pieces of hæmatite, either lean or rich, ploughed up in fields; at others, an ochreous impregnation of the rocks or soil had led to the belief that the prevalence of so much rusty material must indicate the existence of solid hæmatite in depth. In every case, however, a little investigation of the surroundings would demonstrate the connection of the phenomena with the occurrence of outlying patches of the Potsdam sandstone. Where this formation showed distinctly, it would appear as if the supposed hæmatite deposits consisted of shattered portions of the sandstone, the spaces between the broken pieces being filled up with loose ochreous oxide of iron, which had also percolated in and filled the interstices between the grains of the sandstone, thus giving the whole a very rusty appearance. In places, specimens could be obtained of the Hæmatite ores.

* *The Mineral Industry* for 1893, by R. P. Rothwell, Scientific Publishing Company, New York.

Ontario—*Cont.*

solid hæmatite; but these, judging from all the appearances, probably owe their condition to a further consolidation of the original loose ochreous form of the oxide. This action, however, at the points studied, has only gone on to a limited extent, nor did it seem likely at any of these points that any large quantity of the richer and more solid material would be obtained. The bulk of the material wherever seen, consisted of sandstone impregnated or stained with ochreous oxide of iron to a greater or less extent, constituting at best a very lean ore.

Hæmatite reported in many places.

"It was found impossible, in the time at disposal, to visit all the reported occurrences of hæmatite, but in most cases, from the description given, it is evident that they are similar to those noted. In the report of the Ontario Mineral Commission, pages 128 to 142, many such places are mentioned, and at one place, viz., Tamworth, a number of shallow pits were put down which proved the superficial nature of the deposit, and that it was underlain by crystalline limestone. The quality of the ore here is stated to have varied also from rich to quite lean.

"The Geological Survey called attention years ago to similar occurrences in the Potsdam at other places, as will be seen by referring to the Geology of Canada, pages 88 and 89, and the dolomitic nature of this formation in places was also alluded to.

"Taking everything into account, it may be assumed that the phenomena observed are the result of the decomposition of ferruginous dolomitic parts of the Potsdam sandstone, with the formation of ochreous oxides of iron and further consolidation of the same in spots into the hæmatitic form, the lean ores consisting of adjacent portions of the sandstone impregnated with the ochreous decomposition product.

"In a few cases, the ore was found apparently passing down into the underlying Archæan rocks, but evidently to a limited depth only and in such a way as to lead to the belief that, these cases resulted from percolation downwards from the overlying rocks into joint-planes and cavities.

Character of the Dalhousie deposit.

"Of those visited, the Dalhousie mine is the only one having any features of a continuous ore-body, for there the ore was followed down into the crystalline limestone to a depth of 100 feet. Ore was taken out for a length of about 500 feet, with an average width of perhaps 10 feet, although it is stated that the ore-body was very irregular, often thinning down very suddenly to two feet or less. The details of this deposit are well shown in the plan of the mine accompanying Mr.

Vennor's description in the Report of Progress of the Geological Survey for 1872-73, pp. 176-77.* Ontario—*Cont.*

"When visited this summer, it was found that the limestone walls had caved in so as to fill the excavation nearly to the top with débris. The ground being free from cover, however, the surface characteristics of the ore-body can be clearly made out. The surrounding area shows frequent outcroppings of rock, which is seen to be crystalline limestone all round. A close examination for some distance in both directions on the run of the ore-body, showed that it did not extend much beyond the present workings, as far as outcropping at the surface is concerned. The extension of the strike of the ore-body westward, would be along the northern bank of the Mississippi River, and for a distance of about a quarter of a mile, considerable trenching and stripping has been done with a view to tracing its continuity, but without success. In most cases no signs of ore seem to have been found, although at two places some ore was obtained, varying in quality from lean ochreous sandstone to rich and solid lumps of hæmatite. From the appearance of the material and the features presented, these would seem to be simply ferruginous outlying patches of the base of the Potsdam, resting as already described, upon the denuded surface of the Archæan rocks.

Hæmatite filling cavities in limestone.

"The interesting point about the Playfair mine proper, lies in its being a body of ore extending downward for a known depth of 100 feet into the crystalline limestone. It is suggested, however, that it simply represents ferruginous material leached out from the originally-overlying Potsdam sandstones, deposited in a waterworn cavern in the underlying limestone. This view is borne out by several features observed on the spot, and is shown in the plan and sections of the mine already alluded to, viz., the irregular shape of the ore-body; the fact of its continuing eastward underground without out-cropping, being in fact entirely over-arched by limestone; the smooth bounding surface between the ore and the limestone; the tendency of the body to show a general lens-shape and to thin out gradually in depth. This thinning out in depth is also mentioned as a feature of the Arnprior deposit in McNab township which occurs similarly in crystalline limestone.†

"The yield of the Dalhousie mine from the commencement of work to 1873 was about 15,000 tons of ore.

*In reproducing this illustration in the report of the Ontario Mineral Commission, p. 139, figures 21 and 22, the scale as there reduced, has been erroneously given as 600 feet to the inch instead of 200 feet, as it should be, which makes the length of vein developed appear longer than it really is.

†Report of Progress, Geol. Surv. Can., 1873-74, p. 212.

Ontario—*Cont.*

McNab mine.

"From the published description of the McNab mine already alluded to, it would seem to be very similar to the Dalhousie mine. It is said to have been worked to a depth of about 80 feet, when, according to one account it thinned out and according to another it was cut off by a fault.

Bog ores.

"*Bog Ores.*—No deposits of bog-iron ores were visited, but the existence of these ores is reported at a number of places in the district.

Means of transport.

"*Communications, etc.*—In studying the subject of the available supply of ore for a possible smelter at Kingston, it becomes a question as to what district may be fairly taken as tributary to that centre. With its lake communications ores might undoubtedly be brought from afar, but the scope of this inquiry was understood to be confined to the possibilities of the immediately surrounding district. With the present railway and canal communications, this would probably include the counties of Frontenac, Lanark and Leeds with adjacent portions of Carleton and Renfrew counties. The Kingston and Pembroke railway would be the main feeder, connecting as it does with most of the chief mines, but other deposits would be reached by means of its connections with the Canadian Pacific railway at Sharbot Lake and Pembroke and with the Ottawa and Parry Sound railway, as well as by the Ottawa and Kingston canal. In fact, the means of communication of the district are very good to the north and east, and, were it necessary, ore could undoubtedly be also drawn from the deposits in Hastings, Peterborough and Haliburton counties to the west.

"The question of the local facilities for and of the cost of smelting, as well as the question of the marketing of the product, need not be here dealt with, as it is understood that those interested have thoroughly satisfied themselves on these points.

Summary of conditions.

"*Summary.*—Reviewing the results obtained by the investigation and having in view the answering of the questions propounded, the conclusions arrived as may be stated as follows :—

"There seems no reason to doubt the possibilities of the district in the matter of supplying ore for a smelter of the size contemplated (viz. 100 tons per day), providing exploratory and development work is kept well ahead of the actual work of extraction of the ore, for although the ore-deposits are irregular in their nature, yet the occurrences already known are numerous, and doubtless many others would be located by explorers were a demand to arise for the ore.

"Apart, however, from the general chances, as above set forth, and the 16,000 to 17,000 tons in the stock-piles of the district, the question of ore immediately available must remain in abeyance, as naturally no measurement of 'ore in sight' could be made with all the mines abandoned and full of water. The ore supply would be almost entirely magnetite, with possibly some hæmatite or bog ore. In the magnetite, careful selection would probably be necessary, in the case of some of the deposits, to keep the proportion of sulphur and phosphorus low." Ontario—*Cont.*

Work by Mr. Barlow.

The first part of the year, before the commencement of field operations, was occupied by Mr. A. E. Barlow in plotting the surveys of the previous season and procuring such topographical details as were deemed necessary for the completion of the Nipissing sheet (No. 131, of the Ontario series). Much time was likewise consumed in studying the geological results obtained, while considerable progress was made in writing an accompanying report. In connection with Mr. Ferrier, various petrographical studies were undertaken, which proved of material assistance in the more accurate delineation of the various rock formations exposed in the region under examination. The permanent labelling of the large suite of rock specimens obtained, also occupied some time. The map of the area above named has been completed and is now in the hands of the engravers.

As it was considered advisable to continue the work of previous years on the Temiscaming sheet (No. 138 of the Ontario series), Mr. Barlow was instructed to secure such additional topographical and geological information as seemed essential for a map and report of an approximately final character, covering this district. This sheet adjoins the Nipissing sheet to the north, while its south-western corner abuts on the north-east corner of the Sudbury sheet, already published. The map will include nearly the whole of Lakes Temiscaming and des Quinzes, with the northern portions of Lakes Keepawa and Temagami. All information necessary for this sheet has been collected, and it is hoped to finish the compilation of both map and report during the present winter. In regard to the summer's exploration, Mr. Barlow reports as follows :—

Surveys on the Temiscaming sheet.

"I left Ottawa for the field on the 31st of May last, and was joined in Mattawa by Mr. A. A. Cole, B.A. Sc., of Montreal, who had been appointed as my assistant for the whole of the season's work. Mr. Cole's previous experience in the field-work of the survey, when acting as assistant to be Mr. A. P. Low and Dr. Adams, better fitted him for the work he was called upon to perform, while his zeal did much to advance the objects of the exploration.

"By the kindness of Mr. Colin Rankin, of the Hudson's Bay Company, Fort Temiscaming, an abandoned post belonging to this com-

Ontario—*Cont.*

pany, was again made our headquarters for the season. The month of June was taken up in detailed micrometer surveys and geological examinations of Whitefish, Turner, Nonwakamnig, Wakaimika and Muskananing (Lady Evelyn) lakes, in the north-western corner of the sheet, connection being thus made between my survey of Temagami Lake, of 1887, and the Montreal River, which had been surveyed with chain and transit in 1868 by Mr. A. Forrest, P.L.S., of the Crown Lands Department of Ontario. A survey was likewise performed of the route via Mud and Sharp lakes to Lake Temiscaming at Haileybury, as well as of a number of smaller lakes in this neighbourhood. During July, similar measurements, accompanied by a geological examination, were made from Aminipissing Lake via Breeches and Mountain lakes to White-bear Lake, including Thieving Bear and Net lakes. These surveys were continued, and included a chain of lakes which fall into Net Lake, the largest of which is known to the Indians as Waibikaiginaising (rib lake), and which extend to within a short distance of Bay Lake (on the Montreal River). The latter part of July and the first week of August were spent in examinations and surveys of Obascong, Friday and other smaller lakes which empty into the north-eastern bay of White-bear Lake, and of Bear Lake, a narrow sheet of water six miles in length, which flows into the Matabitchouan River below Rabbit Chute. The remainder of August was employed in a geological investigation of the shores and islands of Obabica and Wawiagama lakes, situated to the west of Lake Temagami, and while thus engaged, Mr. Cole was busy making surveys of some lakes to the west of Rabbit Lake.

"This examination being completed, a trip was made through Temagami, Nonwakaming and Lady Evelyn lakes, and the Montreal River was followed as far as Round Lake, the shores and country in the immediate vicinity of this river being closely examined to its mouth, on Lake Temiscaming. During July, Mr. Cole made a survey of all the roads in the townships of Duhamel, Guigues and Laverlochère, on the east or Quebec side of Lake Temiscaming.

Boundaries of Huronian rocks.

"The boundaries between the conglomerates, slates and quartzites, which here constitute the Huronian system, were traced out, as well as the more important line of junction between these Huronian strata and the various granites and gneisses. Great care was taken in the delimitation of the diabases, gabbros and other basic eruptives, which rocks had been found to contain the nickeliferous pyrrhotite and chalcopyrite in the Sudbury district, to the south-west.

Ore deposits.

Extensive deposits of these sulphides were noticed in 1887 and 1888 on the east side of Temagami Island and on the south-east shore of Vermilion Lake to the north of the north-east arm of Temagami Lake. The deposits of argentiferous galena at the Mattawapika (outlet of Lady Evelyn Lake) and at Wright's Mine, Lake Temiscaming, have already been noticed in previous reports. In view of the intention to publish the report covering these explorations at an early date, it is unnecessary to go into further details regarding the geological features." Ontario—*Cont.*

Work on Haliburton sheet.

The work in connection with the above sheet was completed on August 27th, when Mr. Barlow returned to Ottawa to obtain certain maps and other information necessary for the continuation of the geological and topographical survey of the Haliburton sheet (No. 118 Ontario series). Work in this region was commenced by Dr. F. D Adams, in 1892, by the examination of certain mineral deposits which had attracted considerable attention, and which were situated in the townships of Digby, Dalton, Lutterworth, Somerville and Galway.

A preliminary report in connection with these examinations, accompanied by a brief summary of therock formations encountered in a general geological reconnaissance of most of the areacovered by this sheet, has already appeared.* The position of sheet 118 is there described as "situated to the north of Lake Ontario and south of the River Ottawa, in the counties of Victoria, Peterborough and Hastings. In order to describe its position more accurately, it may be stated that the four corners of the sheet lie in the townships of Digby, Finlayson, Hagarty and Grimsthorpe." The work commenced in 1892 was continued by Dr. Adams for only a few weeks in 1893, when, owing to lack of funds, further work in this district was postponed. Two weeks only in the first part of September were occupied by Mr. Barlow in work properly belonging to this sheet. Owing to the difficulty in fixing the exact latitude and longitude of the map, it was thought expedient to run a tie-line from Gelert, on the Victoria division of the Grand Trunk railway, in the south-western part of the sheet, to Waubaushene, on Georgian Bay, the position of which has been accurately determined by the Hydrographical Survey. This tie-line was run with great care by Mr. James White, chief draughtsman of this department, and it is believed will suffice for the purpose for which it was intended. It is hoped that the work thus begun will be resumed early next year, as it is sure to prove of great interest.

Mr. Barlow returned to Ottawa on October 1st.

---

*Annual Report, Geol. Surv. Can., vol. VI. (N. S.), part J.

Ontario—*Cont.*

Work by Dr. Ells.

From the beginning of the year 1895, until exploratory work was resumed in the field in the early summer, Dr. R. W. Ells was occupied with the preparation of map-sheets Nos. 121 and 122, extending along the Ottawa Valley from Rigaud Mountain to the Petewawa, and in compiling the notes of surveys by himself and other observers for an explanatory report upon these sheets. His field-work of the year was principally directed to the completion of the same sheets, but it was considered advisable that some part of the time should be given to the completion and revision of data for the geological mapping of the south-west sheet of the "Eastern Townships" map, shortly to be be published. Dr. Ells makes the following preliminary report of the results of his examinations, which extended from May 25th to September 23rd :—

"The field-work of 1895, was principally devoted to the mapping of the Laurentian and overlying formations found on both sides of the Ottawa in the counties of Renfrew and Pontiac. In September, a revision of the area east of the St. Lawrence, including the Phillipsburg and Stanbridge districts, was made. A careful examination of the islands of Montreal and Jesus and of the country along the Lower Ottawa, was also undertaken, in order to ascertain, if possible, the thickness of the several Palæozoic formations in this vicinity, from the Calciferous upward, which might serve as a guide to any subsequent boring operations in the Ottawa and St. Lawrence river valleys.

Examinations in Renfrew and Pontiac.

"Specimens illustrating the many varieties of the crytalline rocks of the Laurentian were collected, not only of the stratified gneiss and limestones, but also of the several kinds of intrusions which are found throughout the entire Laurentian area. Collections were also made of the crystalline dolomites and schists of the Hastings series, for the purpose of study ; the exact position of this division of crystalline rocks not having yet been definitely settled.

"The occurrence of Palæozoic rocks, ranging from the Potsdam sandstone to the top of the Utica formation, was noted at a number of points throughout the area. Their distribution was mapped as carefully as the heavy mantle of drift would permit. In some places, these newer formations were found to be extensive, while in others they are represented by but small patches resting in depressions of the older crystalline rocks.

Post-Archæan granitic intrusions.

"The Laurentian gneiss and limestone, were found to be penetrated at many points by masses of granite, generally reddish, with syenites, diorites and occasionally trappean rocks. Much of the granite is of the binary variety, composed chiefly of white felspar and quartz, similar to that found so frequently in the Grenville series. That some of the intrusions are comparatively recent, is evident from their action not only on the Laurentian limestones and associated gneiss, which they have penetrated and altered at many points, but also from their relations to the beds of the Calciferous, which at several points have also been broken up by dioritic dykes, apparently projections from the great crystalline series. This peculiarity of some of these intrusives was also noted last year in Nepean township, near Ottawa, where the granites penetrate the Potsdam sandstone. Ontario—*Cont.*

Cambro-Silurian areas.

"The Potsdam sandstone was not seen west of the township of Fitzroy, the Calciferous, westward of this, being the oldest of the Palæozoic formations observed. On Allumette Island, the limestone of this formation is well exposed, on the western end, but is overlain eastward by the sandstones and shales of the Chazy which pass upward through the calcareous part of that formation into the highly fossiliferous beds of the Black River limestone at Paquette's Rapid, near the lower end of the island.

"Inland, to the south, the Chazy and lower part of the Trenton formation have a considerable development in the valley of the Bonnechere, at Eganville, whence they extend eastward to Douglas village. The flat-lying limestones occur for some distance on both sides of that river. Another outlier extends from the east side of Lake Dove eastward to Mink Lake, and thence spreads over the flat area between Douglas and Cobden; while yet another considerable area occurs on the lower west half of Muskrat Lake, which is discharged by the Muskrat River at Pembroke. Along this stream the Chazy beds also show, capped in Stafford township by highly fossiliferous strata of Black River age. A small outcrop of Chazy is again seen in a cutting on the Ottawa and Parry Sound railway, about three miles west of Killaloo station, while on Clear Lake, to the south, the Trenton and Utica beds are exposed at the south-west corner. From these a collection of the characteristic fossils of the Utica formation was made by Mr. W. J. Wilson.

"The western limit of our surveys on the south side of the Ottawa, extended from the vicinity of Golden Lake and the township of Brudenell, northward to a point about seven miles west of the mouth of the Petawawa. The southern limit of the sheet extends from near Arnprior westward past Renfrew and Clear Lake in Sebastopol, though our surveys during the past season extended for some distance further south, in order to connect with previous surveys on the Madawaska by Mr. James White.

Ontario—*Cont.*

Surveys north of Ottawa River.

"On the north side of the Ottawa, the work extended westward to the sharp bend at the foot of the Deep River in the township of Sheen, which marks the most westerly of the settlements on the Quebec side. Traverses were made of all roads in the townships of Sheen, Chichester and along the Black and Coulonge rivers for nearly twenty miles, the country being exceedingly hilly and rough. The crystalline limestones and associated rusty quartzitic gneiss, were found to have a considerable development along the Black River, a broad band of the limestone extending for a long way up the valley of the stream with a general strike of a few degrees west of north. The most westerly observed outcrop of the crystalline limestone and of rusty gneiss on the north side of the Ottawa, was about two miles west of the bridge on the post-road over the Black River, the rocks to the west of this being mostly gneiss and intrusive granite, with syenite and diorite.

Crystalline limestones.

"The relations of the cystalline limestone and its associated quartzose, rusty and often garnetiferous gneiss, to the great masses of the lower reddish gneiss or foliated granitic rock are clear, and confirm the conclusions stated in earlier reports, that the oldest known rock of the Archæan is a foliated granite-gneiss, upon which the more regularly stratified gneisses rest. Whether there is here a direct conformity between these two series, or whether they are distinct and unconformable, cannot be definitely ascertained till all the surveys of the areas in question are plotted and mapped. When this is done, and the masses of clearly intrusive newer granite and syenite have also been separated, it is hoped some conclusive data as to structure will be obtained which will facilitate future work among these crystalline rocks.

Limestone conglomerates.

"It is interesting to note the occurrence of unmistakable limestone conglomerates in the Laurentian crystalline rocks of the Grenville series in Renfrew county. These were seen at several widely separated points, as in the township of Westmeath, along the Rocher Fendu channel of the Ottawa, in the townships of Bromley and Stafford, in Sebastopol, and along the Opeongo road. In these conglomerates, which rest upon the rusty gneiss are pebbles of garnetiferous, hornblendic and reddish gneiss, quartzite and rusty gneiss, well rounded and water-worn. The grayish quartzose gneiss, in the lower part of the calcareous series, presents all the aspects of an altered quartzose sandstone, and the whole series at these places looks like a succession of altered sediments.

Hastings series.

"The Hastings series, as seen about Calabogie Lake and on the line of the Kingston and Pembroke railway, as well as generally throughout the townships of Horton, Bagot and MacNab, consists of a very considerable development of hornblende-schist and diorite, dolomitic limestone and mica-schist, portions of which are garnetiferous. They are cut by masses of granite and syenite, generally reddish in colour. Around Calabogie Lake and at other places, the hornblende-schist overlies directly the rusty gneiss and limestone of the Laurentian or Grenville series. So far as I have yet ascertained, there does not appear to be any decided break between the rusty gneiss and limestone, and the hornblende-schist and dolomite series, but further work in this direction is necessary to settle the relations of these rocks.

Ontario—*Cont.*

Economic minerals

"Some of the reddish syenite and granite rocks associated with the last, and exposed along the line of the Kingston and Pembroke railway between Renfrew and Calabogie, would furnish beautiful building stones. They would take a fine polish, and can probably be obtained in large blocks.

"Other minerals of economic value were not observed in workable quantity at any point throughout the area included in the season's work, with the exception of the iron deposits near Calabogie Lake. West of Douglas, dykes of pyroxene occur, which carry small quantities of pyrites and mica, with irregular quartz-veins of small size. Shell marl is found in several lakes in considerable quantity and should be of economic importance. Perhaps the most extensive of these deposits is in Mink Lake, Wilberforce township, Renfrew Co. Other lakes holding marl were found in Westmeath, and Ross, in Ontario, and in Masham and Upper Wakefield, west of the Gatineau River.

"Very considerable areas of crystalline limestone occur throughout the counties of Renfrew and Pontiac, some of which constitute useful marbles. Of these, the quarries near Portage du Fort were referred to in last year's summary. At Renfrew, extensive quarries exist, which furnish an excellent quality of stone, both for building and for burning, very similar to the stone from the Arnprior quarries. A new deposit of snow-white marble has been opened up on lot 19, concession 6, Ross, on the property of Mr. Chas. Bilson. This is a beautiful stone, highly crystalline, and yields large blocks for monumental or decorative work.

"A deposit of graphite has recently been exploited to some extent near the Madawaska, in the township of Brougham. The pieces already obtained show the vein to be of considerable size, but the locality was not visited by me.

Glacial geology.

"Observations on the glacial geology were made throughout the area. The direction of the striæ was taken at many points on both sides of the Ottawa River, and the course was found to vary from S. 60°

Ontario—*Cont.*

E. or S. 70° E. on the north side, to S. 40° W. in the south-west part of Renfrew county, south of the Ottawa. Along the Ottawa itself, the direction of these ice-markings generally follows the course of the stream, and the movements of the ice seem to have been affected by the local conditions of the surface.

"Kames and deposits of morainic matter occur frequently, with old shore-lines of well-rounded stones. A prominent feature of the surface geology over much of the area, is the distribution of sand and clay. These deposits have a wide extent, and while marine shells are but rarely found, the character of the clays is undoubtedly marine, the presence of organisms at a few widely scattered points, clearly establishing their mode of deposition. They are overlain by extensive sand deposits, especially in the area to the west and south of Pembroke, and in places these are clearly interstratified with the clay. Deposits of Saxicava sand also occur, containing abundance of marine forms.

"During the last part of June and the first half of July, Mr. W. J. Wilson accompanied me and obtained important facts pertaining to the glacial geology of Renfrew county."

Quebec.

(With adjacent parts of Ontario.)

Work by Mr. Giroux.

In the office, since the date of the last Summary Report, Mr. N. J. Giroux was employed principally upon the completion of the north-west sheet of the "Eastern Townships" map.

During the summer, Mr. Giroux has been occupied with field-work, chiefly in the area of sheet No. 120 of the Ontario series of geological maps. This comprises the counties of Grenville, Dundas, Stormont, Glengarry and portions of the counties of Carleton, Russell and Prescott, in the province of Ontario, as well as the counties of Huntingdon, Soulanges and part of Vaudreuil, in the province of Quebec.

The general geological structure of this region had been ascertained very early in the history of the Geological Survey, but questions connected with economic problems such as water supply, building materials, &c., now render it desirable that a more detailed and accurate map should be prepared.

Wells bored at Alexandria.

Mr. Giroux was in the first instance instructed to visit the town of Alexandria, for the purpose of ascertaining, as far as possible, the geological conditions there, in connection with a well then being sunk for water. The well was found to be on the northern bank of the Garry River, a branch of River Delisle, where ledges of grayish fossiliferous Trenton limestone occur, holding crystals of clear white calcite and small partings of black, shiny, very friable shale. These beds lie apparently flat, and extend but a short distance along the stream on which they outcrop. From the information obtained on the spot by Mr. Giroux, combined with that resulting from a careful examination of the samples of drillings received from the well by Dr. H. M. Ami, the subjoined section is drawn up. Quebec—*Cont.*

Depth.	Character of rock.	Formation represented, and thickness.
Feet.		
0	Dark gray impure limestone, holding fossils, among which can be recognized the following: *Rafinesquina alternata*, Emmons; also fragments of what appear to be *Plectambonites sericea*, Sowerby; *Strophomena* cf. *S. incurvata*, Shep.; *Zygospira*, sp.; *Escharopora*, sp.; and *Helopora* or	
470	*Arthroclema*	*Trenton*, 470 feet or more.
	Dark gray impure limestone, softer than preced-	*Black River*, 100 feet
570	ing. No fossils detected......................	(assumed thickness).
	Dark gray impure limestone, underlain by greenish-gray calcareo-arenaceous shales—at times fine-grained, at others coarse and more highly arenaceous. Obscure fossil remains detected in the	
755	upper calcareous beds	*Chazy*, 185 feet.
	Hard, compact, dark, chocolate-coloured limestone, probably magnesian; no fossil remains ob-	
786	served.......................................	*Calciferous*, 31 ft. or more.

At 730 feet, in the Chazy, a porous bed about one foot thick was met with, yielding strongly saline and bitter water. More water of the same character was found in the last twenty-five feet, and the undertaking was abandoned at 790 feet.

A specimen of the saline water from the Chazy formation, above noted, was subjected to a qualitative examination in the laboratory of the Survey, and was found to contain a very large quantity of chlorides (sodium and calcium); a rather small quantity of sulphates (magnesia); and a somewhat large quantity of carbonates (lime).

Mr. Giroux writes: "There was altogether but very little water got in this boring, the water standing at about fifteen feet from the surface when the drill was in the hole, and when taken out of it the water would drop down to 100 feet below the surface. Another test was made, not very far from the station, to a depth of about 350 feet, with as little success as on Garry River." Saline water.

Quebec—*Cont.* Surveys on area of sheet 120.

Of his general field-work for the season, Mr. Giroux gives the following account:—"On the 6th of June I began to survey roads in order to locate as accurately as possible all the rock-exposures, since in a district like this, imperfectly mapped, and so extensively covered with drift, the new roads, and those not much used, generally afforded more exposures than the main roads.

"In order to obtain a general idea of the geological structure, a few sections were made north and south from the River St. Lawrence to the Ottawa River, as well as several east and west, across part of the area to be examined. Starting from Glen Robertson, the road northwardly was surveyed as far as L'Orignal, thence back to St. Isidore de Prescott in a south-westerly direction, and down to Maxville and across Glengarry county to the River St. Lawrence. A very few exposures of Calciferous and Chazy rocks were, however, alone met with. I then surveyed the St. Lawrence shore-road from River Beaudette to Morrisburg, but without finding a single rock-exposure. From this last mentioned village I went as far as Embrun, crossing the township of Dundas and part of Carleton in a south-westerly direction, and from Embrun I travelled eastwardly to Glen Robertson and back to River Beaudette, having seen rocks of the Chazy, Trenton and Utica in this last circuit.

"By making these sections, a district was outlined including part of Soulanges county, almost all Glengarry, all Stormont, half of Dundas, and parts of Carleton, Russell and Prescott counties, forming an area of about 675 square miles, in which roads were surveyed until the 25th of June. Five days were then spent in ascending River Beaudette, in a canoe, as far as Glen Nevis, a distance of about fourteen miles, then descending the River Delisle, and going thence to St. Polycarpe, without seeing any rocks *in situ*. The low state of the water in these streams, compelled us to drag the canoe over sand, gravel and mud banks about half the distance.

Surveys south-east of Lake St. Peter.

"Early in August, the water being then very low in all the streams, an examination was made of the south-east part of the north-west sheet of the 'Eastern Townships' map, as included in your instructions. Leaving Valleyfield on August the 5th, I drove down to St. François du Lac in order to examine the small area attributed to the Medina, to the north-east of St. Francis River, south of Lake St. Peter. All the roads in this district were traversed, but no rocks were found *in situ*, even in the small brooks which ran in rather deep, irregular, clayey ravines. A number of wells have been dug in and about the village of St. Elphège, which is situated in the gore of Upton, and although these are ten to fifteen feet deep, no solid rock was met with in any of them. Quebec—*Cont.*

"The larger Medina area to the east of the last, extends from the south-west branch of Nicolet River to the north-east, haing a width of about three miles on the north-east branch of the Nicolet River, with a maximum width of seven miles, and running about four miles north-east of the Becancour River. The red shales and sandstone forming this area can be seen in many places, and where not visible, the soil has a marked reddish-brown colour, and is, therefore, very different to the soil derived from the Hudson River rocks, which is gray. A paced survey of part of the north-east branch of the Nicolet River was made, in order to locate on that stream, an anticline in the Hudson River formation. These Hudson River rocks are much twisted, altered and faulted on both sides of the above anticline, and more particularly to the south of it. The disturbance has very probably been caused at the same time as the fault between the Hudson River and the Sillery, which Dr. Ells observed on the Becancour River in 1388. Silurian rocks.

"Rev. Mr. Proulx, director of the Nicolet college, is sinking a well just behind that institution in search of gas, the find made in Beauséjour some years ago at about seven or eight miles from Nicolet village, being the only indication which prompted the above named gentleman to make this trial. No gas has yet been found, although the hole was 1100 feet deep when I was there last, and the record kept gives, in descending order :—120 feet of clay, 10 feet of sand, 970 feet of Hudson River shales, with possibly Utica shales at the base. Boring at Nicolet

"On the 17th of August I returned to Vaudreuil, and from that date to the 21st of October, with the exception of a few days spent with Dr. Ells near Montreal and St. Johns, P. Q., continued work in the area of sheet No. 120, chiefly in the eastern half of that sheet. Return to sheet 120.

"The vicinity of Rigaud Mountain was examined, and the Potsdam sandstones of Como and Hudson, which crop out at about one mile southward of Ste. Anne de Prescott and can be traced for a considerable distance in the direction of St. Redemption village. A hill of this rock to the north-west of Ste. Marthe, extends towards Ste. Justine de Newton in the county of Soulanges. The formation also appears on the shore of the St. Lawrence about nine miles east of Côteau du Lac church and extends thence to the Cascades at the lower entrance to the Soulanges canal. In the eastern and southern part of Huntingdon county, the Potsdam was in part outlined. Potsdam sandstone.

"East of the Potsdam appears the Calciferous, first at the mouth of River Delisle, on the St. Lawrence River, where a quarry has been Calciferous.

Quebec—*Cont.*

opened to furnish material for the construction of the Soulanges canal. It also occurs a short distance east of the Canada Atlantic railway, in the canal excavation, as well as at the Canada Atlantic railway bridge, where ledges of limestone were struck at 30 feet below the actual surface. Rocks of this age appear at Glen Nevis on River Beaudette, in Glengarry county, as well as at Glen Sandfield, in the same county. North of Winchester and at a short distance from Ormond are ledges of brownish-weathering, fine, gray limestone with a greenish hue which very probably belong to the Calciferous formation. To the south of the St. Lawrence, impure limestone of Calciferous age outcrops in a few places in the county of Huntingdon.

Chazy.

"The bluish-black, brittle Chazy limestone, has been, and is still quarried, in several places in the district examined, but apart from these openings but few exposures belonging to this formation could be seen. The characteristic green Chazy shales of the vicinity of Ottawa, have not been met with *in situ*, and débris of the same were seen in one place only. Near Glen Robertson station, there are two quarries in very dark, bluish-gray or blackish Chazy limestone. It is very brittle and hard, contains iron-pyrites in places and holds many brillant specks consisting of small crystals of calcite. At about one mile and a half from Glen Robertson station, there is another quarry in dark bluish-gray or blackish limestone of the same age, thick-bedded, and somewhat more concretionary than that at the above station. This limestone is not as good for building purposes as that of the quarries nearer Glen Robertson station; it has in many places a rough, pitted weathered surface and holds fossils amongst which are fine sections of *Pleurotomaria*. At about four miles and a half north of Cornwall station, there is also a small quarry in blackish, brittle, heavy-bedded and jointed limestone; it has a rough weathering which exhibits in many places a coarse net-work, the meshes being of brownish colour. It holds small inclusions of calcite as well as iron-pyrites finely distributed in thin bands.

Trenton.

"Though my surveys are not yet all plotted, I can safely say that the Trenton formation has a greater extent than any of the others in the eastern part of sheet 120. Limestones belonging to this formation have been seen in many places, among which the following may be particularly noted:—At about one mile and a half south of Vankleek Hill, there is a small quarry in fine, gray, very brittle and bituminous Trenton limestone, with partings filled with bituminous matter and joints coated with white crystallized calcite. The beds here are somewhat folded. At one mile south-east of St. Isidore, in Prescott County, hard, gray limestone contains many crinoid stems and other well preserved fossils. On the Nation River at Casselman, limestone occurs, very probably of Trenton age. Not very far from Apple Hill station, on the Canadian Pacific railway, in Glengarry county, are ledges of gray fossiliferous Trenton limestone, and a little over one mile to the north-west of these ledges, is a quarry in bluish-gray Trenton limestone, in beds varying from one to three feet in thickness. This limestone is very fine and compact in some bands and fossiliferous in others; it is much jointed, one set of joints being perpendicular to the other. The beds are concretionary in places and separated by thin shaly partings. At about three-quarters of a mile north-east of Lochiel post-office, in Glengarry county, are ledges of gray fossiliferous Trenton limestone containing corals. At Crysler, in the northern part of Stormont county, the beds and banks of the Nation River, for about 350 to 400 feet below the bridge, and up to the dam, about one-quarter of a mile from the bridge, consist of gray, thin-bedded Trenton limestone. The limestones of this formation dip at low angles in various directions, and the non-continuity of exposures renders it almost impossible to determine their thickness. Quebec—Ont.

"A small basin of Utica rocks occurs about Maxville on the Canada Atlantic railway; débris of black shales belonging to this formation having been seen in half a dozen places in the neighbourhood of this village. On Mr. M. J. Fisher's property, lot 2, range 6, of the township of Roxborough in Stormont county, these black shales holding *Trilobites*, *Orthoceras*, *Lingula*, &c., form the bed of a small brook for some distance, not far from, and to the south of, the Canada Atlantic railway. These shales appear to lie horizontally. I am told that the same shales were met with in many places about Maxville in digging wells, at depths of 20 to 23 feet. Whether this small area is the continuation of the one to the east of the city of Ottawa, has not yet been ascertained. Utica.

"As a rule, the rocks in this district show glacial striæ comparatively seldom, and these vary considerably in direction from place to place. Courses were in fact observed ranging between S. 41° E. and S. 40° W. Marine shells such as *Macoma fragilis*, *Macoma calcarea*, *Saxicava rugrosa*, &c., have been found in many places in the counties of Soulanges, Glengarry and Stormont, and near Côteau du Lac church, in the excavation of the Soulanges canal, at twenty-two feet below surface, was found a fossil skeleton of the white whale or white porpoise (*Delphinapterus catodon*) but unfortunately only one of the vertebræ could be preserved, as all the rest of the bones fell to pieces. Glacial deposits.

Quebec—*Cont.*

"Fine boulders of labradorite were seen in a couple of places in the county of Glengarry. On the road from Alexandria to Glen Robertson, one of these boulders was blasted, and exhibits large crystals of beautiful iridescent labradorite.

Bog-iron.

"Bog-iron ore, is found in small quantity in the sand-hills of Vaudreuil county, and the same mineral occurs on lot 2, range 6, of Roxborough township, in Stormont county, on a small hill, a short distance to the south of the exposure of black Utica shale.

"In regard to water supply, the following notes may be given:—

Water supply.

"On River Beaudette, at about three-quarters of a mile north of the Grand Trunk railway, is a fine spring of good water. An analysis of this water has been published.* Near the hotel in Maxville, there are two wells very close to one another; the water from one of them is very good, while the other is highly sulphurous.

"Some years ago, a well was sunk in search of oil at a short distance from Bainsville, in Glengarry county. The depth is given at 760 feet, but no oil was found. Excellent water, however, flows continually from this well, to about three feet above the surface, the flow being much greater in the spring than during the summer. In the village of Maxville there is another flowing well, twenty-two feet deep only, which furnishes good water in small quantity. At about one mile east of River Beaudette, to the north of the main road to Côteau Landing, is another flowing well which is about seventy feet deep and gives excellent water. One mile further east, along the St. Thomas concession-road running northward, and between the St. Lawrence shore-road and the Grand Trunk railway, are two more very good flowing wells fifty-five to sixty feet deep only.

Peat.

"There are several peat bogs in this district, which, I think, could be worked profitably. That to the south of the St. Lawrence, in the county of Huntingdon, crossed by the road from Port Lewis to Huntingdon village, has been already worked some years ago and presents many advantages for exploitation.

"Good building material as well as numerous and thick deposits of clays very suitable for brick making are of frequent occurrence.

"During the season I surveyed 1249 miles of roads and rivers, viz., 1242 miles of roads by wheel and seven miles of rivers by pacing."

Work by Dr. Bell.

During the winter months, Dr. R. Bell was engaged in elaborating the results of his field-work on sheets No. 129 and 128, and preparing

*Annual Report, Geol. Surv. Can., vol. I. (N.S.), p. 12 M.

local geological maps to be used in laying down the details of the geology of the region from the Sudbury sheet to the eastern shore of Lake Superior, for publication on a scale of four miles to one inch, as soon as these two sheets shall have been compiled upon a proper projection. Some further progress was also made towards the completion of the Manitoulin sheet, No. 126. Quebec—*Cont.*

Previous survey in Upper Ottawa region.

In 1887, as recorded in the Summary Report for that year, Dr. Bell was engaged in the geological exploration of the Upper Ottawa River, and in the course of this work, the late Mr. A. S. Cochrane (one of Dr. Bell's assistants at that time) under his directions crossed the watershed to the north of Grand Lake and followed a chain of lakes and river leading northward to Shabogamog Lake. This lake, which proved to be about thirty miles in length, was also surveyed, and the river discharging from it was followed for a further distance of some ten miles, making in all about seventy miles in a straight line from Grand Lake. The existence of an important belt of Huronian rocks was ascertained by Mr. Cochrane, but its limits, as well as the further course of the river, which at this time was supposed to flow into Hannah Bay, remained indeterminate. The river flowing from Shabagamog Lake, evidently, however, offered a route of some kind which has hitherto remained practically unknown, geographically and geologically, from the head-waters of the Ottawa to James Bay. Dr. Bell, having been requested to make a preliminary examination of the country in question, decided to follow the route indicated. He successfully descended and surveyed the whole length of the river, which proved to be the main branch of the Nottaway or Noddawai, discharging in Rupert Bay. Dr. Bell gives the following account of this interesting exploration :—

Party and route.

"My party consisted of my assistant, Mr. Alexander Barclay, five Indians from the Maniwaki Reserve, and Théophile Michaud, a French Canadian voyageur, who had accompnied me during six previous years. I provided myself with two birch-bark canoes, in which we carried our provisions, outfit and everything necessary while making our measurements during the season. By this means, we proceeded very rapidly, otherwise it would have been impossible to make such an extensive topographical survey, together with various explorations, in so short a time.

"In going northward by canoe from Maniwaki, two routes are available, one by the Gatineau River and its tributary the Gens de Terre, and the other by the Désert and its branch the Thomasine. Both are very difficult for loaded canoes. We left Maniwaki village

Quebec—*Cont.*

on the 1st of July, and followed the Désert route to Lac des Rapides. This lake has two outlets, one southward to the Gatineau and the other northward, discharging part of its water into the Upper Ottawa at a place called The Barrière or Dam. From this locality, we followed the Ottawa down-stream, or westward, to Grand Lake.

Previous surveys by Mr. Cochrane.

"Leaving the northern extremity of Twenty-mile Bay, of Grand Lake, by a small brook, we crossed the height-of-land and descended to Shabogamag Lake, (properly, Shibogama, or lake of channels) referred to in connection with Mr. Cochrane's survey of 1887. Mr. Cochrane's map shows every topographical detail, and it was found to be sufficiently accurate for present geological purposes. Mr. Cochrane supposed the river he had been surveying below Shibogama Lake to be one of the branches of a river which ultimately fell into Hannah Bay. This was at that time, and it still is, the opinion of the few Indians who are aware of its existence, and we did not hear of any white man who had ever visited the stream up to that time, although many years ago a part of it may have been used by the Indian voyageurs of the Hudson's Bay Company. In this connection, I may mention that the lower parts of the stream are frequented by only one Indian, and that he came only a few years ago from the Abitibi region. His name is Taibi, and we had the good fortune to meet him at Grand Lake house, when he was on his annual trading trip to that post, and to engage him as guide for the river as far as he might know it. Although this man knew more of this river than any other person, he declared emphatically that it did not discharge into Rupert Bay, but 'somewhere between that bay and Moose River'; but in this he turned out to be quite mistaken. He had obtained his information from other Indians, who were supposed to know the facts.

Map of the Crown Lands Department.

"Before leaving Maniwaki, I had requested and obtained from the Honourable the Commissioner of Crown Lands of Quebec, a tracing of a map by Mr. Henry O'Sullivan, P. L. S., showing the streams to the north-east of Grand Lake and thence northward to Waswanipi Lake. To the north of Grand Lake this map showed the route we were going to follow about thirty miles further than it had been surveyed by Mr. Cochrane in 1887, but without any details, such as were shown with great accuracy on Mr. Cochrane's map; nor had it the notes on soil, timber, etc., which are shown on the map, dated 22nd October, 1895, and published in the report of the Commissioner of Crown Lands, Quebec, for 1895. This was the only information I obtained from the Crown Lands Department in reference to the region explored.

"The existing sketch-maps show a river named Noddawai * entering the head of Rupert Bay and one named Hannah Bay River flowing into the head of the bay of that name. The upward course of both is represented as being south-east, so that the 'Hannah Bay River,' would, if this were correct, intercept the north-flowing river which we were about to descend from the neighbourhood of Grand Lake. Another stream, called West River, is usually represented on the maps as draining Michigami Lake and flowing into Hannah Bay, west of the river of that name. But the stream which drains Michigami Lake is not West River, but one bearing the same name as the lake itself, and it does not flow towards Hannah Bay, but north-eastward into the lower part of the Noddawai, thus crossing, nearly at right-angles, the course assigned to the so-called 'Hannah Bay River.' The stream which enters the head of Hannah Bay is called by the natives Wash-a-how-sipi, or Bay River. It rises to the south-east of Abitibi Lake, and its course lies to the west of Michigami Lake and river.

Quebec—*Cont.*

Drainage as shown by maps.

"The river which we descended was found to fall into the western part of a lake called Mattakami, or Mattagami, lying nearly at right angles to the general course of the stream. The same lake receives the Waswanipi, which is also a large river, from the east. The name Mattagami means 'lake at the meeting of two rivers.' From the north side of this reservoir the Noddawai, as a very large river, flows out with a northerly course of about 100 miles to Rupert Bay.

Course of Noddawai as now ascertained.

"Shibogama Lake, referred to in the report for 1887, is an expansion of the river which we descended to Mattagami Lake. The Migiskun (or fish-hook ?) River flows at right-angles into the east side of this lake, and its source, which is near that of the St. Maurice, is probably further from the sea than that of any of the other branches of the river-system to which it belongs; but the stream which we descended from the height-of-land near Grand Lake, follows the course of what appears to be the central depression, and it also flows through the central part of the area of this river-system. For these and other reasons, the river we followed from the height-of-land to Mattagami Lake may, I believe, properly be considered the trunk stream and the Migiskun a branch. This line

*This word means the Iroquois Indians, or perhaps more exactly, the Mohawk division of these people, in both the Otchipwé and Cree dialects. It is differently spelled by various authorities, but the pronunciation is intended to be nearly the same in all cases. The following are some examples of the spelling:—Noddawai—Admiralty charts of Hudson Bay. Nottaway and Notaway—Most sketch-maps. Nâdowé (Otchipwé for an Iroquoi Indian)—Bishop Baraga's dictionary. Nâtowew (Cree for Iroquois)—Père Lacombe's dictionary. Nahduwa ("Chippewa" for Iroquois, Mohawk)—Revd. E. F. Wilson's dictionary. Natoowâo (Northern Cree for Iroquois)—Revd. E. A. Watkins dictionary. The first of these is adopted in this report.

Quebec—*Cont.*

of depression is continuous with the straight and narrow Twenty-mile bay of Grand Lake. A low sandy tract now separates the waters of the Upper Ottawa from those flowing north, and forms the watershed at the extremity of the bay just mentioned, but at a recent geological period, the waters of the Upper Ottawa probably flowed down the central stream of the drainage area above referred to. The change to the present conditions has probably been due to the relatively greater uplift of the continent to the north than to the south. This former diversion of the waters of the Upper Ottawa to James Bay, was fully described by me in a paper read before the Royal Society of Canada last May, of which abstracts were published in the *Journal of Geology* and the *Scottish Geographical Magazine* for July, 1895.

Hydrographic basin.

"The hydrographic basin drained mostly by the Noddawai River and its branches, appears to be larger than that of the Moose River or that of the Ottawa. The Wash-a-how, or Bay River, to the west and the Broad-back River to the east of the Noddawai may be properly included in this drainage area, which would thus embrace some 70,000 square miles. The basin, like that of the Moose River, is about as broad as it is long, and, as in the case of the former, the waters flow from all sides towards the northern margin. It lies immediately south-east of James Bay, just as the basin of Moose River lies to the south-west of it, and the one basin is a sort of counterpart of the other.

Wide level country.

"The elevation of the low divide between Grand Lake and the waters flowing north, is probably not much, if anything, over 1000 feet above the sea, and, as the surface of the basin under consideration is mostly level, as far as I could observe or ascertain, the greater part of it is probably under this level. The conditions were very similar throughout the entire distance and the country presented the same general appearance all the way from Grand Lake to James Bay. Isolated hills and ridges were to be seen occasionally from the canoe route. I ascended a number of these and in every case obtained a good view of the surrounding country. It always presented an even or slightly undulating aspect, with a hill or ridge here and there. To the west ward of Gull Lake, on the Waswanipi River, the country is more hilly than elsewhere, and a rocky ridge runs along the south side of Mattagami Lake, with one point rising to the height of 670 feet above its level. I was informed by Mr David Baxter, in charge of the Hudson's Bay Company's post at Waswanipi Lake, that along the canoe route from Gull Lake to the Rupert River the country is almost uniformly low and level.

"The immediate banks of both the main river and its branches, are generally low, averaging only from five to fifteen feet, and it is only in places that they exceed thirty feet in height, although the ground usually rises at a short distance back from the water, and often attains an elevation of from 50 to 100 feet, especially below Mattagami Lake. For long distances, the land along the river-margins is very level and the trees grow quite to the water's edge. The higher scarped banks generally expose bouldery till at the bottom, with thinly stratified horizontal brown clay above, but when the banks are lower they show only the brown clay. The solid rock is commonly seen beneath the superficial deposits at the stronger chutes and rapids, and it forms many projecting points in the rivers and lakes. The brown clay appears to be spread over the greater part of the region, as the water of the main river and most of its tributaries is turbid, except that of the Migiskun, Waswanipi and Michigama. It has the same tint as the clay itself, and resembles that of coffee with milk. Marshes of limited extent occur in places along the rivers and around the lakes, but in looking over the country it was only occasionally that swamps could be seen. The slope of the ground and the ramifications of the numerous streams, appear to afford sufficient natural drainage to reach most of the land fit for cultivation.

Quebec—*Cont.* Surface and soil.

"*Timber.*—The white and red pine extend from the southward for a short distance beyond the height-of-land. Banksian pine is found, where suitable conditions exist, as far as Mattagami Lake, but its range towards James Bay is not restricted on account of the latitude, but by some other circumstance, for in a slightly more easterly longitude this tree ranges northward to Great Whale River, a distance of about 450 miles in a straight line from Mattagami Lake. Tamarack or larch, is abundant and of fine growth, but unfortunately most of the trees, throughout the whole distance from Grand Lake to James Bay, have been attacked by the grub of the recently imported larch saw-fly. A certain proportion of the trees have been already killed by this pest, and the remainder will probably die also if its attacks are continued for a year or two longer.*

Trees.

"White spruce is perhaps the most valuable tree of the district explored. It grows to a great size everywhere along the rivers and lakes, and although, as a rule, it may be larger near their banks, where it often girths upwards of six feet, a considerable proportion of the trees inland also attain a good size. In point of numbers

White spruce.

*In 1893 Mr. Low found the tamaracks in the interior of Labrador as far north as the East Main River, all dying from the same cause. Its ravages extend southward to the Gatineau Valley.

Quebec—*Cont.*

of individual trees, the black spruce takes first rank, and a large proportion of them are of a sufficient size for various useful purposes, such as fuel, building, railway-ties and wood for paper-making. Balsam fir grows in perfection, and is abundant throughout the district. White cedar is confined principally to the margins of lakes and rivers. Its northern geographical limit is slightly beyond the region explored, and it becomes scarce as we approach James Bay. White or canoe birch is a thrifty and abundant tree everywhere. Aspen or trembling-leaf poplar is the most common deciduous tree. The balsam poplar was not observed in the southern part of the great river basin, but was plentiful in the northern part. The timber is almost everywhere of mature age, or consists of old second-growths, and it will be of great importance to preserve these extensive forests, as far as possible, against fires, which have wrought such havoc in so many other districts. A few square miles have been destroyed by fire in recent years on the east side of Siskumika Lake, on the Noddawai, but with this exception we noticed only insignificant patches which had been burnt.

Possible agricultural value

"*Climate.*—The greater part of the region under consideration lies between latitudes 48° and 51°, or south of London. While it does not, like Western Europe, enjoy the advantages of an atmosphere warmed by ocean currents, neither does it suffer from the disadvantages of the chilling effect of the Arctic current, like Eastern Labrador. The climate may be considered as normal for the above latitudes. In estimating its probable suitability for agriculture, it may be mentioned that wheat ripens well at Lake St. John, to the eastward, and also, when tried at different times, at New Brunswick House, on the Missinaibi River, and at Newpost, on the Abitibi, to the west, while barley ripens at Rupert's House and Moose Factory, both of which lie to the north of this region. Newpost lies near the western border and to the north of the greater part of the tract in question, but a straight line drawn from it to Lake St. John would pass through the centre of the area.

Flora.

"The flora of the district may naturally be assumed to be identical with that of the adjoining basin of Moose River in the same latitudes. In 1877, I made a tolerably complete collection of the plants of this region, and Professor Macoun, botanist to this department, after carefully identifying the species, said that, judging from this flora, he saw no reason why wheat might not be successfully grown as a crop.

Crops.

"At Waswanipi post, a little to the north-east of the centre of the region, we saw potatoes and a considerable variety of vegetables all doing well, although the soil at that particular spot is very inferior to the average of the district. Timothy and red and white clover, which had been accidently sown at this post, were also thriving. I did not hear of any experiments in grain-growing having been made at this establishment, but it was said that grain of some kind had been raised many years ago by the North-west Company's agents on land close to the present Hudson's Bay Company's post. Quebec—*Cont.*

"Last summer, we found the rainfall excessive. After the beginning of August, more or less rain fell every day, and often it was heavy and continuous for twelve to thirty-six hours. Thunder storms with heavy rain were also frequent. At Moose Factory we were told that the past summer had been the most rainy one in the memory of the present generation. Although the season was probably an exceptionally rainy one in the region we passed through, several circumstances indicate that a copious rainfall is the normal condition in this district. The ground under the dense coniferous forest is everywhere covered by a thick carpet of yellowish-green moss, and in favourable places along the Noddawai River, peat accumulates to a depth of from five to ten feet, and even more. The number of rivers, brooks and streamlets, full of water in the middle of summer, is unusually large, and the total quantity of water discharged into the sea is also great in proportion to the area. The difference in the amount of the discharge at the high- and low-water levels in the main river and its principal branches did not appear to be greater than the proportion of two to one, if so great. The average height at which the trees are barked by the running ice in the spring, is about ten feet. The conditions all over the drainage area are very favourable for holding back the water and thus regulating or equalizing its outflow. Among them may be mentioned the general level character and moderate slope of the whole region, the thousands of natural dams formed by logs and sticks lying across the smaller branches, and especially the thick coating of moss all over the surface, acting as a sponge saturated with water and draining slowly away. Rainfall.

"Again, the quantity of snow and the conditions under which it melts, must be considered in relation to the water supply of these rivers. Snow lying in the shade of the close evergreen forest, does not melt rapidly in the early spring as it does from among the deciduous trees which are leafless at that season, or, as in a cleared or open country, but is very slowly acted upon, and it lasts for about six weeks longer than it would if exposed to the sun. Mr. Baxter, of Waswanipi, informed me that the average depth of snow in the woods (where it does not drift) was considerably more than four feet. Snowfall.

Quebec—*Cont.*

Climatic irregularities in 1895.

"Notwithstanding the unusually wet summer at Moose Factory, the central and western branches of Moose River were lower in September than I had ever before seen them. But the Abitibi, which lies nearest the basin of the Noddawai, appeared to be moderately full when we passed its mouth about the middle of the month. At Moose Factory, we were told that these conditions had prevailed for some time before we started up the river. In connection with this subject, it may be here remarked that Mr. Low this summer experienced very wet weather in southern central Labrador; also that voyageurs on the Rupert River were troubled by frequent and heavy rains. From all the foregoing and other facts, it would appear that a dry summer prevailed to the south and west of the basin of the Noddawai, while there was an unusually wet one in and eastward of that region.

Storm of exceptional character.

"The extraordinary weather which we experienced at the time of the equinoxes may be worth noting here, as our position was far from any meteorological station, except that of Moose Factory. We were in the neighbourhood of 'The Forks' of Moose River, about fifty miles from Moose Factory. A severe thunder storm, with very dark sky and east wind, occupied most of the forenoon of the 20th of September. In the evening, an extraordinarily warm breeze, for that season, set in from the south-west and continued all night. At 9 p.m. the thermometer stood at 73° Far. The 21st was a fine and warm day, followed by rain at night. At our camp on the Missinaibi River, about twenty miles above 'The Forks,' it rained during the whole twenty-four hours of the 22nd, with a dark sky; distinct thunder was heard at times. Lightning and thunder, with heavy rain, continued throughout the night of the 22nd, and at daylight of the 23rd, a great gale sprang up from the south-west. This continued all day, the force increasing and diminishing at intervals. The water of the river drifted like snow, and it was impossible for us to move. We were obliged to place our canoes in the woods to prevent them from being blown away. The living forest trees were blown down in great numbers. Our camp was about 300 feet above sea-level. The barometer stood at 29·07 at 7 a.m. of the 23rd, and had risen to 29·94 at 7 a.m. on the 24th. On our journey south-westward from this place, we found that the trees had been blown over all along our route as far as the Canadian Pacific railway, a distance of more than 200 miles, but the destruction inflicted appeared to diminish gradually in that direction. For long distances, about half of the trees had been blown over, rendering it it almost impossible to force one's way through the woods. In many places, acres of the forest had been prostrated bodily. Previous to this destructive gale, most of the trees which had fallen had had time to rot away, which must have required a period of fifty years or more, so that even if at any previous time they had been thrown down in large numers at once, such an occurrence must have been upwards of fifty years ago.

Quebec—*Cont.*

"*Fauna.*—In the region explored, fur-bearing animals and game of all kinds were scarcer than might have been expected, and this circumstance probably accounts for the small number of Indians in the district. Caribou are found throughout the whole region, but not usually in any great numbers. Moose and Virginia deer are confined to the southern part. Only a few black bears were seen. The common American hare (or 'rabbit') was rather plentiful, but the chickaree or red squirrel was rare, notwithstanding the abundance of its favourite food, the cones of the balsam fir, and the two kinds of spruce.

Fauna.

"The scarcity of ducks is owing partly to the absence of rice, although the conditions for it appear favourable, and it should grow well if introduced. Another reason is the great reduction which has taken place during late years in the number of the water-fowls in general which migrate to James Bay, owing to the drying of the salt marshes, and to their wholesale destruction in their winter resorts.

"Fish are abundant in all the waters. They consist of whitefish, sturgeon, pike, pickerel, gold-eyes, chubs, suckers and dog-fish. Neither speckled nor gray (lake) trout were seen, nor could we hear of their existence in the district, although the former may occur locally in clear cool streams, as in the case of the Upper Ottawa region and the Moose River basin.

"*Geology.*—The rocks along our route from Maniwaki to Grand Lake all belong to the Laurentian series and consist of gneisses with a little crystalline limestone in some places. To the northward of Grand Lake Mr. Cochrane found Huronian rocks, with some gneiss, as far as he went. Gneiss occurs about the outlet of Shibogama Lake, but beyond that, rocks which may, for the most part, be classed as Huronian were found all along our route towards James Bay, till we reached a point about six miles northward of the outlet or the narrows of Mattagami Lake. A considerable proportion of the area, however, consists of granitic rocks, some of which may perhaps, on close investigation, be placed with the Laurentian, while others are probably true intrusives. Granite was almost the only rock observed on Waswanipi River between Gull and Waswanipi lakes. The boundary between the Huronian and Laurentian rocks runs westward from Noddawai River and crosse the north-west bay of Mattagami Lake. From the above-mentioned

Huronian and Laurentian rocks.

Quebec—*Cont.*

point (about six miles northward of the narrows or outlet of Mattagami Lake), gneisses with some granitoid patches and occasional bands of micaceous and hornblende schists were the only rocks met with *in situ* all the way to Rupert's House.

"The Huronian rocks, in the region traversed, have a greater development than we had expected, and this circumstance adds to the prospective economic value of the country, since these rocks are more likely to produce valuable minerals than the Laurentian. Towards the southern side of the Huronian area, the general strike is north and north-north-westward; in the central part it is north-west, and towards the north side west-north-west to west. The rocks consist principally of a variety of schists, such as dioritic, chloritic, hornblendic, and micaceous and also slatey arkose, alternating with massive greenstones intersected by red and gray granites.

"Veins of quartz were frequently seen and some of them contained small quantities of iron- and copper-pyrites. As gold (generally in small quantities) frequently occurs in such veins in similar Huronian rocks elsewhere, it is very probable that it may sooner or later be found in this region also.

Glaciation and surface deposits.

"*Superficial Geology.*—The surface of the crystalline rocks is everywhere thoroughly glaciated. The general course of the striæ is south-south-westward, with local variations, but towards the northern part of the district there is also a newer set of grooves running south-easterly and close to Rupert Bay there were several local sets having other courses. From Grand to Mattagami Lake, the drift materials consisted principally of the débris of the local Huronian rocks, with a certain proportion from the Manitounuck and Devonian rocks of James Bay, the percentage of these latter increasing as we went northward. Beyond Mattagami Lake this percentage became very considerable, the remainder of the materials in that region consisting principally of Laurentian gneiss. The Manitounuck and Devonian drift had probably been first carried to the south-westward from James Bay and afterwards south-eastward when a change had taken place in the direction of the glacial movement. As already mentioned, the horizontally stratified clay in the higher cut-banks along the rivers was seen to be underlain by boulder-clay or till.

"In travelling by water through a densely wooded country like this, very little could be done in the way of observing any terraces or other evidences of former water-margins that may exist in the region. The first proof of the former submergence of the land afforded by fossils, was found only when we came near the head of tide-water, where the clayey banks of the Noddawai are about seventy feet high, and in their upper parts contain the brackish-water varieties of a number of the commoner northern marine mollusca. Quebec—*Cont.*

"Before closing this report, I wish to express my obligations to Mr. Charles Logue, of Maniwaki, and to Messrs. W. K. Broughton, Donald McTavish, David Baxter, Captain Taylor, and other officers of the Hudson's Bay Company whom we met, for assisting me in various ways to carry out the objects of the season's operations."

Work by Mr. Chalmers.

Mr. R. Chalmers was, during the winter of 1894-95, engaged in working up for publication the results of investigations on the Surface Geology of New Brunswick and adjacent provinces, including part of South-western Quebec. His report, covering a portion of the work above indicated and accompanied by five maps, has since been printed.

The field-work of the past summer was chiefly directed to the investigation of the auriferous districts of the province of Quebec, but a short visit was also paid to the salt spring at Saline, King's county, New Brunswick, on which a note is appended (p. 97). Mr. Chalmers reports as follows upon the work carried out :—

Instructions and plan.

"On the 25th of May, I left Ottawa for the Eastern Townships of Quebec to begin field-work there for the season. The object of the work as stated by you in letter of instructions, was to ascertain more precisely than has yet been done, the relations of the alluvial deposits containing gold, (1) to the places of their origin, and (2) to the glacial drift of the region. In pursuance of this object, you further stated, 'it would be necessary to investigate the general character and sequence of all the superficial deposits systematically,' etc.

"In commencing the work thus outlined, it was considered best to examine the deposits in those districts where alluvial gold mining has hitherto been carried on, and where shafts and other excavations have been opened, the facts thus obtained being considered as more likely to elucidate the problems presented for solution. The gold mining operations have been practically confined, (1) to Beauce county, and principally to the valleys of the Chaudière River and its affluents, (2) to the valley of Little Ditton River, township of Ditton, and (3) to Dudswell Mountain, townships of Dudswell and Westbury. For the sake of brevity these will be called, the Chaudière area, the Ditton area and the Dudswell area. Outside of these areas no profitable gold mining has been carried on, although gold is known to occur, as shown by Dr. R. W. Ells,* in the alluviums, as well as in quartz, in a great

*Annual Report, Geol. Surv. Can., vol. II. (N.S.), pp. 51 J–53 J.

Quebec—*Cont.*

number of localities between the international boundary and the range of mountains nearest the St. Lawrence River, known as the north-easterly extension of the Green Mountains.

"In the investigation of the auriferous gravels and other superficial deposits of these three areas, the principal part of the season was spent; but some weeks were devoted to the study of the glacial phenomena of the region, and to the work of tracing the post-glacial shore-lines along the northern slope of the Notre Dame Range.

Chaudière area.

"*Alluvial gold mining in the Chaudière area.*—Of the three gold-producing areas mentioned, the largest and most important is that of the Chaudière. This area has been worked for alluvial gold since 1846, and the total production in that time is said to be of the value of about two million dollars. For some years, however, very little gold mining has been carried on except in a desultory manner, at intervals, with pick, shovel, and rocker or sluice-box, and a number of locations which might be profitably worked are idle. This condition of things is said to be due to several causes:—First, to a lack of the knowledge and skill necessary to successful alluvial gold mining, as pointed out by Dr. Selwyn in his Report on Gold Mining in Nova Scotia and Quebec;* second, to the extravagance with which the mining has been carried on by those who operated on a larger scale than the local miner; and third, to the fact that large portions of the best mining lands are owned by private individuals and companies, who do not work them themselves, but hold these lands at such high values as to place them altogether beyond the reach of the ordinary miner. Other causes might be specified, one of which is said to be the difficulty of securing good titles in some localities. Taking everything into consideration, the gold mining industry in the Chaudière is heavily handicapped, and capital has very naturally shrank from investment there.

Present activity in mining.

The prospects of some revival are, however, becoming noticeable of late, especially in those portions of the area lying outside the De Lery seigniory, while some work has also been carried on in the latter district, especially in Gilbert River valley, by Mr. F. Wadsworth, of the American Gold Mining Co. of Boston, with Samuel Byrne, an old California miner, in charge. On the Du Loup, Mr. E. B. Haycock of Ottawa, who has a three-stamp quartz mill there, has been doing some good work in prospecting for gold-bearing gravels and testing the quartz found in numerous veins in the lower part of that river. Mr. John Blue, manager of the Eustis Mines, Capelton, and his son, have also been prospecting for gold in the alluviums of the Du Loup, with,

*Report of Progress, Geol. Surv. Can., 1870-71, pp. 275-76.

so far as I have been able to learn, encouraging results. Mr. Louis Gendreau, of Jersey Mills, worked at Chaudière falls for several weeks during the past summer, and extracted gold from the gravels there. Sluicing for gold was also carried on at the Devil's Rapids, Chaudière River, for a short time, but I did not learn the result. Late in the autumn, Mr. J. E. Hardman, the well-known Nova Scotia gold miner, began operations at St. George, Beauce county, and at the time of my leaving the field—October 17th—had started a tunnel from the bank of Chaudière up Slate Creek valley, expecting to reach the pre-glacial gold-bearing gravels in the old bed of that stream. Capt. Geo. Macduff, an experienced alluvial miner, was in charge of the work. Quebec—*Cont.*

"*Alluvial gold mining in the Ditton area.*—The Ditton area is another from which a large amount of alluvial gold is reported to have been taken, it is said, to the value of seventy-five thousand dollars or more. The richest deposits were met with in that part of the area known as the Pope mine, lots 39 and 40, range 9, Ditton. For some years, however, little or no mining has been done there except prospecting and testing for gold some of the numerous quartz-veins which occur in this area. That the alluvial gold of the Little Ditton valley is exhausted, does not seem reasonable to suppose; but the country along both sides is thickly wooded, and exploration difficult, and so far seems to have been carried on in a desultory and unskilful manner. Ditton area.

"*Alluvial gold mining at Dudswell.*—The Dudswell gold area seems to have been yielding satisfactory returns, at least to some of the parties lately operating there. From Kingsey Brook, lot 3, range 4, Dudswell, several thousand dollars worth of alluvial gold are reported to have been extracted within the last three years, and work is still carried on there by Mr. Chas. Rodrigue, and by Messrs. Copal, Mathieu & Co. Messrs. Osgood and Hall have a claim on the upper part of this stream, lot 4, range 4, Dudswell, which has been prospected, and promises well. Operations have also been begun on the first stream to the west of Kingsey Brook, flowing into St. Francis River, called Maynard's Brook, where gold washing was carried on by Mr. Frederick Harrison, on lot 1, range 6, Westbury, with, I am informed, fair success. Latterly, gold has been discovered in quartz there. Dudswell.

"Alluvial gold mining seems capable of being prosecuted at less expense at Dudswell than in the Chaudière, and perhaps, even then in the Ditton area, owing to the thinness of the superficial deposits overlying the gold-bearing gravels, and the narrowness of the valleys

Quebec—*Cont.*
Mode of occurrence of the gold.

"*Mode of occurrence of the alluvial gold.*—The mode of occurrence of the alluvial gold is nearly the same in all the three areas under review. The principal portion of the gold is found in pre-glacial gravels in the old river-beds, as was pointed out by Dr. Selwyn,* or in these gravels eroded and transported along the present river-bottoms by fluviatile action since the ice age. The general succession of the deposits in the areas which yield alluvial gold in the 'Eastern Townships' of Quebec, may be thus stated in descending order:—(1) Surface gravel and sand, stratified, sometimes auriferous in river-terraces, but not containing gold, so far as known, in quantities sufficient to pay for working. (2) Boulder-clay, of greater or less thickness, usually containing traces of gold. (3) Sand, or sometimes gravel, stratified (the 'quicksand' of the miners), containing traces of gold in some places, but not in paying quantities, often absent. (4) Clay, usually fine-grained, stratified and compact (the 'pipe-clay' of the miners), not auriferous, so far as known, often thin or altogether wanting. (5) Gravel, usually yellow or oxidized throughout, stratified, compact, water-worn, containing boulders of all sizes up to two feet in diameter, but none glaciated; all the materials of local origin, evidently deposited in old river-beds; contains most gold. (6) Non-glaciated rock-surfaces, usually ochreous; if slates, the top layers for one to three feet down, often contain gold between the laminæ.

"The intermediate members of the series (3 and 4) are often wanting, but boulder-clay and yellow gravel (5) are generally present, the latter, however, often thin. It is the 'pay-gravel' of the miners, and in the bottom, close to the bed-rock, gold almost always occurs most abundantly. The compact 'pipe-clay' of the miners (4) is regarded by them as indicating gold in the gravels beneath, if any gravels are present.

Section of surface deposits.

"*Pre-glacial rivers and origin of the yellow gravels.*—The pre-glacial rivers appear to have followed channels on one side or the other of the existing river-valleys, somewhat different from those which the rivers now occupy, and the Chaudière and Du Loup, at least, have flowed at lower levels. The present rivers cross the ancient river-beds at various points. In pre-glacial times, however, there would seem to have been a filling up of the river-channels by sediment, in some parts of the valleys, at least, as at the present day, while in others there would probably be erosion. The materials of which these pre-glacial river sediments are composed, are such as have been carried down off the slopes by the sub-aërial and fluviatile agencies which

*Report of Progress, Geol. Surv. Can., 1870-71, pp. 275-76.

were in operation at the time, and brought into the valleys by tributaries. The gold contents would seem also by these means to have been transported greater or less distances from their parent sources, and concentrated in the sediments along certain parts of the ancient river-courses When the ice of the glacial period advanced over the region, it failed to plough up and carry away many of these deposits, especially where they were protected by the inequalities of the surface, and hence their preservation to the present day. The rivers, in excavating their post-glacial channels have, however, cut through the boulder-clay, and also these pre-glacial river-sediments in certain parts of their courses, distributing the materials along the valley below, and again assorting and scattering the gold contents along the river-bottoms. In this case, the gold occurs most abundantly in the lee of protecting reefs and ledges, and as in Kingsey Brook, at Dudswell, of even the large boulders, as referred to later on. Where the yellow pre-glacial gravels have not been altogether denuded, however, and are auriferous, the gold in them, is regarded by the miners as following 'leads,' that is, has originally been concentrated along certain zones or bands by the action of the pre-glacial rivers.

Quebec—*Cont.*

Subsequent changes.

"*Localities where the yellow auriferous gravels were observed in the Chaudière area.*—In the Chaudière area, sections of the superficial deposits were examined in a great number of localities, and auriferous gravels were noted in the old river-beds in the following places:—In the Chaudière Valley at the falls and at the Devil's Rapids; in the Du Loup Valley at the mouth of Gold Stream; at Humphrey's pit, a short distance below that, and at the Star Gold mine near the mouth of the river, where an excellent section is exposed, which will be described presently. In Slate Creek gold-bearing gravels occur, also along the Famine River below the falls, where the St. Onge Bros. tunnelled, and again near the upper falls. In the Gilbert River valley they seem to extend along the old river-bed almost continuously, though in some places apparently as a very thin sheet lying on the bed-rock. In Rivière des Plantes, these deposits were also observed in several places, and on the north bank of Meule Creek, a branch of Mill River, opposite St. Francis village, there seems to be an extensive deposit.

Occurrences of auriferous gravels.

"The remarkable series of superficial deposits occurring on the north bank of Rivière du Loup, about a quarter of a mile from the mouth, in hydraulic pit No. 1, Star Gold Mine, already referred to, may be briefly described, as it affords a section exhibiting the general character and sequence of the pre-glacial and glacial deposits in the Chaudière

Section of Rivière du Loup.

Quebec—*Cont.*

area better than any other known to me. In descending order, the following beds are disclosed:—(1) Surface gravel and sand, 1 to 3 feet. (2) Unstratified boulder-clay, containing glaciated boulders from 5 feet in diameter downwards—some of them foreign to the locality, 37 to 38 feet. (3) Irregularly stratified boulder-clay, apparently in lenticular beds, with glaciated boulders and pebbles, 15 feet. (4) Unstratified boulder-clay, more compact than No. 2—boulders not so large, and a greater number from local sources, 20 feet. (5) Tough, dark-gray stratified clay, with sandy layers which are ochreous in places, 1 to 3 feet. (6) Stratified, gray, ochreous sand, containing a few pebbles, 12 to 14 feet. (7) Compact stratified clay, with variegated bands and an occasional layer of sand; the whole deposit full of joints and breaking into rhomboidal-shaped pieces ('pipe-clay'), 6 feet. Divisions 5, 6 and 7 maintain a strictly horizontal attitude as seen on the west side of the pit, but the bottom of No. 7 rests on the surface of a gravel-bed which slopes slightly to the north, *i. e.*, away from the river, the slope being about 2 feet in 40. (8) Gray stratified gravel, containing numerous pebbles and a few boulders, water-worn. In the bottom lies a sand bed 8 or 9 inches thick, containing scarcely any boulders or pebbles; material local, non-glaciated; strata dipping northward as described above, 5 feet; these gravels and sands slightly auriferous. (9) Yellow, oxidized, hard gravel, stratified, containing numerous worn boulders from 2 feet in diameter downwards, of local origin, non-glaciated; strata dipping as in above division of series. The bottom of this member of the series was not seen, being covered by tailings and *talus*, but it is supposed to rest on ledges which crop out in the river's bed, and to be probably as low as these. It is auriferous; thickness about 28½ feet. The transport of the material of these pre-glacial beds seems to have been in the direction of the flow of the present Rivière du Loup; (10) non-glaciated rock-surfaces near by, jagged and broken, with gold in the crevices.

Conditions of deposition implied.

"This section exhibits several noteworthy features which can only be referred to here. These are:—(1) the bipartite division of the boulder-clay, (2) the great thickness of the pre-glacial beds, about 45 feet, and (3) the change in the character of these from the bottom to the summit, denoting changes in the conditions of deposition and of drainage. The lower coarse beds have apparently been laid down in rapidly flowing and shallow waters; the clay beds in the upper part in deeper and quieter waters, probably in a lake-like expansion of the Du Loup and Chaudière rivers at their confluence. But what caused the supposed deepening of the waters here at that time? The conditions of deposition are probably to be sought for in the changes which seem to have taken place in the attitude of the region just previous to the advent of the ice age.

"*Auriferous gravels of the Ditton gold area.*—Passing to the Ditton gold area, we find the succession of the superficial deposits at the Pope mine, the only place where a section could be seen here, to be about the same as in certain valleys in the Chaudière area, viz., (1) stratified water-worn material; (2) boulder-clay; (3) yellow oxidized pre-glacial beds, thin and irregular,—auriferous, especially in the bottom; (4) decomposing slates, highly ferruginous, surface non-glaciated, open and fissile to a depth of 1 to 3 feet, and containing gold between the laminæ. It is in the latter that the most gold occurs.

Quebec—*Cont.*

Superficial deposits of Ditton.

"*Auriferous gravels of the Dudswell gold area.*—In the Dudswell area, the yellow pre-glacial gravel was seen in Hall's Stream, where alluvial gold mining was formerly carried on. Work was stopped owing to the difficulty of keeping the shaft and drifts free from water. The superficial deposits at this mine are about 40 feet thick, but I could obtain no exact information respecting the thickness of the constituent beds.

The section at Dudswell.

"On Kingsey and Maynard's brooks, to the west, the glacial and pre-glacial deposits which may have formerly occupied their valleys, have been largely denuded and reassorted by fluviatile action since the ice age, and the gold contents scattered about in the bottom of these. In the portions of the valleys thus denuding by the streams, the deposits seldom exceed a thickness of three or four feet. A section of these on Kingsey Brook, in descending order, is as follows:—(1) One to three feet of mould, or alluvial wash, becoming coarser in the bottom. (2) Gravel, brown and ochreous, with angular or slightly worn pebbles, and a few boulders, some of which are from five to ten feet in diameter; there stand up above the surface, and are glaciated; materials of the gravels, local, or transported only short distances by the stream. They contain gold; thickness, one to two feet. (3) Compact ochreous gravel, in detached masses; materials as in No. 2, but so hard that a pick is required to remove them; this is apparently the equivalent of the yellow gravels of other river-valleys,—the remnants which escaped denudation; contains gold; thickness from three inches to two feet. (4) Gray, slaty, or schistose rock, non-glaciated; in the crevices of this and below reefs and ledges, or in the lee of the large boulders, most gold is found in the bottom of the gravels.

"The succession of the deposits and the mode of occurrence of the gold are very much the same in Maynard's Brook as in Kingsey Brook. The valley of the former is rather wider, and the beds rather thicker. The great advantage of alluvial mining in Kingsey and Maynard's brooks, thus far, is that no shafting or tunnelling is required, the

Quebec—*Cont.*

superficial beds not being more than from three to six feet thick, except in the flat ground, where the streams debouch from the mountain upon the plain.

Sources of gold local.

"*Source or sources of the alluvial gold.*—The sources of the alluvial gold are supposed, in view of all the facts thus far obtained, to be mostly, if not altogether, local. The unworn condition of much of the 'coarse gold,' the local character of the materials composing the pre-glacial, auriferous gravels, and the fact that there were no known agencies in the region in pre-glacial times to transport either the gravel or its gold contents, except atmospheric and fluviatile, all tend to support the conclusion that the precious metal cannot have been transported far. While this is true of the gold found in the pre-glacial bottom gravels, and embedded in the rotten rock beneath these, the gold met with in the shallow deposits of the present river-bottoms, also in the boulder-clay and in the post-glacial river-terraces, may have been carried further, the fine 'scale gold,' indeed, considerable distances. The reason of this seems to be that the latter has been subjected to a second transportation since the ice age, either in the boulder-clay, or in the denudation of the river-valleys and slopes.

Circumstances on the Chaudière.

"Though the above view regarding its local origin is generally accepted, the gold has not been traced to its source in the matrix in any part of the 'Eastern Townships,' except, perhaps, at Dudswell. Alluvial gold has been mined in the Chaudière area for fifty years, yet no free visible gold has been found in veins there to this day. Nuggets, with quartz attached, have been picked up in several places, notably at the Devil's Rapids, near St. Francis; and a number of quartz-veins have, on assay, yielded traces of gold, (one of these, at the falls of the Bras River, having a small quantity of felspathic rock associated therewith and carrying some iron-pyrites, showed, on assay in the laboratory of the Survey, a trace of gold); but the true sources of the alluvial gold of the Chaudière have yet to be discovered. The veins from which it is derived probably traverse parts of the area not yet prospected, and though near the deposits of auriferous gravels, are most likely covered with boulder-clay, and perhaps by the forest. The irregular, broken ridge which crosses the Chaudière Valley at the Devil's Rapids, seems to me to be one locality where gold-bearing veins might be looked for, as the rich gold-producing valleys of the Gilbert River and of Meule Creek occur on either side. Both slopes are largely covered with drift. The ridge along the south-eastern side of the Famine River might also be prospected with advantage, as well as a number of other places, more especially where diorites and other intrusive rocks occur. While the quartz-veins along the river have been repeatedly examined, those upon the higher grounds have been to some extent overlooked. Quebec—*Cont.*

"The source of the gold of the Ditton area is as problematical as that of the Chaudière. Quartz-veins are numerous in the slates, but none have hitherto yielded free gold. The difficulty of prospecting here has already been alluded to. At Ditton.

"The Dudswell area has afforded better results in the search for gold in the matrix than either that of Chaudière or Ditton. The coarse character of much of the gold found there and the comparatively unworn condition of the gravels, show that the source must be in the Dudswell Mountain. The total area of the mountain is limited, and it could easily be examined were it not that it is still forest-clad. The small auriferous quartz-vein discovered on lot 1, range 6, Westbury (Harrison gold mine), cannot be the source of the alluvial gold of this area, being lower, and to the south of its place of occurrence, but proves the existence of gold *in situ* in the vicinity. This vein is only an inch or two wide, but cuts a bed of gray arkose conglomerate, of which specimens showing no free gold were subjected to assay in the laboratory of the Survey and found to contain 0·35 ounces to the ton. It is possible that this deposit may prove to be of a workable character. At Dudswell. Gold in conglomerate.

"*Localities where alluvial gold might be sought for.*—The gold-bearing gravels of the several rivers, within the areas where alluvial mining has been prosecuted, have only been partially worked, mining having been carried on apparently in those parts of the valleys where the deposits are of least depth. The lower parts of the Gilbert and Famine rivers, also Mil River and the great valley of the Chaudière itself, below the Du Loup, have not yet been worked for alluvial gold. The pre-glacial valley of the latter, especially between the falls, or mouth of the Du Loup, and the Devil's Rapids now forms a deep trough occupied with a heavy bed of superficial deposits. Into this trough the Du Loup, Famine, Gilbert, Pozer's stream, etc., must have carried large quantities of gold. Along the western bank of this part of the valley, there must also be considerable deposits of pre-glacial gravels buried beneath the boulder-clay. This seems to be a promising field of investigation, at least, for the practical alluvial miner. Localities deserving examination.

"In Ditton, the north bank of the river at and above the Pope mine, might be more carefully examined and prospected for gold. It seemed to me that there are yellow gravels along that bank beneath the boulder-clay. The heaviest ice passed over that district from north to south, apparently filling in the pre-glacial valley on that side. Thick deposits of superficial materials occur in that vicinity.

Quebec—
Cont.

"At Dudswell, further exploration would seem to be required on the summit of the mountain, near the sources of the streams along which gold has been found. The terraces or flats along the south-eastern base should also have gold beneath, especially where the streams debouch from the mountain upon them. These streams, flowing as they do rapidly in narrow valleys, must have carried down considerable quantities of gold to places where the currents slackened. Exploration in these terraces had commenced late in the autumn.

"The foregoing brief statement of the results of investigations during the past season, merely touch on a number of the questions relating to the gold-bearing deposits of the region, and many of the facts obtained will have to stand over till a detailed report is written.

Glacial phenomena.

"The following is a synopsis of the more important observations on the glacial phenomena:—

"The courses of striæ given by Dr. Ells in his reports on the geology of the 'Eastern Townships' seem, so far as I have examined the region, to be mainly correct.* The ice-movements have been widely divergent, and the facts relating thereto are extremely perplexing, and appear to be explicable only on the theory of two, if not three, systems of glaciation by land ice, and probably one by floating ice. The chief difficulty lies in the classification of the different sets of striæ. West of the watershed separating the St. Francis waters from those of the Chaudière, our observations are disconnected and incomplete; but in the area to the east of that watershed and of the head-waters of Becancour River, a considerable body of facts has been collected indicating the ice-movements pretty clearly. First there would seem to have been a northward ice-flow, whether entirely independent of the Laurentide glacier or not, remains to be determined. The direction of movement of this ice varied from N. 45° E. to N. 15° W.,† but was principally between N. 15° E. and N. 10° W. The striæ have been traced from the higher grounds near the international boundary down to the border of the marine plain of the St. Lawrence Valley. In many parts of the region they have been effaced by later ice, but where they dominate, as in Tring and Broughton townships, west of the Chaudière Valley, and in Cranbourne, Frampton, the Etchemin River valley and eastward, the subsequent glaciation by ice moving south-eastward and eastward has either been light or wanting. Following this system of glaciation, there seems to have been an invasion of the region by the Laurentide glacier, which brought in boulders and strewed them pro-

First system of striation.

Second system of striation.

---

* Annual Report, Geol. Surv. Can., vol. II., pp. 46J-48 J, and vol. III., p. 99 K.

†The courses of striæ are all referred to the true meridian.

fusely over some parts of the country up to a height of 1500 or 1600 feet. This ice defaced the earlier striation in most places, and in the valleys of the Chaudière and St. Francis almost entirely obliterated it. The evidence is wanting to show that it overrode the higher summits of the mountain range nearest the St. Lawrence, especially to the east of where the St. Francis River traverses it. Great tongues of the Laurentide glacier have moved up the valleys of the St. Francis and Chaudière, however, and from the latter it seems to have spread out fan-like, south-eastward, eastward and apparently north-eastward. St. Anselme Mountain, about fifteen miles south-east of Quebec, and 650 feet high, presents an abrupt face to the St. Lawrence with *talus* at the base, while its summit is glaciated in the direction of N. 30° E. and N. 40° E. The N. 5° W. and N. 10° W. sets of striæ are also common in this locality. Quebec—*Cont.*

"A portion of the Laurentide glacier, or of the ice which distributed Laurentian boulders, passed over the low divide between the Chaudière and St. John waters, which is only 1200 or 1300 feet high, in the direction of S. 60° E. to S. 75° E. Extent of Laurentid glacier.

"The Laurentide glacier seems to have stossed some portions of the north side of the mountain range nearest the St. Lawrence River, especially that between the Chaudière and St. Francis rivers. My examinations have not yet extended further westward.

"Ice flowing southward to south-eastward, occupied a considerable part of the drainage-basin of the St. Francis and its tributaries, and Laurentian boulders occur in many places. Whether this ice overrode the range along the international boundary has not yet been determined. Other ice-movements are shown to have occurred in this area by Dr. Ells, and the facts relating thereto were also observed by me.

"On the withdrawal of the Laurentide glacier from the 'Eastern Townships' region, many local glaciers seem to have occupied it, flowing in different directions, and producing a great number of divergent courses of striæ. Local glaciers.

"The facts observed respecting the action of floating ice in the St. Lawrence Valley are still meagre and scattered.

"*Boulder-clay and boulders.*—The boulder-clay as seen at Le Rocher, in the Chaudière Valley, and near Dudswell in the valley of the St. Francis, show, as at Rivière du Loup, in the section described on a previous page, a bipartite division. At Le Rocher, the lower division is of a dark gray, or bluish-gray colour. Then occurs a stratified band, overlying which is a gray boulder-clay. The deposit in the bank of the St. Francis Boulder-clay.

Quebec—*Cont.*

appears to be of much the same character. The far-travelled and larger boulders appear to be in the upper part. Owing to the sliding down of the beds a good view of the exposures could not be obtained, and it is not yet known to what extent the division may be of classificatory importance.

"Laurentian boulders are abundant in certain areas, while in others they are entirely wanting, their distribution evidently depending upon the movements of the ice which occupied the region. At St. Odolin, which is 1300 feet high, the Roman Catholic church is built of blocks of Laurentian granite, gneiss, etc., hewn out of boulders collected within a radius of a few miles.

Terraces and beaches.

"*Changes of Level in the Region.*—The evidences relating to changes of level in the region during the post-Tertiary period, were investigated along the south side of the St. Lawrence in several places from Rivière du Loup, Intercolonial railway, westward as far as Ste. Julie and Arthabaska stations, Grand Trunk railway. Within this distance, a number of the highest marine terraces and benches that could be found were levelled by aneroid, working from the railway stations. Facing the open St. Lawrence Valley, as these terraces do, there can be no doubt as to their marine origin.

Height of shore-lines on on north side of Notre Dame Mts.

"South-east of St. Charles Junction, Intercolonial railway, on the road from St. Gervais to St. Lazare, a shore-line occurs at the height of 540 to 550 feet.* Above St. Anselme, on the west side of Etchemin River, another was seen at 620 feet. About two miles south of Ste. Henedine, Quebec Central railway, the highest shore-line is 750 feet. A lower terrace lies nearer Ste. Henedine station at 715 feet. In the Chaudière Valley near Ste. Marie, 740 to 750 feet on the east side, and 760 feet on the west; and near the head of Beaurivage River, 835 feet. From three to four miles south-east of Ste. Julie station, Grand Trunk railway, three terraces, 855, 865 and 895 feet; and on road leading from the same railway to St. Joseph Lake terraces occur at northern base of mountains at 720, 755 to 765 feet and at 860 feet. Denuded gravel hills and mounds rise above these to 885 or 890 feet. This is as far west as I levelled the shore-lines on the north side of the range.

Height on south-east of mountains.

"On the south-east side of Dudswell Mountain, an extensive terrace or beach abutting against it, is 840 to 850 feet high, and at the north end of Lake Memphremagog terraces of stratified gravel and sand were noted 860 to 865 feet high. The two last localities are on the south-east side of the range nearest the St. Lawrence and within the drainage basin of the

*The heights are above mean tide-level.

St. Francis River. Other terraces were observed in the region, but whether they are marine is doubtful. Quebec—Cont.

"Evidences of still more local changes of level, and of uplifts and dislocations were seen in some places. At St. Evariste de Forsyth, a ridge of slate shows some remarkable displacements since the surface was glaciated, one band having been pushed up five feet and a half above the apparently undisturbed rocks on the north side. Similar occurrences are frequent in this region, the displacements, however, seldom exceeding a foot or so. The most notable example of local upheavals, is that of the ridge of intrusive rocks which crosses the Chaudière Valley at the Devil's Rapids. The surface of these in the river-channel is higher than any part of the rock-bottom of the Chaudière above the rapids, as far up as the mouth of the Du Loup, as shown by shafts sunk in two places. As there does not appear to be any other course by which the river could have passed, this uplift must have taken place since the channel of the river below the Du Loup was eroded. This rock-rimmed portion of the Chaudière Valley is that to which I have elsewhere alluded as being probably a receptacle for the gold carried into it by the streams on both sides. Evidences of differential elevation.

"The examination of the gold areas occupied the principal part of the season up till the 9th of September, after which I was engaged in the investigation of the glacial phenomena, surface deposits and elevated marine shore-lines of the region on both sides of the Chaudière to the north and east of the gold area, including the drainage basin of the Etchemin and Rivière du Sud, and along the south side of the St. Lawrence Valley to Montmagny and L'Islet. Subsequently, an examination of the country west of the Chaudière Valley was made, crossing and re-crossing the range of mountains nearest the St. Lawrence River as far westward as Wolfstown and South Ham. A further investigation of the Dudswell gold area was then made, after which I returned to St. Francis by the lakes—Weedon, Aylmer and St. Francis—and through Winslow, Forsyth and Tring. A trip to the upper part of the Du Loup River was then undertaken, and the mines on lot 1, range 7, Marlow, examined and some mineral specimens collected. Returning to St. Francis, a number of points were afterwards examined along the railway lines till the close of field-work. Time occupied in the work.

"*The Salt Springs at Salina, Kings Co., N. B.*— Salt springs, New Brunswick.

An examination of the salt springs at this place was made, and samples of material from the bore-hole and of brine from a spring near by, were forwarded to the laboratory of the Survey for analysis. The boring was 330 feet deep at the time of my visit, disclosing: (1) super-

Quebec—*Cont.*

ficial deposits, 64 feet; (2) gypsum, 21 feet; (3) sandstone, 15 feet; (4) gypsum, 220 feet; (5) sandstone, 10 feet. The pre-Carboniferous rocks were apparently not reached.

"As the beds here are nearly vertical, the above measurements do not represent the actual thickness of the several deposits.

"Field-work closed on the 18th of October, and on the 23rd I reached Ottawa."

Work by Mr. Low.

During the early part of the winter, Mr. A. P. Low was engaged in writing a preliminary report on the explorations of the previous two years, and, with the assistance of Mr. D. I. V. Eaton, in preparing a map of the surveys made. The latter part of the winter was occupied in the compilation of a general report embracing the work of the preceding three years' explorations in the Labrador Peninsula.

Labrador Peninsula.

In June, Mr. Low was instructed to undertake an exploration by way of the Manicuagan River, which flows into the Gulf of St. Lawrence from the north, some 220 miles below Quebec, the object being to gain further information on the country near the central watershed of the Labrador Peninsula. Mr. Low was assisted in this expedition by Mr. Eaton, who carried out the necessary topographical work. After his return, in the autumn, Mr. Low was engaged for ten days in the vicinity of Three Rivers in further defining the outcrops of the several Palæozoic formations between the St. Lawrence and the Archæan region to the northward, for the purposes of the north-west sheet of the "Eastern Townships" map.

The subjoined preliminary report on the exploration above alluded to is given by Mr. Low:—

Exploration of Manicuagan River.

"At Quebec, provisions and outfit were obtained, and with four canoemen from Lake St. John, we left on the steamship 'Otter,' and arrived at Bersimis on the 24th. Here two Indian guides were secured, and also six extra canoemen, who were engaged to assist in the transport of provisions to Lake Mouchalagan, some two hundred miles above the mouth of the Manicuagan River.

"On account of head winds, the mouth of that stream was not reached until July 1st. A survey of the river to the head of Lake Mouchalagan had been made by the Crown Lands Department of Quebec, and in consequence no surveys were started until that point was reached; but the geology and natural resources of the intermediate regions were carefully examined, and located on a tracing of the previous survey.

"Fine weather and long hours, enabled the party to reach the outlet of Lake Mouchalagan on the 12th July, or about ten days ahead of the time estimated by the guides at starting. From here, the extra men were sent back to Bersimis, and the whole loads were transported in four canoes to the head of the lake, where the micrometer survey work was commenced. Owing to the rapid current in the river, double loads were made for the first thirty miles, passing over on the way, two miles and a half of portages, where the route leaves the river-valley and rises more than five hundred feet to a chain of small lakes, to avoid a cañon, in which the river, for over six miles, descends between almost vertical walls in a continuous heavy rapid.

Labrador Peninsula—*Cont.*

Head of Mouchalagan Lake reached.

"This portion of the work was accomplished on July 21st. A câche was now built, and in it were stored all extra baggage and provisions not required for the next six weeks, which was the time estimated by the guide as necessary to explore the head-waters of the main branches of the river.

"The Indians do not ascend the main stream beyond the poin where the câche was made, being unable to do so on account of its rapid character and high rocky banks, which preclude portaging. The hunters of this region generally ascend in their canoes to the neighbourhood of the câche, and there await the snow and ice before journeying further northward, when they haul their canoes and outfits northward on toboggans. In the spring they descend from the heads of the various branches in their light canoes, making only one load over the portages. On this account, the portages of the upper country are exceedingly rough and often hardly marked.

"From the câche, the stream was left, and the best and easiest portage-route to the height-of-land was followed. It passes out of the river-valley on the west side, following a small tributary through a chain of little lakes. The first portage is upwards of one mile and a half long, with a rise of over six hundred feet. The route next leads, in a zigzag manner, through small lakes and ponds and along crooked, small streams, with many connecting portages, in a direction almost due west, to Lake Matonipi. The distance in a straight line from the river is only thirteen miles, but is upwards of twenty miles by the crooked route, the portages numbering thirteen, with a total length of seven miles and a rise of more than one thousand feet. Lake Matonipi is some five miles long, and discharges by a small stream into the Outardes River.

Mouchelagan to Matonipi.

"From this lake, the direction of the route changes to nearly due north, and ascends rapidly to the high rolling ground northward of

Labrador Peninsula—*Cont.*

the lake, following the valley of a small tributary to its head, some eight miles away from the lake, and at an elevation of six hundred and eighty feet above it. Of the eight miles of route, only two are water, the remainder being made up by six exceedingly rough portages.

Portage route thence to the height-of-land.

"A portage of a mile next leads across a summit which divides the waters of the Outardes and Manicuagan rivers. Passing through a small lake, a portage of over seven miles leads to and along a small stream, which is then descended some three miles, where it is left by two portages with small lakes, followed by a portage of three miles and a half to another tributary. Next, nine small lakes connected by portages were passed through to another small branch of the Manicuagan, which was followed about three miles and then left by a ten-mile portage-route, which ends in Lake Kichewapistoakan on the south-west branch of the Manicuagan River. The portages along this part of the route are ten in number, and aggregate eight miles in length. Where the south-west branch was reached, it was found flowing with a sluggish current, in a deep channel about fifty yards wide. There is a wide area of swampy land on either side, extending on the north side about ten miles, to the foot of a high range of barren hills, which forms the watershed between streams flowing south into the St. Lawrence and the head-waters of the Big River of Hudson Bay.

"The south-west branch of the Manicuagan River, takes its rise near the sources of the Outardes and Peribonka rivers, some fifty miles to the south-west of where the portage-route reaches it. From its head it skirts the southern base of the high, barren hills, and is fed by many small streams from their southern slopes.

Lakes Attikopi and Attikopis.

"This stream was followed in a winding course for twenty miles, to Lake Attikopi, a body of water about three miles wide and six miles long, full of deep bays and covered with islands. Another large stream flows into this lake from the northward. This last-mentioned stream was then ascended in a general north-easterly course for twenty miles, to Lake Attikopis, where a second câche was made, and everything not required for a week's flying trip left behind.

"A portage-route through small lakes was now followed almost due west, eight miles, to the water-shed dividing the Manicuagan from the Big River. Crossing this height-of-land, a small stream connecting a number of little lakes was descended westward thirty-five miles, until the stream emptied into a large irregular body of water, deeply indented with narrow bays and almost covered with islands of all sizes. This lake is called Naokokan, and it southern shore was traced some thirty miles, to its western end, passing on the way a large stream flowing in

Lake Naokokan and Nichicun.

and said by the guide to be the main branch of the Big River, which rises close to the heads of the Outardes and Peribonka rivers some fifty miles to the southward. Labrador Peninsula—*Cont.*

"A hill of 400 feet, at the west end of the lake, was ascended, from which a fair view of the surrounding country was obtained. The lake was seen stretching to east and north for many miles, but so filled with large islands and broken by long points that it presented the appearance of a multitude of small lakes. A high chain of hills bounds the northern and eastern horizon. As five of the seven days allowed for this trip were now past, we were forced to return to Attikopis without reaching Nichicun, which is situated on the discharge of Naokokan, and probably only a few miles from where we turned back; but from our lack of knowledge as to where the discharge might be, and of the irregular shore-line of the lake, several days were likely to be required for its discovery, especially as the weather was at this time very unfavourable, with continuous rain and fog.

"After again reaching Lake Attikopis, a small stream flowing into the lake was ascended in a north-easterly direction, through five small lakes to a portage separating the waters of the Attikopis branch from those of the main stream. Continuing in the same direction through six small lakes, the general bearing of the route changes to east, and in twelve miles reaches Lake Itomamis, after passing through three lakes connected by a considerable stream. A short stretch of rapids connects Itomamis with Summit Lake, which lies almost on the 53rd parallel of north latitude. It is seven miles long and occupies a deep valley between ridges of semi-barren hills that run north-and-south. The lake has two discharges of about equal volume, both sufficiently large for canoe navigation. The northern discharge, with a short rapid, empties into the first of a number of long narrow lakes that fill the northern extension of the valley, and that finally empty into Lake Kaniapiskau, and so reach the Koksoak or Ungava River. The southern discharge forms the chief branch of the Manicuagan River. After surveying Summit Lake, the main stream was followed southward. On leaving Itomamis Lake it has a breadth of thirty feet with an average depth of one foot in rapids, and being joined by many considerable streams from valleys on both sides, it soon becomes a large river. For eight miles below Itomamis Lake, the river is formed of small lake-expansions connected by short rapids. It then contracts and descends in a deep narrow valley, in an almost continuous rapid, for twenty-four miles, to the junction of the Attikopi Branch. A sur-

Attikopis to Summit Lake.

Descend main branch of Manicuagan.

Labrador Peninsula—*Cont.*

vey was carried some twelve miles up this branch, in order to connect with that of the trip northward.

"Below the forks, the main stream spreads out into a number of shallow channels, separated by long low islands, between which it flows with a swift even current for eight miles. Beyond this, the river again narrows and passes into a deep valley with rocky banks, down which it swiftly flows with almost continuous rapids for forty-five miles, to the place where it was previously left by the portage-route. While descending this portion of the river, owing to the accidental upset of a canoe, one of the Indian guides named Paul Bacon was unfortunately drowned in the heavy waters of the rapids, and although search was made for his body along the river-banks for many miles below, nothing was seen of it, nor of the canoe which was lost at the time of this disaster.

Canoeman drowned.

Return journey.

"The câche was reached on the 25th August; and from there, the river was descended to its mouth, where we arrived on September 1st and then returned to Ottawa on the 5th of September.

Physical features of the region.

"The physical character of the region visited is similar to that of the rest of the Labrador Peninsula. Within a few miles of the coast, the country rises into an irregular, rocky plateau, upwards of one thousand feet in elevation, but having a further gradual rise towards the interior, so that near the central watershed the general level is nearly two thousand feet above the sea.

"From its mouth to the head of Lake Mouchalagan, the Manicuagan River flows in a deep, ancient valley from a quarter of a mile to two miles wide, with steep, rocky walls rising from five hundred to fifteen hundred feet above the water, and usually flanked with high terraces of stratified sands, gravel and clay. The river, especially towards its mouth, is broken by a number of falls and chutes, where the channel narrows greatly and the large volume of water pours in a swirling mass downwards between perpendicular rocky banks. None of these cañons are of great depth or length, nor do they compare in grandeur with those of the Koksoak and Hamilton rivers. They may be of more recent origin than these.

"Lake Mouchalagan is formed by a widening of the valley; it is upwards of forty miles long, and varies from one to two miles wide. Its surface is about nine hundred feet above sea-level, and it is remarkable for its great depth of water, the deepest sounding taken being six hundred and fifty feet, or some two hundred feet deeper than any previously known lake in Labrador.

"Above this lake, the valley of the river continues northward, but, as the river now flows down it with a heavy grade, the walls of the valley gradually become lower, so that at Summit Lake, the water-level is not more than three or four hundred feet below the general level of the country, which is here characterized by barren hills, arranged in roughly parallel ridges, running north-and-south. Labrador Peninsula—*Cont.*

"The country beyond the main river-valley, as seen along the portage-routes followed, rises above two thousand feet, and is broken by long, rounded ridges of hills that stand from two hundred to five hundred feet above the general level. The lower lands are covered with swamps and dotted with small lakes. The higher ground is often rocky, and everywhere the surface is covered with a great thickness of boulders and broken rock, arranged in irregular ridges, and often without any finer material filling the spaces between them. These ridges form the portage-paths, through the innumerable swamps, but are dangerous and difficult roads for travelling with heavy loads.

"In the river-valley, as far as Lake Mouchalagan, many large trees of white spruce are seen, which would make excellent timber. These trees are most numerous along the first hundred miles from the mouth of the river, and many places were noted, in this distance, where the quantity was sufficient for the establishment of lumber camps. The falls at the mouth of the river would furnish much more power than would be necessary for all milling purposes, and the only drawback to successful working, is the shallow water at the sea coast, where the mouth of the river is greatly obstructed by sandy shoals, extending several miles from shore and affording a very dangerous anchorage outside. Trees

"Besides white spruce, in the valley, large quantities of black spruce, fit for superior pulp-wood, grow far inland, together with balsam fir, Banksian pine, larch, aspen, balsam, poplar and white birch; all of which grow to a fair size, for upwards of two hundred miles inland. Below the first forks, or for about fifty miles from the coast, occasional trees of white pine are seen on the rocky sides of the valley, while on the bottom-lands yellow birch and black ash are found in small quantities. The growth of these trees shows that the climate of the lower river-valley is sufficiently moderate for the cultivation of hardy crops, thus affording a considerable area for future settlement, On the uplands of the interior, the country is only partly wooded with small growths of black spruce, larch, and, in places, Banksian pine; these trees rarely exceed eight inches in diameter, and, branching out close to the ground, are unfit for commercial purposes. All the higher hills rise above the tree-line, and as the central watershed is approached. Arable land.

Labrador Peninsula—*Cont.*

more than half the country is barren. From the above description it will be seen, that much, or all of this high interior region, is unfitted for agriculture.

Laurentian rocks,

"Rocks, of Archæan age alone, were met with along the various routes followed. On the river below Lake Mouchalagan, they belong to the Laurentian, and are largely mica granite-gneiss, often garnetiferous, together with hornblende granite-gneiss, and anorthosite. In these rocks there are few indications of metalliferous veins or minerals of economic value. About Lake Mouchalagan, the garnetiferous gneisses predominate, and appear to be associated with thin bands of crystalline limestone.

Crystalline limestones.

"Above the lake, for some thirty miles, these crystalline limestones are developed in great thickness, and are associated with mica-schists, and garnetiferous gneiss. The limestone is often pure, and at times contains tremolite, or mica, of which latter no large crystals, however, were seen. The mica-schists, close to the limestones, often contain large quantities of graphite, and at other times pyrites, or magnetite. There is an extraordinary band of iron-ore, which appears to belong to the beds associated with the limestone. The ore occurs in a gneiss, composed of quartz, felspar and magnetite; and according to the proportion of magnetite present, grades from ferruginous gneiss into an almost pure iron-ore of high grade. This band was seen in places ten miles apart, on the portage-route leading from the river towards Lake Matonipi, on the Outardes River, and in one place had a thickness of over two hundred feet. Numerous scattered blocks in the river valley, below the portage-route, point to an extension of the band to that place; while to the westward, and twenty-five miles beyond where last seen by us, the guide said that the mass of the 'shining mountain' is composed of similar ore. This mountain is referred to in the *Relations des Jésuites* as a burning mountain, and acquires its title from the glistening of the ore-faces in the sun, when they present a most dazzling appearance. From the above it will be seen, that this bed, in great thickness, can be traced along the strike of the rocks for upwards of thirty miles, forming one of the greatest known deposits of iron-ore.

Great band of iron-ore.

Schists with quartz-veins.

"To the northward of the portage-route, the rocks along the main stream consist of an apparently bedded series of mica-schists, together with hornblende-schists, and decomposed, massive, basic eruptives; the whole cut by large masses of garnetiferous, mica-hornblende granite-gneiss. The schists are full of quartz-veins, often holding a good deal of pyrites. They may yet be found to contain gold, as they somewhat resemble the Huronian rocks of localities where gold is now known to occur. *Labrador Peninsula—Cont.*

"As Summit Lake is approached, the schists give place to a coarse, hornblende-granite, which extends westward to Nichicun, and is apparently a south-eastern extension of the great area of similar rock, previously met with between the East Main and Ungava rivers."

Nova Scotia.

Work by Mr. Fletcher.

From the date of the last Summary Report, part of the winter of 1894-95 was spent by Mr. Fletcher in plotting his surveys, in revising those made by his assistants in the district described on pages 91-94 of that report, in correcting proofs of Nos. 35 and 36 of the Nova Scotian series of maps, in colouring geologically sheets photographed by Mr. Topley from the manuscript maps, in reducing, tracing and adding supplementary surveys to these sheets, in studying Sir Wm. Logan's notes and plottings of the Pictou coal-field and in compiling plans by the late Mr. Scott Barlow of part of Cumberland county and cataloguing and arranging others. The greater part of his time was, however, occupied in compiling from these surveys and other sources, maps of Cumberland county from Moose River and Five Islands towards Cape Chignecto and the Joggins and Springhill coal-fields on a scale of one mile to an inch, and of Hants county between the Shubenacadie and Avon Rivers, on a scale of half a mile to an inch. The latter still remains to be reduced to one mile to an inch for publication. Surveys of the Nictaux and Torbrook iron mines in Annapolis county and of the North River and Truro Devonian rocks in Colchester county were also compiled.

Revision of Sydney coal-field.

He left Ottawa on June 10th, 1895, to resume field-work in Nova Scotia, with the particular object of obtaining the information necessary for new editions of the Glace Bay, Sydney and New Campbellton map-sheets in the Sydney coal-field, the revision of which it is desirable to make as thorough and complete as possible by adding geological and geographical detail to the original maps. The greater part of the season has, consequently, been spent by Mr. Fletcher in Cape Breton; but before beginning work there he reëxamined (June 14-21) localities in Antigonish and Pictou counties where he hoped to find fossils in the rocks classed as Cambro-Silurian, in the quartz-veins of which at Sutherland River a discovery of gold has recently been reported. This examination was continued (October 6-18), in company with Dr. H. M. Ami, who was collecting fossils to assist in determining certain doubtful points of structure. Silurian fossils were found in small

Nova Scotia—*Cont.* Investigations in Pictou county.

patches of greatly altered rock previously supposed to be Cambro-Silurian at Dunbar's, Sunnybrae (Report for 1886, part P, p. 32) and Glencoe Brook, while a *Streptelasma*, like that from the Silurian of Beechhill Cove, was subsequently found, near the post-office on Brown's Mountain, in a small outcrop of rocks also previously included with the Cambro-Silurian but which do not resemble those of the typical exposures of that series.

From November 15th, Mr. Fletcher was again in Pictou county, where he obtained a copy of Mr. Poole's geological plan of the coal-field, made a few supplementary surveys in that vicinity and, with the kind coöperation of Mr. F. H. Chambers of Bridegville and Messrs. J. D. Fraser and O. Herting of Ferrona, collected a quantity of specular iron-ore to send to Ottawa for use in collections. Work is being vigorously prosecuted at the iron mines on the East River of Pictou. A new quarry of dark bituminous limestone has been opened at Spring ville. At the old Blackrock quarry, a cave was examined, along the floor of which runs a stream of water, the roof being hung with rough stalactites.

A spring of strongly saline water, not before mentioned, was also visited at Dunmaglass on Knoydart Brook, a quarter of a mile north-west from the road to Eigg Mountain.

Cape Breton. Surveys made.

Respecting the work done in Cape Breton, Mr. Fletcher reports as follows :—"My field assistants were M. H. McLeod and T. S. McLean who were employed for more than four months and surveyed brooks, lakes and roads, principally in the region underlaid by rocks of the Millstone grit, between Mira Bay and Sydney Harbour, near North Sydney and on Boularderie Island. Their work was greatly facilitated by the use of a large map now being constructed for the Dominion Coal Company by Mr. Hiram Donkin, C. E., and his assistants, kindly lent by the manager, Mr. McKeen, M. P., which shows the new lines of road and railway together with chained surveys of most of the sea-coast, lakes and large streams.

"In this district, in the absence of rock-outcrops and pits, useful geological work can be done by tracing certain bands of coherent rock by means of blocks which lie unweathered on the surface, the loose rocks on the surface being for the most part, as was long ago pointed out by Mr. Robb, derived from beds immediately underlying. In some cases, confirmation of results obtained by this method was obtained in pits subsequently sunk.

Hub seam

"The outcrops and water-levels of the coal-seams in the productive measures, were for the most part well defined before 1874, although the progress of mining admits of their being now delineated with greater precision than on the map of that date. On the Hub seam (Report for 1872-73, p. 260), which has lain idle for twenty years, work has been resumed in an attempt to win the coal from the submarine area. It was found that while wood submerged for that period in the pit-water has remained sound and well preserved, the iron of rails and castings of all kinds has been completely eaten away, a light, porous skeleton, composed of carbon, silica, iron oxides, &c., being left. Wrought iron is also greatly wasted, but steel points have remained unchanged.

Nova Scotia—*Cont.*

"At the western workings of the Gowrie mine, a north-and-south fault was met, which threw the coal down thirty-six feet on the west side. From its face, at the level of the shaft-bottom, a stone drift was extended 284 feet, and borings were made to the coal from this drift and also from the surface along the shores of Morrison Lake, which prove that the Martin pit is on the McAulay seam, as indicated on Lyman's map; but which, taken in connection with the underground workings, also proves that, west of the fault, the axis of the basin is deflected further to the north, and that this seam, instead of terminating, probably continues for more than a mile past the Martin pit, in a narrow basin, to the outcrop of the seam, eight to twelve feet thick, discovered by Neville (Report for 1874-75, p. 189). The dis crepancy in the size of the two seams is accounted for by the fact that at certain points on the north rise at the Gowrie mine, the coal attains a thickness of eleven feet, though nominally only five. That the Long Beach anticline or fault (Report for 1874-75, pp. 205 and 212) passes the old Louisbourg railway, was proved by a line of pits sunk in 1891 by Mr. E. T. Moseley, in search of the westward extension of the large seam above mentioned, the steep southerly dips of the bottom of the Cow Bay basin, being found also nearly to the fork of the Hines and Cow Bay roads.

Gowrie mine

"On the investigation of the lower coal-seams of the Millstone grit, much money has been spent during the last twenty years, in the hope of their proving economically available, and the acquisition by the Dominion Coal Company of nearly all the mining areas of known value east of Sydney Harbour has stimulated prospecting, yet the results have not generally been encouraging, the coal-seams found seldom exceeding three feet in thickness, and being usually much less. One of the areas, on the Morrison road, visited in 1894 in company with Dr. Gilpin, the Inspector of Mines, and the Deputy Inspector, is shown by the former, in the last number of the Transactions of the Nova Scotian Institute of Science, to contain no seams of more than two feet in

Search for lower coal-seams.

Nova Scotia—*Cont.*

thickness, and subsequent close examination has not disproved this statement. It is on the line of the Tracy seam and the little seams that accompany it, as given in Mr. Robb's sections and map (Reports for 1874-75, p. 189; 1875-76, p. 414).

"Mr. Lewis Stephens and others have continued to search for workable coal on the strike of these seams on the Mira and Morrison roads near Black Brook, but appear to have found none. From one of the seams a few inches of excellent cannel was obtained. Nearer Sydney, prospecting has been carried on intermittently at the Cossitt pits, but with only the disappointing results explained by Mr. Robb (Report for 1874-75, p. 191). The red rocks of Mira Bay extend nearly to these pits before being replaced by the gray strata of Sydney Harbour.

Tracy seam.

"Since 1874 the Tracy mine has not been worked to any extent. An attempt made, some years ago, to cut through False Bay beach and make of False Bay Lake a suitable port of shipment, was, like a similar effort more recently made to convert McIsaac Pond at Broad Cove into a ship harbour, frustrated by the closing of the excavation by the sea.

"Explorations made by Mr. Simon E. Landry and his associates on the supposed extension of the Tracy seam west of False Bay Lake, have cut two little seams apparently overlying it (Report for 1874-75, pp. 177 and 188) near the Back-lands road. Their explorations have been greatly impeded, however, by a great quantity of surface deposits.

"In a pit sunk near the North-west Brook of Bridgeport Basin, at the most southerly of those called 'Macdougall's pits' on the map of 1874, a coal-seam, with a low southerly dip, generally supposed to be the Carroll, has the following section:—

	Ft.	In.
Top coal	2	6
Shale or clay	0	6
Coal	2	0
Clay	0	3
Coal, not well seen	1	9
	7	0

"In other pits of the immediate neighbourhood, however, it is not so thick. These pits are probably, as stated by Mr. Robb (Report for 1874-75, p. 194), on the crown of the anticline, on the north side of which are those at the mouth of the North-west Brook, supposed to be on the same seam. In one opened by the Messrs. Routledge, the dip is N. $<$ 6°, and the section as follows:—

Nova Scotia—*Cont.*

	Ft.	In.
Top coal	1	3
Clay	0	2
Coal	1	9
Parting	..	..
Coal	0	11
	4	1

"In other adjoining pits, dug by Messrs. Neville and McVey, the coal is said to be four feet four inches thick. The anticline apparently lies a little south of these pits, but its exact position is still uncertain.

Carroll seam.

"Although the Carroll seam has not yet been positively traced into the Glace Bay basin—unless it be the small pyritous seam known as the Buchanan seam (Report for 1874-75, p. 190,) on which several new openings were made last season—a thorough and systematic search for it was begun last August by Mr. E. T. Moseley, Q.C., and Mr. D. J. Kennelly, formerly manager of the Reserve mines, by means of a series of diamond-drill borings and pits along the old Louisbourg railway. These explorations have tested the strata underlying the Lorway seam far to the south of the crossing of the Hines road, and have discovered a seam of coal, eighteen inches thick, at a little brook three-quarters of a mile north of the Hines road, and another of about the same thickness at that road. The first is, perhaps, the equivalent of a seam, twenty-one inches thick, opened on the south side of Cow Bay basin, in a pit about one mile north-east of the post-office at Cochran's Lake. The average dip north of the Hines road has been shown by these borings to be about one in twelve. It is hoped that a workable seam may yet be found underlying. Apparently near the same horizon, also near the Cow Bay anticline, good exposures including a one-inch seam of coal, have been made on the new Louisbourg railway at the crossing of Sand-lake Brook. They consist chiefly of red and green marly rocks and of bluish-gray shales full of impressions of fossil ferns and other plants, the dip being about N. 6° E. $<$ 5°.

District west of Sydney Harbour.

"Little need at present be said of the district west of Sydney Harbour. From the Sydney mines, there is the usual large annual output of coal. On the crop of the Indian Cove seam, a small mine has been opened by Mr. Greener, and a quantity of coal shipped over a short railway to a wharf built in the cove. The shipment of coal from the Cape Breton colliery at New Campbelton, has been affected by the closing of St. Peter's canal for repairs. An adit, driven to the shore at sea-level, now drains the upper workings. The owners, Messrs. Burchell Brothers, have, during the last few months, bored with the diamond drill some twelve or fifteen hundred feet of strata, in various

Nova Scotia—*Cont.*

holes, for the purpose of finding the large seams which lie above and below the equivalent of their main seam in other parts of the field, but which here seem to be scarcely workable. Sections have been made of the borings here as well as on the old Louisbourg railway, which are useful as proving the strata and for comparison with the sections in Mr. Robb's report.

Dolomites used as flux.

"The bed of white, massive, gray-weathering, broadly-crystalline dolomite discovered in the crystalline limestone series by Mr. Robb and analysed by Dr. Hoffmann (Reports for 1873-74, p. 174; 1874-75, p. 253), has been to some extent utilized by the Messrs. Burchell, who are shipping sixteen hundred tons for the use of the steel works at Trenton, and are building a short branch from their coal-mines railway to the foot of the mountain at the North Brook, where it occurs in great cliffs. Analyses of this dolomite and of others from similar rocks at George River and Marble Mountain, obtained from Mr. J. D. Fraser, manager of the iron-works at Ferrona, are appended for comparison with that made by Dr. Hoffmann.

Analyses.

	I.	II.	III.	IV.
Silica	1·41	0·73	2·58	2·00
Oxides of iron and alumina	1·92	1·55		0·50
Calcium carbonate	50 19	54·83	88·67	77·47
Magnesium carbonate	42·16	42·95	7·89	20·00
Phosphate of lime		None.		
Sulphate of lime		None.		

I. and II. give the average of a number of samples from the North Brook, tested by different analysts, the first at Ferrona laboratory by Mr. Fraser, the second at Pittsburg. III. is the average of twelve analyses made by Mr. O. Herting at Ferrona, from samples collected at Marble Mountain; IV., the mean of a large number of pieces taken from different beds in George River district, between Crane Brook and the limestone quarries near the mouth of the river.

Other minerals.

"From the crystalline limestone formation at George River, speci mens of chalcocite and chrysotile have been sent to the Geological Survey by Mr. Hugh R. MacKenzie, C.E., of Sydney. Attempts have also been made to work the traces of iron-ore found in this district but without success.

"No use has yet been made of the fire-clay of Coxheath (Reports for 1873-74, p. 173; 1875-76, p. 373; 1876-77, p. 456) 'suitable for the manufacture of fire-bricks and pottery,' and rendered more accessible by the completion of the Intercolonial railway to Sydney, from the line of which the deposit is distant about three miles.

"A diamond drill is at present at work in a search for coal on the eastern shore of Sydney Harbour, three-quarters of a mile north of Beatty Brook, where, of course, it will cut only the Carboniferous limestone rocks of the section given in the Report for 1874-75, page 169, and infallibly result in disappointment. In Pictou county, also, money has been uselessly spent during the past few weeks in sinking among the red rocks of the Foxbrook road, which underlie the productive measures, and also among the rocks of the East River below New Glasgow, which overlie them." Nova Scotia—*Cont.*

Work by Mr. Faribault.

Mr. E. R. Faribault's office work, since the date of the last Summary Report, has continued to be in connection with the compilation and completion for publication of the results of his surveys in the gold-bearing regions of Nova Scotia. The manuscripts for the nine sheets numbered 39, 40, 41, 42, 48, 49, 50, 51 and 52 have been completed. They cover the area extending along the Atlantic coast from Salmon River to Musquodoboit Harbour, and inland to the Pictou and Stewiacke valleys, and are included in the counties of Halifax, Colchester and Pictou. Structural sections for sheets 39 and 40 have also been made, but similar sections for the remaining seven sheets have still to be prepared.

Special plans.

In addition to the regular map-sheets, on a scale of a mile to the inch, special plans have also been plotted, on a scale of 500 feet to one inch, of the gold-mining districts of Tangier, Mooseland, Moose River, Caribou, Oldham, Montague and Waverley. Some of these plans are not quite completed, and sections still require to be prepared before they will be ready for publication. They are on a sufficiently large scale to show the interesting and important relation of the auriferous quartz-veins to the general structure of the anticlinal folds, with the numerous faults and disturbances affecting them. It is also intended to show upon these plans, the quartz-veins known to occur in the districts, their width and length, the extent to which they have been worked in depth and along their cropping, together with their average richness when this can be ascertained, the direction and dip of pay-streak and that of the anticlinal axes.

Field of operations.

Mr. Faribault's field-work was in continuation of that accomplished in previous years. His progress report upon it is as follows :—"I left Ottawa on May 30th to resume field-work in Nova Scotia, and continue the mapping and study of the structural geology of the gold-bearing rocks of the Atlantic coast, and to complete as far as possible the surveys required for the sheets numbered 53, 54, 55, 56, 66, 67 and 68. Owing to the limited amount of exploration fund at my disposal, field operations had to be discontinued by the end of August, and consequently the Waverley sheet numbered 67 and the Halifax City sheet numbered 68 have not been completed.

Nova Scotia—*Cont.*
Positions and names of map-sheets.

"The five sheets just enumerated, comprise the gold-bearing region of the central part of the province, extending along the Atlantic coast from Musquodoboit Harbour to Halifax Harbour, and inland to the northern boundary of the gold-bearing rocks, where they are overlaid by Carboniferous strata along the St. Andrews River, the Shubenacadie River, the Nine-mile River, and on the north side of the Rawdon Mountains. Each sheet covers an area of 12 miles by 18 miles, and the five sheets thus cover 1080 square miles and include portions of the counties of Halifax, Colchester, and Hants. Each sheet is well designated by the name of the most important place it contains, which are the following:

No. 53, Lawrencetown sheet,
" 54, Preston sheet,
" 55, Middle Musquodoboit sheet,
" 56, Stewiacke sheet,
" 66, Rawdon sheet.

"The rocks of the region examined have been forced into a series of folds, almost parallel to each other, bearing a general easterly and westerly course. As many as fifteen folds were located across the belt of forty miles of gold-bearing rocks, extending from the Atlantic coast to their northern limits on the north side of the Rawdon Mountain. The structure of these plications was carefully studied and the anticlinal axes were traced and worked out with as much accuracy as possible, on account of the importance of these axes in regard to gold occurrence.

Enumeration of anticlines.

"The names given provisionally to the fifteen anticlines, in the order of their occurrence from the shore to the Rawdon Mountain, with notes on the gold mines worked and quartz-veins prospected along their course, are as follows:—

"1. *Three-fathom Harbour Anticline.*—Crosses only some outlying points along the Atlantic coast.

"2. *Lake Catcha Anticline.*—Worked extensively on two or three properties at Lake Catcha gold district, and a few auriferous quartz-veins have been prospected along its course east of Oyster Ponds.

"3. *De Said Lake Anticline.*—A few auriferous quartz-veins have been prospected on this axis in the vicinity of De Said Lake.

"4. *Lawrencetown Anticline.*—Important operations have been prosecuted on two or three properties at various times at Lawrencetown gold district, and a few auriferous quartz-veins have been opened up at Upper Chezzekook.

"5. *Porter's Lake Anticline.*—Promising auriferous quartz-veins have been prospected along this anticline on the east side of Porter's Lake, one mile north of the telegraph road. Nova Scotia *Cont.*

"6. *Montague Anticline.*—Half a dozen properties have been extensively worked at various times for a number of years in Montague gold district. Very promising quartz-veins have been prospected east of Lake Major, where one of the main faults of the region has shoved the anticlinal axis on the west side of the lake, nearly one mile and a half to the north of its normal position. A few quartz-veins have also been tested along this line east of Bedford Basin.

"7. *Waverley Anticline.*—Extensive mining operations have been carried out on one or other of the many properties of the Waverley gold district, almost continuously since its discovery, to depths of over 400 feet. Auriferous quartz-veins were also prospected on this anticline in the vicinity of Karney Lake and south of Goff post-office.

"8. *Caribou Anticline.*—This only brings up the upper black slate group. Quartz-veins have been prospected along its course on Lively Brook, and north of Goff post-office.

"9. *Oldham Anticline.*—The extensive gold mining district of Oldham has been considerably worked since its opening, two or more shafts on an incline of 43°, reaching a depth of 574 feet, on the Dunbrack lead, while some of the leads have been worked, or opened up, for over one mile in length along their course.

"10. *Carroll's Corner Anticline.*—Auriferous quartz-veins have been opened up at Key's Brook and at the Horn settlement.

"11. *South Uniacke Anticline.*—A few quartz-veins are being worked very successfully at the south Uniacke gold mines, to depths of 500 feet, on some very rich and persistent pay-streaks.

"12. *Mount Uniacke and Renfrew Anticline.*—Mining operations have been prosecuted extensively in both gold districts of Renfrew and Mount Uniacke, for a number of years.

"13. *East Rawdon Anticline.*—Considerable mining work has been done in the East Rawdon gold district for some years.

"14. *Rawdon Mountain Anticline.*—A minor anticline in the slate, between the two main synclines of the upper black slate belt of the Rawdon Mountain. Exploratory work has been done recently at the Withrow gold mine, and numerous quartz-veins have been tested on the surface, along this axis, but most of them proved to be barren.

Nova Scotia—*Cont.*

"15. *Gore Anticline.*—Crops out only in a few places along the southern boundary of the Carboniferous rocks of the Kennetcook basin, by which it is mostly covered.

Faults.

"A number of faults, bearing a general north-and-south course, cut the stratification at right angles, and time was taken up in tracing these and working out the magnitude of the displacements. Some of them cut the whole width of the gold-bearing belt from the Atlantic coast to the Carboniferous boundary on the north side of the Rawdon Mountain, a distance of forty miles, with horizontal displacements sometimes as great as one mile and a half.

Detailed surveys.

"During the summer, special detailed surveys were also made of the gold-mining districts of Lake Catcha, Lawrencetown, Renfrew, East Rawdon, Withrow and Central Rawdon, and necessary data taken in the field, in order to prepare plans of these districts, like those already made of the eastern part of the province, on a scale of 500 feet to one inch.

"A topographical survey of the gold-field of Nova Scotia was undertaken jointly by the Geological Survey and the Nova Scotian government in 1881, and W. Bell Dawson, C. E., was entrusted with the work, and made a most accurate map, on a scale of two inches to one mile, representing an area of twelve miles by eighteen miles, including the city of Halifax and its vicinity. He also made a special plan of each of the gold districts of Lawrencetown, Montague and Waverley on a scale of 500 feet to one inch. These topographical surveys were intended to become the basis of a geological map, but were not prosecuted further, the arrangement under which they were undertaken having fallen through. The area covered by the above plans is partly included in the south-western portion of the region surveyed last summer, they were found most useful in the field in working out readily the structure of the rocks and will be a great help in compiling the map of that area.

"I was again ably assisted in the field during the season by Messrs. Archibald Cameron and Jas McG. Cruickshank, who have been my assistants for the last twelve and eleven summers respectively. They were also employed another month plotting their summer's work. Mr. Frank D. Phinney was also one month with me last summer."

Work by Prof. Bailey.

In the Annual Report for 1892-93 (Vol. IV.), a preliminary report, on the Geology of South-western Nova Scotia by Professor L. W. Bailey is printed. The relation of this to a more detailed report by the author is there stated. It was not found possible to arrange for any lengthened period of field-work in this connection during the past summer, but Professor Bailey having volunteered his services for a portion of the season, about a month was spent upon the work by him. Of the observations made, he writes as follows :— Nova Scotia—*Cont.*

"These observations had, as their primary object, the obtaining of data required to complete a report upon the geology of Yarmouth and Digby counties, materials for which had already been partially obtained in the summers of 1892 and 1893, by the examination of certain sections not at that time visited, and the reëxamination of others. The results relate, therefore, mostly, to minor details of structure. In particular, a minute examination was made of considerable portion of the micaceous and hornblendic belt which stretches inland, along the line of the Dominion Atlantic railway, from the city of Yarmouth to the border of Digby county; and secondly of the section of Cambrian rocks lying between the head of St Mary's Bay and the Grand Joggins on the Annapolis Basin. Objects in view.

"Both examinations fully confirmed the conclusions previously stated in my preliminary report published last year. As regards the former belt, both the sequence and the characteristics of the rocks composing it, and which had at one time been supposed to be of pre-Cambrian (Huronian) age, were, as seen particularly in the vicinity of Brazil Lake, Lake Ausier and Lake George, found to bear the closest resemblance to the rocks exhibited at Jordan Falls and about Shelburne Harbour, in the county of Shelburne, both being clearly of Cambrian age. The rocks of the second section above referred to, which are in character and sequence typical of a large part of Digby county, are as certainly also a portion of the same Cambrian system. This being the case, it had been hoped that from the black slates which here, as in Queen's county, form the upper member of the system, organic remains might be obtained which would place the age of the containing beds beyond all question; but the search for these, though prolonged, proved unavailing. Results.

"It was also hoped that some further light might be thrown upon the doubtful relations of the peculiar beds about Cape St. Mary, to those of the fossiliferous Silurian and Devonian belt previously recognized at Bear River and Mistake settlement; but upon this point also, little of a definite character could be ascertained, the frequent interposition of areas of eruptive rocks, together with accompanying metamorphism, making it very difficult to follow or to recognize the identity of beds, more particularly when separated, as those of Digby county

Nova Scotia—*Cont.*

so frequently are, by wide intervals of drift. Many features of resemblance have been noted between the beds of Cape Cove, near Cape St. Mary, in Yarmouth county, and those of the tract bordering Annapolis Basin between Bear River and the Grand Joggins, but it would still be unsafe, from present data, to assert their identity or to fix their age.

"In addition to the observations on the Cambrian system, referred to above, some time was devoted to a further study of the traps and sandstones of Digby Neck, including the iron deposits of Waterford, etc. Native copper in threads and small nodules was observed near the entrance of Digby Neck, but the quantity was small. No other minerals of economic value were noted."

Chemistry and Mineralogy.

Chemistry and mineralogy.

Reporting on the work of this division, Dr. Hoffmann says:—"The work in the chemical laboratory during the past year has been carried out upon the same lines as those heretofore followed, that is to say, it has been chiefly confined to the examination and analysis of such minerals, etc., etc., as were considered likely to prove of economic value and importance. The ground covered included:—

Analyses.

"1. Analyses of fuels.

"2. Analyses of mineral and other waters and brines.

"3. Analyses of iron-ores.

"4. Analyses of certain ores in regard to nickel content.

"5. Analyses of marls.

"6. Assays, for gold and silver, of ores from the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia.

"7. Examination, and in some instances complete analysis, of several minerals not previously identified as occurring in Canada, some of which promise to prove of economic importance.

"8. Miscellaneous examinations. These include the examination and testing of brick and pottery clays; of limestones and other materials, supposed to possess hydraulic properties; of some samples of silt, bog manganese and disseminated graphite, and of other materials not included under the above headings.

Mineral specimens examined.

"During the period in question, five hundred and seventy-three mineral specimens were received for the purpose of identification or the obtaining of information in regard to their economic value. The greater number of these were brought by visitors, and the information sought in regard to them was not infrequently communicated to them at the time of their calling. In other instances—those where a more than mere cursory examination was called for, or a partial or even complete analysis was deemed desirable, as also in the case of those specimens which had been sent from a distance—the results were communicated by mail. The number of letters written, chiefly in this connection, and generally of the nature of reports, amounted to two hundred and fourteen, and the number of those received to eighty-nine. Chemistry and mineralogy—*Cont.*

"Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have both applied themselves diligently to the work in hand, and rendered excellent service. The former has, in addition to the carrying out of a lengthy series of gold and silver assays, also made some important analyses of minerals, and likewise conducted a great variety of miscellaneous examinations; whilst the latter has, as a principal work, been engaged in the analysis of mineral and other waters, marls and iron-ores. Work by assitants.

"In the work connected with the mineralogical section of the museum, I have been ably assisted by Mr. R. L. Broadbent. He has, apart from general museum work, including the maintenance of the collection generally in an orderly condition, been engaged in the permanent labelling of specimens—a work which must of necessity be of a more or less continuous character by reason of frequent additions to the collection; and also prepared the manuscript of over eight hundred labels for the collections illustrating the distribution of iron, copper, lead, antimony and other ores.

"The additions to the museum amounted to one hundred and thirty specimens. Some of these consisted of minerals not previously represented in the collection, the greater number, however, were of minerals already contained in it, but from new localities, and serve to illustrate their distribution. Contributions to museum.

"Amongst the additions just referred to, are the following, of which—

"(A.) Were collected by officers on the staff of the Survey:—

Ami, Dr. H. M.:—

Crystals of pyrite from Willards Mill, Castle Brook, west shore of Lake Memphremagog, Brome county, Q.

Barlow, A. E.:—

Cyanite from Snake Creek, (ten miles north of Mattawa) Pontiac county, Q.

Contributions to museum—*Cont.*

Bell, Dr. R.:—

Chalcocite from the Borron location, tp. of Gould, district of Algoma, O.

Chalmers, R.:—

a. Pre-Glacial or Pleiocene clay from the mouth of Rivière du Loup, Beauce county, Q.
b. Auriferous quartz from the Harrison gold mine, lot 1, range VI., Westbury, Compton county, Q.
c. Rock specimens from lot 4, range IV., Dudswell, Wolfe county, Q.
d. Rock specimen from same locality as *b.*
e. Quartz showing native gold from same locality as *b.*
f. Rock specimens from Falls of Bras River, Beauce county, Q.
g. Scheelite, eight specimens from lot 1, range VII., Marlow, Beauce county, Q.
h. Twelve specimens illustrating mineral associations of scheelite from lot 1, range VII. of Marlow, Beauce county, Q.
i. Auriferous quartz from lot 2, range I., Linière, Beauce county, Q.

Dawson, Dr. G. M.:—

a. Chabazite from road at head of Chasm, north of Clinton, B.C.
b. Shale conglomerate constituting bed rock at the Horsefly mine, carrying gold, Cariboo district, B.C.
c. Bornite from the Tenderfoot claim, east side of Copper Creek, Kamloops Lake, B.C.
d. Gypsum occurring in concretionary or nodular masses in 'china-stone' deposit on west side of Fraser River, opp. Spatsum Station, Canadian Pacific Railway, B.C.
e. Cinnabar from Last Chance No. 2 claim, east side of Copper Creek, Kamloops Lake, B.C.
f. Molybdenite from same locality as the preceding.
g. Native copper in serpentine from 'Painted Bluffs,' near Copper Creek, Kamloops Lake, B.C.
h. Cinnabar from Six-mile Point, Kamloops Lake, B.C.
i. Silver ore, five specimens from the Homestake claim, near Adams Lake, B.C.
j. Magnetite from the Glen iron mine, Cherry Bluff, Kamloops Lake, B.C.
k. Selenite from Fort Kipp, Old Man River, district of Alberta, N.W.T.
l. Limestone showing cone-in-cone structure, from Athabasca Landing, district of Alberta, N.W.T.

Contributions to museum—*Cont.*

m. Coal from Holloway's Spring Creek mine, Middle Fork of Old Man River, district of Alberta, N.W.T.

n. Coal from Highwood River, district of Alberta, N.W.T.

o. Auriferous quartz from the Sultana, Winnipeg Consolidated and Gold Hill mines, Lake of the Woods, district of Rainy River, O.

Ells, Dr. R. W.:—

Magnetite from lot 16, con. IX., Bagot, Renfrew county, O.

Faribault, E. R.:—

Stibnite and kermesite, six specimens from West Gore, Hants county, N. S.

Ferrier, W. F.:—

a. Quartz showing native gold from the Ledyard Gold Mines, Belmont, Peterborough county, O.

b. Arsenopyrite from the Gatling mine, Marmora, Hastings county, O.

c. Bismuthinite from lot 34, con. III., Tudor, Hastings county, O.

d. Epidote from lot 8, con. XIX., Tudor, Hastings county, O.

Fletcher, H. :—

a. Hæmatite from Doctor's Brook iron mine, Arisaig, Antigonish county, N. S.

b. Manganite from Morley road, Cape Breton county, N.S.

c. Talc from Kennington Cove, Cape Breton county, N.S.

Giroux, N. J. :—

Allanite from east shore of Lac à Baude (Lake Bouchard), Champlain county, Q.

Ingall, E. D. :—

Crystals of galena from Gold Hill claim, Illecillewaet mines, West Kootanie district, B. C.

Low, A. P. :—

Almandite crystals from mica-schist from Manicuagan River, Saguenay county, Q.

McConnell, R. G. :—

a. Galena, zinc blende and tetrahedrite from the Antelope claim, Slocan mining district, West Kootanie, B.C.

b. Zinc blende with pyrite from the Bluebird mine, Slocan mining district, West Kootanie, B.C.

Contributions to museum—*Cont.*

c. Galena coated with earthy carbonate of lead from the Deadman mine, Slocan mining district, West Kootanie, B. C.

d. Galena from the Reco mine, Slocan mining district, West Kootanie, B.C.

e. Galena with cerussite, from the Reco mine, Slocan mining district, West Kootanie, B.C.

f. A mixture of earthy sulphate and carbonate of lead with quartz, from the Reco mine, Slocan mining district, West Kootanie, B.C.

g. Galena, pyrite, chalcopyrite, and a little mispickel from the Sheep Creek Star claim, Sheep Creek, Trail Creek mining district, West Kootanie, B.C.

h. Quartz with galena, pyrite and chalcopyrite, from the O. K. mine, Sheep Creek, Trail Creek mining district, West Kootanie, B.C.

i. Quartz with pyrite from the Gold Hill claim, Trail Creek mining district, West Kootanie, B.C.

j. Pyrrhotite with chalcopyrite (auriferous and argentiferous) four specimens from the Leroy mine, Trail Creek mining district, West Kootanie, B.C.

k. Pyrrhotite with chalcopyrite from the Great Western claim, Trail Creek mining district, West Kootanie, B.C.

l. Iron pyrites, pyrrhotite and zinc blende, from the Lilly May claim, Trail Creek mining district, West Kootanie, B.C.

m. Iron pyrites, galena and zinc blende from the Lilly May claim, Trail Creek mining district, West Kootanie, B.C.

n. Pyrrhotite with chalcopyrite (auriferous and argentiferous) from the Kootanie claim, Trail Creek mining district, West Kootanie, B.C.

o. Mispickel from the same locality as the preceding.

p. Pyrrhotite with chalcopyrite from the Iron Colt claim, Trail Creek mining district, West Kootanie, B.C.

q. Pyrrhotite with chalcopyrite (auriferous and argentiferous) from the Nickel Plate mine, Trail Creek mining district, West Kootanie, B.C.

r. Pyrrhotite with chalcopyrite (auriferous and argentiferous) from the War Eagle mine, Trail Creek mining district, West Kootanie, B.C.

s. Pyrrhotite with chalcopyrite (auriferous and argentiferous) from the Monte Christo mine, Trail Creek mining district, West Kootanie, B.C.

t. Pyrrhotite with chalcopyrite (auriferous and argentiferous) from the Cliff mine, Trail Creek mining district, West Kootanie, B.C. Contributions to museum—*Cont.*

u. Mispickel with chalcopyrite and pyrrhotite from the Josie claim, Trail Creek mining district, West Kootanie, B. C.

v. Galena, coated and intermixed with carbonate of lead, ferric hydrate and green carbonate of copper, from the Noble Five claim, Slocan mining district, West Kootanie, B.C.

Tyrrell, J. B. :—

Marcasite from the bank of the Assiniboine River, Manitoba

"(B.) Were received as presentations :—

Abrahamson Brothers, Revelstoke, B.C. :—

Asbestus (chrysotile) and serpentine from Trout Lake City, West Kootanie, B. .

Bell, B. T. A., Ottawa, O.

Muscovite from Tête Jaune Câche, Rocky Mountains, B. C.

Brown, C., per C. W. Willimott :—

Phlogopite from Kingsmere, Hull, Ottawa county, Q.

Brunet, J., Montreal, Q.:—

Granite, three specimens polished, from the Laurentian Granite Co.'s quarry, St. Philippe, Argenteuil county, Q.

Butchard, R. P., Owen Sound, O.:—

Marl from Shallow Lake, township of Keppel, Grey county, O.

Campbell, A. M., Perth, O.:—

Calcite from near the east end of Dalhousie Lake, Dalhousie, Lanark county, O.

Carter, Alfred, Wairau, Blenheim, New Zealand :—

a. Sample of briquettes or tiles composed of magnetite (separated from Taranaki iron sand by Carter and Purser's process) and glue.

b. Sample of ingot-iron smelted, in cupola furnace, from briquettes similar to '*a.*'

c. Cog-wheel cast from ingot iron, similar to '*b.*'

d. Borings from cog-wheel '*c.*'

Chambers, F. H. (Bridgeville, N.S.), New Glasgow Iron, Coal and Railway Co., Limited, Ferrona, Pictou county, N.S.

a. Limonite from Bridgeville, Pictou county, N.S.

b. Manganite " " " "

c. Barite " " " "

d. Göthite " " " "

Contributions to museum—*Cont.*

Costigan, J. R., Calgary, N.W.T.:—

Zinc blende from South Fork of Red Deer River, district of Alberta, N.W.T.

Coursolles, T. G., Ottawa, O.:—

Phlogopite from lots 16*a* and 17*b*, range VIII., Templeton, Ottawa county, Q.

Ferrier, W. F., Ottawa, O.:—

a. Galena from Tudor, Limerick, Elzevir and Hungerford, Hastings county, O.
b. Galena from Nairn and Galbraith, district of Algoma, O.
c. Quartz with chalcopyrite from Craig's gold mine, Tudor, Hastings county, O.
d. Chalcopyrite from the Begley mine, Batchehwahnung Bay, Lake Superior, O.
e. Chalcopyrite from the township of Snider, district of Algoma, O.

Greenshields, Montreal, Q., per Dr. J. Thorburn:—

Asbestus (chrysotile) from the Jeffrey mine, lot 9, range III., Shipton, Richmond county, Q.

Guillim, J. C.:—

Nine specimens of ores and rocks from the West Kootanie district, B.C.

Hall, G. B., Quebec:—

Microcline from the McGie mine, Block 'G,' Bergeronnes, Saguenay county, Q.

Harding, H.:—

Bituminous shale, so-called 'cannelite,' from Baltimore, Albert county, N. B.

Hill, A. J., New Westminster, B.C.:—

a. Bog-iron ore from Campbell River, lot 14, range VII., New Westminster district, B.C.
b. Slag from burnt seam of coal or lignite, near Village Bay, Mayne Island, Gulf of Georgia, B.C.

Hobson, J. B.:—

Barite in lignite from the Horsefly mine, Horsefly River, Cariboo district, B.C.

Jacques, Captain, Victoria, Vancouver Island, B.C.:—

a. Ilvaite with andradite from Uchucklesit Harbour, near head of Barclay Sound, Vancouver Island, B.C.
b. Ilvaite with pyrite, same locality as above.
c. Chalcopyrite with ilvaite, same locality as above.

Laprairie Pressed Brick and Terra Cotta Co., Laprairie, Q., per J. S. Buchan :— Contributions to museum—*Cont.*

a. Building brick, grade No. 1, colour 7, four specimens.
b. " " 8, "
c. " " 9, "
d. " " 10, six "
e. 'Buff' brick, four specimens.
f. 'Plastic' brick, six specimens.
g. 'Ornamental' brick, three specimens.
h. 'Paving' brick, six specimens.

Ledyard Gold Mines Company, Limited :—

a. Eleven specimens of auriferous quartz from the east half lot 18, concession I., Belmont, Peterborough county, O.
b. Small bottle of concentrates.
c. " tailings.

Legge, Joshua, Gananoque, O. :—

Steatite from lot 5, concession I., Kaladar, Addington county, O.

McKenzie, H. R., Sydney, N. S. :—

Chalcopyrite from Old French road, Gabarous, Cape Breton county, N. S.

McRae, Hector, Ottawa, O. :—

Graphite from lot 12, concession III., Brougham, Renfrew county, O.

Moffatt, C. P., North Sydney, N.S., per H. Fletcher :—

Chrysotile from George River, Cape Breton county, N.S.

Morris, M., per C. W. Willimott :—

Phlogopite from lot 17, range II., Wakefield, Ottawa county, Q.

O'Connor, M., Delora, O., per Dr. R. Bell :—

Mispickel with lepidomelane from lot 11, concession IX., Marmora, Hastings county, O.

Ontario Peat Fuel Company, Toronto, O., per W. A. Allan :—

Peat fuel from peat bed about five miles from Welland, Welland county, O.

Prest, W. H. :—

a. Thirteen specimens representing the mineral associations of the auriferous quartz from Gold River, Lunenburg county, N. S.
b. Crystals of quartz and pyrites from the Lake lead, Caribou, N.S.

Contributions to museum—*Cont.*

Smith, J. F., Kamloops, B.C.:—

Beryl from Tête Jaune Câche mica deposit, Canoe River, B.C.

Sorette, H., Bridgewater, N.S.:—

Granite, polished specimen from Shelburne, Shelburne county, N.S.

Spotswood, G. A., Kingston, O.:—

a. Petroleum from the Strait of Belle Isle, Newfoundland.

b. Piece of contact rock showing impression of overflow of trap from same locality as the preceding.

c. Sillery sandstone from under the trap, charged with bitumen, from the same locality as the two preceding.

d. Bitumen, anthraxolite (?) from the trap of Port au Port Bay, Newfoundland.

Thain, J. H., Vancouver, B.C.:—

Chalcopyrite and pyrrhotite from Queen's Reach, Jervis Inlet, B.C.

Thompson, H. B., Victoria, B.C.:—

Infusorial earth from south side of Fraser River, opposite Mission City, B.C.

Thorburn, Dr. John, Ottawa, Ont.:—

Asbestus (chrysolite) from the Jeffrey mine, lot 9, range III., Shipton, Richmond County, Que.

Trethewey, T. H., per E. D. Ingall:—

Seven specimens of native copper, two specimens of chalcocite and one specimen of bornite, all from the Copper Creek Mining Company's property (Sand Bay and Pancake Bay locations), Mamainse, Lake Superior O.

Wells and Redpath, Messrs., Kamloops, B.C., per J. McEvoy:—

Asbestus (amphibole) from south side of Tulameen River, nearly opposite Bear Creek, Yale District, B.C.

Weston, T. C., Ottawa, O.:—

a. Nodule of magnetite and hæmatite from one of the Magdalen Islands, Q.

b. Agate from Scaumenac Bay, near Campbellton, Restigouche county, N.B.

Educational collections supplied.

"Mr. C. W. Willimott has, for the most part, been engaged in making up collections of minerals and rocks for various educational institutions. The following is a list of those to which such collections have been sent:—

Educational collections supplied—*Cont.*

1. Huron College, London, Ont.........	consisting of	135	specimens.
2. Public School, Bloomfield street, Halifax, N.S........................	"	90	"
3. Digby Academy, Digby, N.S	"	90	"
4. Richmond School, Halifax, N.S......	"	90	"
5. Normal School, Fredericton, N.B....	"	135	"
6. Lunenburg Academy, Lunenburg, N.S.	"	90	"
7. Provincial School of Pedagogy, Toronto, Ont........................	"	135	"
8. Collegiate Institute, Winnipeg, Man.	"	135	"
9. Public School, Medicine Hat, N.W.T.	"	90	"
10. Brébœuf School, Ottawa, Ont........	"	90	"
11. Prince Street School, Charlottetown, P.E.I........................	"	90	"
12. Public School, Nauwigewauk, N.B...	"	90	"
13. County Academy, Guysborough, N.S.	"	90	"
14. Public School, Chipman, N.S........	"	90	"
15. Acadia College, Wolfville, N.S......	"	188	"
16. Amherst Academy, Amherst, N.S....	"	90	"
17. Couvent de Jésus Marie, Lévis, Que..	"	90	"
18. High School, Iroquois, Ont..........	"	135	"
19. " " Hopewell Hill, N.B....	"	135	"
20. " " Keswick Ridge, N.B ...	"	135	"
21. Collegiate Institute, London, Ont....	"	135	"
22. Grammar School, Alma, N.B........	"	135	"
23. Public School, Breslau, Ont.........	"	90	"
24. Acadia Seminary, Wolfville, N.S	"	90	"
25. Public School, Carpe, Ont...........	"	90	"
26. Holy Cross Convent, Alexandria, Ont.	"	90	"
27. Superior School, Millford, N.B......	"	135	"
28. Art, Historical and Scientific Association, Vancouver, B.C.............	"	135	"
29. Superior School, Dalhousie, N.B.....	"	135	"
30. " " Hillsborough, N.S..	"	135	"
31. Provincial Normal School, Truro, N.S.	"	135	"
32. Superior School, St. Martin's, N.B...	"	135	"
33. " " Salisbury, N.B.....	"	135	"
34. Public School, Elgin, N.B...........	"	90	"
35. Columbia Methodist College, New Westminster, B.C................	"	135	"
36. Superior School, Harvey Station, N.B.	"	135	"
37. High School, Douglastown, N.B......	"	135	"
38. Public School, Petitcodiac, N.B......	"	80	"
39. Superior School, Hampton, N.B......	"	135	"
40. Lakeside School, Hampton Station, N.B............................	"	80	"
41. Public School, Maugerville, N.B.....	"	80	"
42. Caledonia High School, Seneca, Haldimand County, Ont...............	"	135	"
43. Public School Inspector, Toronto, Ont.	"	135	"
44. High School, Hagersville, Ont.......	"	135	"

Educational collections supplied—*Cont.*

45. Superior School, Butternut Ridge, N. B.	consisting of	120	specimens.
46. Windsor Academy, Windsor, N.S.	"	120	"
47. Sydney Academy, Sydney, N.S.	"	120	"
48. Public School No. 3, Harvey, N.B.	"	120	"
49. Forest Glen School, Forest Glen, N.B.	"	80	"
50. Grammar School, Chatham, N.B	"	120	"
51. Public School, Rat Portage, Ont.	"	80	"
52. " " Boiestown, N.B.	"	80	"
53. Harkin's Academy, Newcastle, N.B.	"	120	"
54. High School, Newbury, Ont	"	120	"
55. Public School, Shenston, N.B.	"	80	"
56. Albert Public School, Hopewell, N.B.	"	80	"
57. Grammar School, Campbellton, N.B.	"	120	"
58. City Hall, London, Ont.	"	160	"
59. High Commissioner, London, England	"	122	"

"Making a total of 6,665 specimens, aggregating over two tons in weight of material.

Collecting of minerals.

"In addition to the foregoing work, Mr. Willimott visited, in the course of the summer—for the purpose of procuring further material for the making up of collections for educational purposes—the townships of Hull, Templeton, Wakefield, Buckingham and Orford, in the province of Quebec, and those of Bagot, MacNab and Ross, in the province of Ontario.

"Whilst so engaged, he collected a large and varied assortment of minerals, comprising :—

	Specimens.	Weight.
Actinolite	100	
Albite	....	75 pounds.
Amazon stone	100	
Apatite, crystals	100	
" in calcite	100	
" pyroxene in calcite	100	
Baryta	....	150 "
Calcite, crystals	....	150 "
"	100	
Chrome garnet	100	
Diorite—from Bagot	....	200 "
" —from Wakefield	100	
Dolomite, tremolitic	....	100 "
Fluorite	100	
Gneiss	....	100 "
Graphite, disseminated	....	100 "
Hornblende-schist	....	200 "
Idocrase, crystals, loose	150	
" " in gangue	20	
Jasper	....	150 "

Collecting of minerals.

	Specimens.	Weight.
Limestone (marble)	....	150 pounds.
" hydraulic	....	150 "
" serpentine	....	150 "
Microcline	....	75 "
Molybdenite	75	
Ochre	....	30 "
Phlogopite, crystals (amber coloured)	150	
" " (black)	75	
Pyroxene "	300	
" massive	100	
Quartz	....	75 "
Rutile	75	
Sandstone	....	100 "
Titanite	....	100 "
Tourmaline	100	
Tremolite	....	200 "

"The foregoing included some handsome cabinet specimens which have been placed in the Museum.

"Mr. Willimott has also received—

	Weight.
Clay iron-stone, collected by Dr. G. M. Dawson	150 pounds.
Calcareous tufa, collected by Mr. Geo. Stewart, Banff	150 "
Basalt, collected by Mr. J. McEvoy	200 "
Tufaceous sandstone, collected by Mr. J. McEvoy	200 "
Hornblende, presented by Mr. R. Hamilton	100 "
Tremolite " "	50 "
Talc, received through Mr. W. F. Ferrier	100 "
Mispickel " "	150 "
Selenite, collected by Mr. E. R. Faribault	150 "

LITHOLOGY.

Mr. W. F. Ferrier, lithologist, reports on the work of the past year as follows:— Lithology

"Labels have been prepared for the stratigraphical collection of rocks, and those for the flat cases are now all placed in position. As the nomenclature of the majority of the rocks is, as yet, of necessity, based largely on their macroscopic characters, and therefore liable to some alterations, written, instead of printed, labels have in the meantime been provided. It is intended to arrange typical local sets of rocks in the large drawers under the museum cases, where they will be readily accessible to those wishing to study the geology of any particular district.

Lithology—*Cont.*

"The microscopical work of the year included the examination of fifteen additional thin sections of rocks from the Kamloops district, British Columbia, also of thirty sections of rocks from Labrador. The results of the former examination have been incorporated in the appendix to Dr. Dawson's report, which is now in the press, whilst those of the latter will form an appendix to Mr. Low's report on the interior of Labrador.

"Much time has been occupied in the study of Mr. Barlow's interesting and important rocks from the Nipissing and Temiscaming sheets, numbering in all some one hundred and fifty specimens, and the work is now nearing completion. One hundred typical rocks of the West Kootanie district, British Columbia, collected by Mr. McConnell, have been sectioned, but, as the field-work is not yet completed, examinations of only a few of the specimens have as yet been made.

"Twenty-four specimens of Archæan rocks were sent to Prof. H. A. Nicholson of the University of Aberdeen, and sixty-one—principally Archæan—to Prof. Groth of Munich, in exchange for specimens received.

"The miscellaneous work carried on during the year, included many macroscopical determinations of rocks and various microscopical or blowpipe examinations of building stones, minerals and miscellaneous materials.

"Two papers were, with the permission of the Director, published in the 'Ottawa Naturalist,' in one of which the occurrence of stilpnomelane *var.* chalcodite and crystallized monazite, at Canadian localities is recorded for the first time.

Examinations in the field.

"Having detected erythrite, the hydrous arsenate of cobalt, and smaltite, the arsenide of that metal (usually containing some nickel) in some samples of ore given to me by Mr. John Stewart, in 1892, from the Dominion Iron Mine, lot 2, concession II., of Madoc township, in the county of Hastings, Ont., it was thought advisable that I should visit the locality in order to ascertain the extent of the deposit of these cobalt minerals. Accordingly, during the summer, I went to Madoc and examined the mine where they occur as carefully as the circumstances would permit. No work has been done at the opening for many years, and consequently it is difficult to make out the precise relations of the cobalt minerals to the main mass of ore, but they appear to occur in bands or seams, one of which was noted dipping at a high angle. The width of these bands, judging from specimens collected on the dumps, must in some instances have been two feet or more. Blocks of the iron-ore sometimes show surfaces of over nine inches square coated almost completely with thin-bladed crystals and earthy coatings of the erythrite, which still retains its beautiful peach-red and pink tints of colour, although exposed so many years to the action of the weather. Little masses of earthy erythrite also occur filling cavities, and this mineral appears to have been largely derived from the alteration of smaltite, etc. The smaltite, of a tin-white colour on a freshly fractured surface, is distributed through the iron-ore, usually in small but very perfect crystals, mainly cubes and octahedrons, which, when weathered, tarnish, and greatly resemble iron-pyrites. The massive mineral has also been observed. The minute crystals are often thickly aggregated together so as to form small patches in the iron ore. Lithology—*Cont.*

"Several other localities in Hastings county were visited and numerous specimens of rocks and minerals collected, amongst which the fine glassy crystals of epidote from a new locality on lots 10 and 11, concession XIX., of the township of Tudor, are worthy of mention

Mining and Mineral Statistics.

This work has been carried on upon the usual lines under Mr. E. D. Ingall's control. The absence of Mr. H. P. Brunnell on leave, for three months, and his subsequent resignation for the purpose of accepting an engagement in the line of his profession, to some extent interfered with the progress of the work for the time being. Mineral statistic.

The early months of the year were taken up with the work of collecting and compiling statistics of the production of the country for 1894. A summarized statement was prepared as usual in advance of the main report. It was completed on 30th March, and was printed and distributed shortly afterwards. This was earlier than in any previous year.

The manuscript of the report on mineral statistics and mines for 1893, was completed last April, but it was subsequently decided to add to this the figures of mineral production in 1894. The report thus enlarged has since been printed and at the time of writing is nearly ready for distribution.

In the latter part of the year, the usual preparations were made for the collecting of statistics and general information regarding mining operations in the Dominion for 1895.

Mineral statistics—*Cont.*

During the year, various memoranda have been prepared in reply to questions upon special subjects, and in connection with mining and the mineral resources of the country.

Much of Mr. Ingall's time during the summer, was taken with the special investigation of the iron-ore deposits in the vicinity of the Kingston and Pembroke railway, in which work Mr. A. M. Campbell acted as general assistant. A first report upon the results of the investigation has been given on preceding pages, under the heading Ontario, in which province the entire district examined is comprised.

Palæontology and Zoology.

Palæontology and zoology.

Mr. Whiteaves submits the following report upon the work done in these branches of the Survey's operations.—

Publications

"The second part of the third volume of 'Palæozoic Fossils' was published in September, 1895, and has since been distributed. It consists of two papers, the one a 'Revision of the Fauna of the Guelph formation of Ontario, with descriptions of a few new species' and the other a 'Systematic List, with references, of the Fossils of the Hudson River or Cincinnati formation of Stony Mountain, Manitoba.' The first of these papers was written in 1894, but the receipt of an important consignment of additional specimens from Mr. J. Townsend, in January, 1895, necessitated considerable additions to the manuscript and a final revision thereof. The second was written in the early part of 1895.

"Considerable progress has been made with the MS. of the third part of the third volume of 'Palæozoic Fossils.' This part is intended to consist of an illustrated report upon the fossils of the Cambro-Silurian rocks of Lake Winnipeg and its vicinity, based upon the large collections made by various officers of the Survey during the last fifteen years or more. A paper description of eight new species of fossils from these rocks has been published in the 'Canadian Record of Science' for July last.

Fossils from British Columbia.

"Ten boxes of fossils from the Cretaceous rocks of Hornby, Denman and Vancouver islands, have been received from Mr. Walter Harvey, of Comox, B.C., and one box of fossils from the Comox River, B.C., from Mr. J. B. Bennett of Comox. These have been critically examined and most of the species determined. They throw much new light on the fauna of these rocks, and give some new and important information which it is intended to utilize in the preparation of the fourth and concluding part of the first volume of 'Mesozoic Fossils.' In the mean time, a paper entitled 'Notes on some Fossils from the Cretaceous Rocks of British Columbia, with descriptions of two species that appear to be new,' has been published in the April number of the 'Canadian Record of Science.' This paper consists of a preliminary description, which it is intended to reprint, with such modifications as may be necessary and with illustrations, in the 'Mesozoic Fossils,' of some of the most interesting specimens in Mr. Harvey's collections. These specimens he has generously presented to the museum. No short-tailed decapod crustaceans or fossil crabs had previously been recorded as occurring in the Cretaceous rocks of the Dominion, but in the collections of fossils made by Mr. Harvey in 1891-93 at Hornby Island and the Comox River, there are several specimens of three species. Specimens of each of these, and of an additional species of fossil crab from the Cretaceous rocks of the Queen Charlotte Islands, were sent to Dr. Henry Woodward, F.R.S., president of the Geological Society of London and an authority on fossil crustacea,—who exhibited them at the meeting of the British Association at Ipswich last September, and read a paper upon them, in which all four were described as new to science. Palæontology and zoology—*Cont.*

"In September, also, Dr. C. F. Newcombe, of Victoria, B.C., visited the Queen Charlotte Islands and collected a fine series of the fossils of the Cretaceous rocks at Skidegate and Cumshewa inlets, which he has kindly promised to send to the writer for examination. So far, four consignments of these fossils have been received and most of the species therein have been determined. Dr. Newcombe has also sent, during the year, some additional species of fossils from Hornby and the Sucia islands. The whole of these specimens will be most useful in enabling the writer to complete a revision of the fossil faunæ of the Cretaceous rocks of the Queen Charlotte and Vancouver islands. In the early fall a few days were spent, with Dr. Ells and Mr. Giroux, in the examination of several rock-exposures on the Island of Montreal and its immediate vicinity, and in determining the exact geological horizon of each, upon purely palæontological evidence. At St. Vincent de Paul, on Isle Jésus, the lower beds of the Trenton limestone, with their characteristic fossils, were seen to lie immediately and conformably on the Black River limestone.

"In Zoology, a paper entitled 'Additional notes on Recent Canadian Unionidæ' was published in the April number of the 'Canadian Record of Science,' and another, a 'Note on the occurrence of *Primnoa reseda* on the coast of British Columbia,' was read at the last meeting of the Royal Society of Canada, and has since been Zoology.

Palæontology and zoology—*Cont.*

published in its Transactions. A small series of recent marine shells from Alert Bay, B.C., has been named for Mr. Harvey, in return for favours received, and specimens of eighty-five named species of duplicate shells, mostly from the Vancouver district, have been sent to Mr. Herbert H. Smith, of Brooklyn, New York, in exchange for specimens received last year.

"Several interesting additions to the Survey's collection of native birds, birds' eggs, mammals, etc., have resulted from Professor Macoun's explorations in the North-west Territories during the past summer, (and more particularly a pair of the Sage Grouse, *Centrocercus urophasidnus*, and a fine example of the Yellow-haired Porcupine, *Erethizon dorsatus*, var. *epixanthus*, both from the White-Mud River, Assiniboia) but these will be referred to more in detail in his report. In addition to these, several interesting species of mammals, birds, birds' eggs, etc., have been acquired by presentation, exchange or purchase. Among them are a specimen of the Red-backed Mouse, *Evotomys rutilus*, from Metcalfe, Ontario; two specimens of the Whistling Swan, *Olor Columbianus*, one from St. Clair Flats, Ontario, the other from Manitoba; a fine male of the brown Pelican, *Pelecanus fuscus*, shot on Pictou Island, N.S.; a female Richardson's Merlin, *Falco Richardsonii*, with three downy young ones,—and a female American three-toed Woodpecker, *Picoides Americanus*,—all from the neighbourhood of Calgary, Alberta. The acquisition of these and of other rare specimens for the museum often entails considerable trouble and a more or less lengthy correspondence. Four mammals and 110 specimens of birds have been mounted by Mr. S. Herring during the year, and he has gone over and cleaned, as he does annually, all the mounted vertebrata in the museum. The collection of stuffed birds, mammals, etc., for the museum in connection with the Rocky Mountain Park at Banff, referred to in my last report, was sent there in the spring."

Work of Dr. Ami.

"Dr. H. M. Ami has during the year completed the local lists of fossils to accompany Dr. Ells's report on the Geology of the south-west quarter-sheet of the 'Eastern Townships' map of Quebec. This appendix contains an extensive series of systematic lists of fossil organic remains, arranged chronologically and zoologically, employed in the definition of the different geological formations represented, in so far as these have yielded fossils.

"A similar appendix has been prepared to accompany a report on the geology of the Great Manitoulin and other islands in Lake Huron by Dr. R. Bell, including fossil remains from the Cambro-Silurian formations of that district.

"Systematic lists of fossils have also been prepared and filed, for reference, from collections made by Dr. R. W. Ells, Mr. J. F. Whiteaves, Dr. W. E. Deeks, the late J. Richardson, Mr. T. C. Weston, Mr. N. J. Giroux, the late Scott Barlow, Mr. W. F. Ferrier, Dr. Robert Bell, Mr. A. E. Barlow, Mr. Hugh Fletcher and by himself and others from various places in the provinces of Nova Scotia, New Brunswick, Quebec and Ontario. These lists include collections (1) from twenty-two localities in Nova Scotia; (2) from thirty-four localities in Quebec; (3) from eight localities in New Brunswick and from seven localities in Ontario. A considerable addition of material both new to Canada and new to science was made during the year, and among other valuable additions are several Cambro-Silurian forms which serve to illustrate species described by R. P. Whitfield and Alpheus Hyatt from the 'Fort Cassin Rocks' of Vermont. Palæontology and zoology.—*Cont.*

"The examinations above referred to, comprise in all more than 60 separate collections. Besides these, he has also recorded for reference lists of fossil organic remains from the Cretaceous coal-bearing rocks at Anthracite, Alberta; from the Silurian of Hamilton, Ont., collected by Col. C. C. Grant; from Highgate Springs, Vermont, collected by himself in 1883; from the Shumardia limestone of Point Lévis &c., collected by Mr. T. C. Weston, 1894.

"Work has been continued on the fossils of Lake Temiscaming, where an interesting outlier of the Silurian occurs, and drillings obtained from a couple of borings have been examined and reported upon. In the early part of the year he prepared a provisional catalogue of the species of fossil remains contained in the collection, and began a catalogue of the species of fossils described by the late E. Billings, with exact references.

"Much miscellaneous work of a routine character has also been attended to, such as the reception and cataloguing of specimens, both palæontological and ethnological.

"On the 25th of September, Dr. Ami was instructed to go to Nova Scotia for the purpose of obtaining, if possible, palæontological evidences of the age of certain rocks of Pictou county, in conjunction with work carried on there by Mr. Hugh Fletcher. He spent nearly four weeks there, and obtained a large suite of specimens, which, in many cases, serve to throw considerable light upon the age of the iron-bearing rocks of Pictou county. A few days were also spent in Antigonish county and in Cape Breton with Mr. Fletcher in similar work. Field-work.

"During the year, Dr. Ami has been absent on leave for a period of nearly four months on account of illness.

Palæontology and zoology—*Cont.* Work of Mr. Lambe.

"During the first half of the year, Mr. L. M. Lambe was engaged in a preliminary study of the fossil corals of Canada, with the idea of concentrating later on each group in turn, the object being a revision of this important class. It was necessary at first to ascertain what material was available for study besides the specimens exhibited in the museum cases. To accomplish this end, about ninety boxes, in the outbuildings, containing fossils from different horizons and from many typical localities in several parts of the Dominion, were examined, and any corals that were thought likely to throw light on the structure, etc., of the peculiar group were selected and placed in the basement workroom in the Survey building so as to be readily accessible. From the duplicate specimens in the drawers beneath the museum cases, a series of corals was also selected. These in conjunction with those already mentioned constitute the mass of material now arranged for study.

"Having completed a preliminary examination of the Canadian fossil corals as a whole, Mr. Lambe in the latter half of the year concentrated on a few particular groups, in the hope of adding to the knowledge of their structure and affinities and of their relation to geological horizons in this country. Critical notes relative to certain genera and species have been prepared and it is hoped to have the first of a series of short papers ready for publication shortly.

"In connection with work being carried on by Mr. Whiteaves, Mr. Lambe has also, during the year, prepared drawings of certain fossils from the Cretaceous rocks of the Pacific coast and the Trenton of Lake Winnipeg, to illustrate the papers or reports already mentioned as published or in course of preparation. Drawings were also made of a collection of Tertiary plants from Burrard Inlet, B.C., to be used in illustration of a paper, by Sir J. William Dawson, for the current volume of the Royal Society of Canada. The specimens described and illustrated in this paper are chiefly those collected by officers of the Survey or presented to it. These have now been named and returned to the museum.

"While finishing his studies of the recent marine sponges of the North Pacific, he named for the Smithsonian Institution at Washington, D.C., the remainder of the specimens collected by Dr. Dall some years ago in that region, and received for the museum in return, a first set of duplicates of the collection.

Contributions to museum.

"The following is a list of specimens collected by or received from officers of the Survey during the year 1895, in addition to those collected by Professor Macoun, which will be found enumerated in his report:—

Dr. Robert Bell :—

Several specimens of Devonian fossils from the lower part of Moose River. Bird-skins from Manitoba and Cross Lake, Nelson River.

Contributions to museum—*Cont.*

Dr. R. W. Ells :—

Several specimens of Cambro-Silurian fossils from Montreal and its vicinity.

J. B. Tyrrell :—

About twelve specimens of five species of Cambro-Silurian fossils from Markham Lake, on Telzoa River. About 200 specimens of 20 species of Cambro-Silurian and Silurian fossils from the mouth of Churchill River. Forty specimens of marine shells, from Hudson Bay. About thirty specimens of fresh-water shells from Manitoba and Keewatin.

Dr. H. M. Ami :—

1320 specimens of Palæozoic fossils from various formations in Pictou Co., Nova Scotia.

100 specimens from the productive coal measures of Indian Cove, North Sydney, Cape Breton Co., Nova Scotia.

A. P. Low :—

Fifty specimens of fossils from the Cambro-Silurian rocks at the Radnor Forges, Champlain Co., Que.

L. M. Lambe :—

Three specimens of Trenton fossils from Cap à l'Aigle, Murray Bay, Que.

Wm. McInnes :—

One bone skin-scraper, from Otukamamoan Lake, Rainy River District.

N. J. Giroux :—

One hundred and fifty spe imens of fossils from Glengarry, Prescott, Russell, Stormont and Dundas. Fifteen marine fossils from the Pleistocene deposits of the counties of Soulanges and Glengarry.

James McEvoy :—

One stone pestle from the interior of British Columbia.

W. J. Wilson :—

About forty specimens of Utica fossils from Clear Lake, Renfrew Co., Ont.

Contributions to museum—*Cont.*

The additions to the palæontological, zoological and Ethnological collections during the year, from other sources, are as follows :—

By presentation :—

(A. *Palæontology.*)

Sir J. W. Dawson, Montreal :—

A series of named specimens of four species of Microsauria, and one specimen of the rare *Anthrapalæmon Hilli*, all from the Coal Measures of the South Joggins, N.S.

J. B. Hobson, Vancouver, B.C. :—

Eight specimens of fossil fishes from the Tertiary rocks of the Horse-fly River, B. C.; three specimens of two species of fossil wood from the auriferous gravels of the same river; and three specimens of two species of fossils (*Monotis* and *Aulacoceras*) from a Triassic boulder at the Horse-fly Hydraulic Mining Company's pit, Cariboo, B.C.

C. Hill-Tout, New Westminster, B.C. :—

Twenty-four specimens of fossil plants from Burrard Inlet, B.C.

Colonel C. C. Grant, Hamilton, Ont. :—

Seven specimens of fossils from the Niagara formation at Hamilton, and one from the Hudson River or Trenton drift.

Alex. Graham, Ottawa :—

Humerus, ulna and part of radius of seal (probably *Phoca Grœnlandica*) from the Pleistocene clay at Graham's brick-yard, near Ottawa.

James Gibbons, Edmonton, Alberta :—

Portion of molar of mammoth found about six miles above Edmonton.

C. A. Magrath, Lethbridge, Alberta :—

Fine large specimen of an Ammonite (*Placenticeras placenta*) from the Cretaceous shales near Lethbridge.

Walter Harvey, Comox, B.C. :—

Fine specimens of *Anisoceras Vancouverense*, and three other rare orunique Cretaceous fossils from Hornby Island, the types of two species recently described in the 'Canadian Record of Science.'

Contributions to museum—*Cont.*

J. B. Bennett, Comox, B.C. :—

Two specimens of a long-tailed decapod *(Podocrates Vancouverensis)* from the Cretaceous rocks of the Comox River, B.C.

The Smithsonian Institution, Washington, D.C. :—

A fine specimen of a fossil coral *(Streptelasma robustum)* from the Galena Trenton of the Red River Valley, Manitoba.

W. H. Porter, Fort Erie, Ont :—

Four specimens of fossils from the Corniferous rocks at Fort Erie.

T. C. Weston, Ottawa :—

Fifteen specimens of rare fossils from the Lévis limestones and shales at Lévis, P.Q.

Dr. H. M. Ami, Ottawa :—

Fifty specimens of fossils from the Montcalm market rocks, Quebec city; fifty specimens of graptolites from the Intercolonial railway cutting at Lévis, P. Q.; 100 specimens of graptolites from lot 5, range XV., Magog Township, Lake Memphremagog, P.Q., and a small collection from the Devonian shales, holding *Spirophyton*, at Sargent's Bay, Lake Memphremagog.

Walter F. Ferrier, Ottawa :—

Eleven species of fossils from the Pleistocene of Montreal, Murray Bay and Rivière du Loup, and twelve specimens of fo sils from the Trenton limestone at Murray Bay.

(B. *Zoology.*)

The Smithsonian Institution, Washington, D.C. :—

Forty specimens of twenty-two species of recent marine sponges from the North Pacific and Arctic Ocean.

Rev. W. Lowndes, Nassau, N.P.:—

Twenty-one species of marine shells from Nassau.

John McMenomy, Metcalfe, Ont. :—

Specimen of the Long-eared or Red-backed mouse (*Evotomys rutilus* var. *Gapperi)*, from Metcalfe.

J. H. Fleming, Toronto, Ont. :—

Egg of the king eider *(Somateria spectabilis)*, from the Cary Islands, Baffin's Bay.

Contributions to museum—*Cont.*

R. A. Fowler, Emerald, Lennox, Ont. :—

Mottled variety of field mouse *(Arvicola riparia ?)*, from Emerald.

R. S. Lake, Grenfell, Assa. :—

Two eggs of Swainson's hawk *(Buteo Swainsonii)*, three of the mallard *(Anas boschas)*, and five of the pintail *(Dafila acuta)*, from Assiniboia.

James Fletcher, Ottawa :—

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

Walter Harvey, Comox, V.I. :—

Five specimens of *Mactra falcata* and three of *Psammobia rubroradiata*, from Denman Island, P.Q.

(C. *Ethnology.*)

H. B. Munro, Renfrew, Ont. :—

One hundred and forty-two Indian implements from Lytton and Boothroyd's Flat, B.C., and from the vicinity of Pembroke, Ont.

W. H. Porter, Fort Erie, Ont. :—

Three arrow-heads, two sinkers and two fragments of Indian pottery, from Fort Erie.

C. Hill-Tout, Vancouver, B. C.:—

Forty specimens of chipped arrow- and spear-heads from Burrard Inlet, B.C.

James White, jun., Elphin, Ont. :—

One copper spear-head or knife found in Dalhousie township, Lanark, near the shore of Dalhousie Lake.

Mrs. De Hertel, Perth, Ont. :—

Copper spear-head ploughed up about thirty-five years ago near the head-waters of the Mississippi River, Frontenac Co., Ont.

Dr. T. W. Beeman, Perth, Ont. :—

One arrow-head of quartzite and two fragmentary spear-heads from Rideau Lake, Ont. :—

Malcolm McMurchy :—

One stone skin scraper, six fragments of pottery, a fragment of a pipe and a chipped flint, from the township of Collingwood, Ont.

Contributions to museum—*Cont.*

By exchange :—

Eggs of fifteen species of North American birds.

Trumpeter swan *(Olor Americanus)*, from St. Clair Flats, Ont., and females of the following species from western Ontario :—Semipalmated sandpiper, *(Ereunetes pusillus)*; turnstone *(Arenaria interpres)*; meadow lark *(Sturnella magna)*; American goldfinch *(Spinus tristis)*; white-throated sparrow *(Zonotrichia albicollis)*; chipping sparrow *(Spizella socialis)*; red-eyed Vireo *(Vireo olivaceus)*; Nashville warbler *(Helminthophila ruficapilla)*; chestnut-sided warbler *(Dendroica Pennsylvanica)*; and Blackburnian warbler *(Dendroica Blackburniæ)*.

By purchase :—

Brown Pelican *(Pelecanus fuscus)*, adult male shot on Pictou Island, N.S., in 1892.

Richardson's merlin *(Falco Richardsoni)*, adult female, and three downy young, from near Calgary, Alberta.

American three-toed woodpecker *(Picoides Americanus)*, adult female, from near Calgary.

Three eggs of the canvas-back Duck *(Aythya vallisneria)*, from Snake Lake, Alberta.

Twenty-eight bone implements and ten stone implements, of Indian manufacture, from various localities in British Columbia.

One copper implement (gouge or adze) from the township of Canonto, Ont.

Natural History.

Natural History.

Under this head, Prof. Macoun reports as follows upon the work accomplished in the office and museum.—

"After the date of my last summary report, I prepared a complete tabulated list of the birds known to occur in the Dominion of Canada and Alaska, as well as of all stragglers that have been taken on our northern coasts. The total number of forms known to occur in Canada is 624, of which 443 are represented in the museum collection. Our chief desiderata are sea-birds, and stragglers from Europe which are difficult to obtain. After the completion of this work, I began the arrangement of our Lichens. This, and the routine work of the office occupied me until my departure for the field.

Natural History—*Cont.*

"My assistant, Mr. Jas. M. Macoun, has been for the whole year occupied with herbarium work, but has not yet reached the collections of the past season; and the work of distributing exchanges has progressed but slowly, though enough have been labelled by Miss Barry, to balance accounts with those from whom we have received specimens, when time to distribute them is available.

Determination of specimens.

"The number of collections sent to the herbarium for determination increased materially during the year and was especially large during the collecting season. This branch of the work consumes considerable time, but it is a means of adding to our knowledge of distribution as well as a help to collectors. The most important of these collections were received from H. H. Gaetz, Red Deer, Alberta; Rev. H. H. Gowen, New Westminster; Dr. Newcombe and A. J. Pineo, Victoria, B.C.; and R. Cameron, Niagara, Ont. Of the Survey staff Messrs. Bell, Low and McEvoy brought in small collections from the regions in which they had been working.

Specimens distributed.

"Since December 31st, 1894, 4318 sheets of specimens have been sent to scientific institutions and individuals, for the most part in exchange for specimens sent us for our herbarium. The herbaria to which the largest number of specimens were sent, are:—

The British Museum	199
Kew Gardens	724
The Gray Herbarium, Harvard University	458
Botanical Museum, Copenhagen	125
Botanical Museum, Christiania	325
California Academy of Sciences	300
United States National Museum	295
Columbia College	339
University of Minnesota	150
Botanic Gardens, Natal	125
Missouri Botanic Gardens	426

"Specimens have been received during the year from all the institutions mentioned above, with the exception of the British Museum, Kew Gardens and the California Academy of Sciences. The most important collections were from Newfoundland and the state of Washington, both sent from the Gray Herbarium. Of the exchange with collectors, no details need be given here.

Additions to herbarium.

"The most valuable contribution to the herbarium during the year, was a set of the plants collected by Dr. G. M. Dawson, when on the Boundary Commission during the summers of 1873-74, in the vicinity of the forty-ninth parallel between the Lake of the Woods and the Rocky Mountains. This comprises about 400 species.

"During the year 3717 sheets of specimens have been added to our herbarium, as follows:— Natural History—*Cont.*

Canadian	1371
United States	895
European	373
Cryptogams	1078
Total	3717

"The work of the botanical department is at present in a better condition than it has ever been, and, after all the herbarium material has been got out, an attempt will be made to effect further exchanges for desiderata and to work up and describe some of the doubtful and new species in our herbarium. Routine office and herbarium duties have in the past left little time for this most important branch of our work."

The following short report, also by Prof. Macoun, relates to field work carried out by him during the season, in the North-west Territory:—

Field work by Prof. Macoun.

"In accordance with your instructions, I left Ottawa on May 13th, reaching Moose Jaw three days later. On the morning of the 18th, I started south with two men, a wagon and light cart, and provisions for two months. Our first camp was on Old Wives Creek, fifty miles from Moose Jaw.

"During the summer and autumn of 1894, there had been no fires between Moose Jaw and the crossing between Old Wives Lakes, yet the old grass was extremely short and the whole surface showed the effects of the long-continued drought, in the seedless grass, the cracked sod, the parched soil and dried-up ponds and grass-marshes. West of the crossing, the prairie had been swept by fire during August of last year, and only the hollows were now green. All the uplands were black, giving little or no response to the warmth of the sun.

"This was the condition of the country when the first rain came on May 24th. It rained, more or less, all day, and the next morning the moisture had penetrated three inches into the soil and by the evening of the 25th was down another inch. The effects of the rain were seen almost immediately, and very soon the black or brown hills had changed to green.

"Formerly Old Wives Creek was well-wooded throughout the lower part of its course, but now the wood is dead, and in a few years there will not be a stick left. The wood consisted of box-elder, with a little green ash and willow. There are still large thickets of shrubs, chief

Natural History—*Cont.*

among which are choke-cherry, cornus, white thorn, willows, saskatoon berry, rose bush and gooseberry.

"While camped on Old Wives Creek, large collections of birds, birds' eggs, small mammals and plants were made. On May 31st, we went south ten miles, to the forks of Old Wives Creek, passing for the whole distance over an undulating plain covered with short grass.

"At 'the forks' we found the skeleton of a turtle and a large dark-coloured water-snake, both of which must be very rare, as no more of them were seen during the season. The turtle is, apparently, the Oregon golden-turtle, *Chrysemys Oregonensis*, which Dr. Coues obtained in the Souris River in 1874. The water-snake was large, dark brown on the back and reddish-yellow beneath, and is probably the red-bellied water-snake, *Tropidonotus erythrogaster*, Shaw.

Rainfall.

"Between May 24th and June 2nd, there were almost daily showers, and by the latter date the moisture had, on the level prairie, got down into the soil nearly six inches, and the grass and flowers feeling its influence, began to grow with vigour.

"A day and a half after leaving the forks of Old Wives Creek, we reached Twelve-mile Lake, near Wood Mountain, and camped on the creek at its head. We saw no fresh water between Old Wives Creek and Twelve-mile Lake, and at Thirty-mile Creek, where we camped for a night, the water was so bad that one of the horses became sick from its effects. Owing to the long-continued drought, there was no water in the country except in running streams, and as this was the case all summer, our drinking water was carried in a barrel on the wagon.

Birds breeding.

"Twelve-mile Creek was found to be almost dried up, but the marsh at its head received the waters of the creek, and in the upper part of it waders and water-birds were still breeding, though in diminished numbers, as both shelter and water were scanty. Fully sixty species of birds were breeding, or preparing to do so, in and around the lake and on the prairie, but mammals of all kinds were very scarce.

"During the early days of June, more or less rain fell every day, and on the 8th there was a severe storm which left the ground whitened with snow until noon the next day. On the 10th we moved to Wood Mountain post, and by this time the rains had penetrated to such a depth that the drought was overcome and the soil thoroughly moistened. So rapid had been the change from brown to green in the covering of the country that men were heard to say that for eleven years grass had never before been so good at this season.

"Wood Mountain may have deserved its name many years ago, but now it is almost treeless and except in the stream-valleys and sides of coulées, there is no wood whatever. Protected by the Mounted Police considerable young wood is growing up around Wood Mountain post, and were fires prevented, the hillsides where snow-drifts form would soon be forest-clad ; for the aspen roots are still there, and were groves once started they would increase every year as the drifts would extend and give adequate moisture for tree growth.

Natural History—*Cont.*

Protection of young trees at Wood Mountain.

"From Wood Mountain post we travelled south until we reached the Boundary mound near Rocky Creek, where we camped. For two days we explored the 'Bad-lands' to the north-east of our camp and found the hills cut by the action of rain and frost into a great variety of shapes, but the vegetation about them differed in no respect from that of other alkaline soils. Scarcely a green thing was found on the hills themselves, owing to the waste that is constantly going on. A number of rare birds were breeding in crevices on the hillsides and nests of the arctic blue-bird, rock wren, Parkman' wren, the bald headed eagle and many species of hawks were seen or taken. We hoped here to get specimens of the sage hen, but on account of our ignorance of its habits we failed to secure any. Seven fine males were seen but disappeared before we got within range. We obtained good specimens later, on White Mud River, and learned that they are found the whole length of that river from the Boundary to, and into, the Cypress Hills. They live among the sage brush (*Artemisia cana*) in the river-valley, and lie so close that without a dog it is almost impossible to flush them. The last trace we saw of them was at Farewell Creek in the Cypress Hills.

Bad-lands near Wood Mountain.

"On June 17th we again left Wood Mountain post, with the intention of making our way to Cypress Lake near Fort Walsh on the south side of Cypress Hills. We reached the lake on June 29th and camped on Sucker Creek which enters the lake at its eastern end, where its discharge formerly was. For a number of years the waters of the lake have been drying up, and Sucker Creek now flows into the lake instead of into White Mud River.

"The grass was good, in fact very good, from Wood Mountain post to the crossing of the White Mud River, a distance of seventy miles. Water was found in all the branches of Old Wives Creek, but all ponds and marshes were dry and no water-fowl were seen at any time. Wood was even scarcer than water, for not a bush was seen except at the 'Holes,' where the watershed was crossed. The valley of the White Mud is wide and covered with sage-brush (*Artemisia cana*),

Grass good from Wood Mountain west.

Natural History—*Cont.*

greasewood *(Sarcobatus vermiculatus)* and cactus *(Opuntia Missouriensis)*. These may be said to constitute the great bulk of the vegetation in the river-valley from the boundary up into the Cypress Hills. Only four small trees were observed in the valley, and willow scrub was far from being continuous. Owing to the character of the river-bottom, safe crossings are few and even wading across is not always safe. We kept south of the river for thirty-one miles and in that time saw neither bush nor water. We then crossed to the north side and in a day reached East End post, where the old trail crosses the White Mud River. From there we ascended into the Cypress Hills, crossing over to Frenchman's Creek on which we camped for a day and made extensive collections of plants as well as careful notes on birds and mammals.

"Passing westward twenty-seven miles further, we camped at Sucker Creek for three days, while we communicated with Maple Creek and obtained supplies for our journey to the south. The four days spent here were devoted to collecting specimens of the flora and fauna of the vicinity, and much valuable information was obtained.

"We were now able to compare the fauna and flora of Old Wives Creek and Wood Mountain with that of the Cypress Hills, and found that in their main features there was very little difference. This was particularly true of the vegetation along the water-courses and of the prairies. It may be said here that from Moose Jaw to the foot-hills of the Rocky Mountains, by the course we travelled, the forage plants are practically the same. Locally they may vary slightly, but speaking generally there is no change. On rich and rather moist soil, the herbage and grasses are taller but the species are always the same. My decided opinion, after a summer spent on the open prairie, is that were shelter and water assured, there is no part of the southern prairie where cattle and horses will not fatten as well as along the foot-hills of the Rocky Mountains. Our horses ate only prairie grass all summer, and pulled a heavy wagon 1200 miles over faint trails or the unbroken prairie, reaching Moose Jaw in better condition than when they left in the middle of May. Day after day I watched them eat, and as they were always picketed they had to clean off the grass pretty well. While we were on the open prairie scarcely a blade was left; in the creek- or river-valleys, where the grass was good in our estimation, they were fastidious and ate only a few species. In the Cypress Hills and foot-hills of the Rocky Mountains they invariably left the 'bunch' grasses and turned to the species that formed a sward and grew on the driest ground. While the bunch grasses are therefore not so suitable for pasture, they are spoken of in Southern Alberta as being

Forage plants.

valuable for hay, and are in winter often the only available food when the shorter grasses are covered with snow. The very grass *(Festuca scabrella)* that is cut for hay on the Belly River ranches, grows all over the Cypress Hills and could be made into hay there. The fact that horses and cattle leave the coarser grasses untouched when pasturing, must not be taken as proof that they would not be readily eaten as hay in winter. Our cultivated grasses in the east are neglected in the same way, when shorter, sweeter grasses are to be had. If cut at the proper time, these coarse grasses are just as nutritious as the finer kinds, though perhaps not so pleasant to the taste. All the grasses of the prairie region are nutritious, but all are not suited for pasture, and while horses seem to prefer hay composed of grasses only, cattle will eat with avidity almost any green thing if made into hay.

Natural History—*Cont.*

"With an increase in the number of settlers and a wider knowledge of the capabilities of the country, Southern Assiniboia will become a valuable district. As regards its soil and climate, much of it is suited for agriculture, but my purpose now is to draw attention to the numerous small streams traversing it and the ease with which this water could be used for irrigation purposes and the watering of stock. It is not intended to assert that at present this region is in a condition to receive a large influx of settlers, but I do wish to say that the time will surely come when cattle, sheep and horses will be as plentiful in Southern Assiniboia as they now are in Southern Alberta. The settlement of this region will necessarily be slow, as it is almost wholly devoid of trees, and water is at present scarce, especially in the winter; but all these difficulties will in time disappear, as there are no physical disabilities which cannot be overcome by care and patience. As an experiment, a moderate outlay towards the sources of Swift Current Creek, would soon show whether a series of small dams in the region under consideration would not store enough water to irrigate sufficient land to produce hay, and a supply of water for a number of ranches or sheep farms, besides what might be needed for root crops and grain. Cattle and horses quite wild were frequently seen during the summer. They had evidently lived out all winter.

Value of Southern Assiniboia.

Erection of dams for irrigation purposes recommended.

"The first three days of July were very hot, and they had a marked effect on the grass south of Cypress Lake. On the 4th and 5th, we traversed the driest section seen during the summer, and camped on Spur Creek, a western branch of Willow Creek. Between Cypress Lake and Willow Creek, the grass was short but formed a sward. As we went west, the soil grew drier, and bare patches with more cactus frequent, especially after we crossed Willow Creek. This section had

Natural History—*Cont.*

escaped the June rains, and everything had ceased to grow, so that between Battle Creek and Spur Creek scarcely a plant had produced a flower.

"Very heavy rain fell on the 5th and 6th and saturated the whole country, so that from that date we had no difficulty in finding good water in pools. From Willow Creek to Sage Creek we crossed a cactus and alkaline plain, and owing to the recent rains found it almost impassable. This was the only worthless tract we saw during the summer, and where we crossed it, it was less than sixteen miles wide. A few miles south of Sage Creek we crossed a ridge, and could then look over the valley of Many-berries Creek as well as the Milk River country beyond it. Before we reached the ridge the soil had changed, and henceforth the grass was excellent and no bad-lands or poor pasture were seen again.

Cactus plain.

"After crossing Many-berries Creek, we turned south and kept down it until we reached the margin of Milk River, and could see the river meandering from side to side of the valley at least 300 feet below us. We now turned up the Milk River, and for over 100 miles, until we came to Milk River Ridge, always kept it in sight, and occasionally camped near it and descended into its valley and made natural history collections. A trip was made from the 'Castellated Rocks' to the West Butte, and collections and observations were made which showed the flora of the Sweet Grass Hills to be the same with that of the foot-hills of the Rocky Mountains.

Milk River.

"After passing these hills, we noticed a slight change in the vegetation, and although we were assured that the rainfall was light, we were convinced that the air contained more moisture, and hence produced heavier dews and retarded evaporation. Gradually the grass became taller, and a few miles east of the Benton Trail, a geranium (*G. incisum*), that is a real hygrometer, began to appear on the damp slopes of the hillsides and afterwards increased so much that it was a very prominent feature of both thicket and prairie in the foot-hills of the mountains.

Milk River Ridge.

"We were unfortunate in our weather while examining the Milk River Ridge, as it rained a great part of the four days we spent on it. Large collections were, however, made, and many notes taken on the fauna and flora. The 'Ridge' is a plateau with a system of lakes and creeks which contain excellent water and are the home of many species of water-fowl. A large part of the interior produces hay in great abundance, which is cut every year and taken to Lethbridge, the Police posts, and to various ranches in the neighbourhood.

"Late on the evening of July 20th, we descended the north-western face of the Ridge and camped near Pot-hole Creek. This stream is well named as it is nothing but a series of pools of very good water. The next day we reached the St. Mary River and camped in its valley. Extensive collections were made there, as well as in the valley of Lees Creek at Cardston and in the 'big bend' of Belly River. On the evening of July 27th we camped on the shore of Waterton Lake, almost under Sheep Mountain, which rises steeply from the water to an altitude of 7500 feet. Natural History—*Cont.*

"After reaching the St. Mary River, the whole country was covered with tall grass, which, in most places, was fit for hay and the soil was exceptionnally good. South of the Blood Reserve, between the St. Mary and Belly rivers, most of the land has been homesteaded by the Mormons and some very good farming has been done around Cardston and vicinity. All the settlers there expressed themselves as well pleased with the locality and their prospects. Morman settlements.

"Six days were spent collecting around Waterton Lake and on Sheep Mountain, and over 200 species of plants added to the season's list. On August 2nd, we started north, crossed Waterton River at Stand Off on the 3rd and passing by Fort McLeod reached Lethbridge on the 7th. From there I went by train to Medicine Hat, where I made collections of plants, as well as at Maple Creek, Moose Jaw and Indian Head, leaving the latter place on August 16th and reaching Ottawa on the 19th. The outfit in charge of my assistant and the teamster, I sent across the country from Lethbridge to Moose Jaw where they arrived August 28th.

"During the season close attention was given to the distribution of the summer birds of the region traversed and many interesting results were obtained. Besides their distribution, their breeding habits and the structure of their nests was carefully noted, and eggs were collected of at least seventy species during the past two seasons. Up to date the number of species of birds recognized in Assiniboia and Alberta is 226. Nearly all of them are represented in the museum collection. Water-fowl and waders breed in the above districts in enormous numbers, and egging expeditions, along the line of the Canadian Pacific Railway and north of it, should be stopped by the necessary legislation; as from the writer's personal knowledge such expeditions, in which thousands of eggs of game birds are destroyed, have been taking place for the past five years, greatly to the injury of the country. Distribution of birds.

"Botanical collections were made in all parts of the region traversed, and the distribution and occurrence of the species noted, and since my return the plants collected have been examined and determined.

Natural History—*Cont.*

"Perhaps the most important result of the past season's work, as shown by the flora of the region traversed, is that from Western Manitoba to the Milk River Ridge, the plants of Southern Assiniboia are practically identical with those of Southern Alberta. A comparison of these plants with collections made by me in 1879, at and around the Hand Hills, lead me to believe that Northern Assiniboia and Alberta have a warmer climate than the region south of the Missouri water-shed, probably as a result of lower elevation.

Causes of drought.

"Following out your instructions, I made inquiries of every person I met regarding the drought and the alleged drying up of the whole prairie region. Although the reasons given were often diverse, all agreed that lakes, pools and marshes were drying up, and that where water formerly stood, hay was now being cut. At every point visited during the summer, I took notes on the condition of the country, which have been in part embodied in the preceding summary. The conclusion I have reached is that such changes are periodic, throughout the region visited, and that the present dry period will pass and the lakes and ponds fill again.

"This agrees with the opinions expressed by most of the old settlers. If the snowfall is light and evaporates without turning into water, and this is followed by a dry spring, the ponds and marshes dry up, but if there is a heavy fall of snow in April or early May, the ponds will be filled and water plentiful.

"Last August, the drought was broken everywhere, and the ground fairly moist, but no water collected either in ponds or the sites of old lakes. Should this winter be a normal one and the melting snow in spring saturate the ground, I look forward confidently to a quick return of the condition of ten years ago. At any rate, I am satisfied that the permanent drying up of the country is a myth.

"Over 100 skins of birds and about 50 mammals were secured, principally of species collected last season."

Mr. J. Fletcher on Entomological collection.

Mr. James Fletcher, F.R.S.C., Entomologist and Botanist to the Central Experimental Farm, to whom the Geological Survey is greatly indebted for his services as honorary curator, in connection with the entomological collections in the museum furnishes the following report upon these collections:—

"I beg to report that the entomological collections are in good order, and that a few additions have been made during the past year.

The most important additions were contributed by Prof. John Macoun, who brought back a collection of Lepidoptera from seven different localities in the west. Natural History—*Cont.*

"The following rare species are worthy of record:—

Anthocharis Olympia, Walsh's Ranch, Old Wives Creek, 23rd May.
Hypparchia Ridingsii, *Satyrus Œtus*, *Chrysophanus Sirius*, } Milk River, near West Butte, 14th July.

"A small collection was also brought in by Dr. Robert Bell, and another was contributed by Mr. J. C. Gwillim. These consisted of only a few specimens; but as each insect was labelled with the locality and date of capture, they have a scientific value as bearing on the known distribution of species.

"A small collection of Coleoptera was made by Mr. A. P. Low in Labrador, and since I last reported to you, collections were made on the Alaska Boundary survey by Messrs. Ogilvy, St. Cyr and Wolston Small, and have been handed in.

"In accordance with your suggestion, I am preparing for the Museum of the Rocky Mountain Park at Banff a collection of butterflies characteristic of that neighbourhood. This will I think be ready by April next."

Maps.

Mr. James White reports as follows upon the condition of the mapping work in the office, and upon a connecting line of survey run by him in Ontario for the purpose of establishing the latitude and longitude of points in sheet No. 118 of the Ontario series:— Maps

"The ordinary routine work in connection with the laying down of projections and general supervision of the draughting has been attended to. Considerable time was also given to the preparation of the new list of publications.

"As the position of the townships in sheet 118, Ontario (Haliburton sheet) was somewhat doubtful, you deemed it advisable to connect the south-western part of the sheet with some point whose position had been accurately determined. In accordance with instructions I left Ottawa on the 16th September and proceeded to Gelert Station, where I joined Mr. Barlow. From this point we carried a traverse-line with transit and chain to the village of Waubashene on Georgian Bay, as its position had been determined by Commander Boulton in connection with the Georgian Bay survey. This fixes the position of

Maps—*Cont.* the townships in the south-western part of sheet No. 118 and along the traverse-line through the northern part of sheet No. 114. A few of the results are appended herewith, adopting the position of the Episcopal church at Waubashene (the terminal point of the survey) as given on chart No. 2102, viz., Long. 79° 42′ 24″ W., Lat. 44° 45′ 29″ N.:—

Gelert Station	Long. 78° 37′ 02″;	Lat. 44° 53′ 52″
Kinmount Station	Long. 77° 35′ 07″;	Lat. 44° 46′ 47″
Norland Post Office	Long. 78° 48′ 39″;	Lat. 44° 43′ 34″
Narrows between Lakes Couchiching and Simcoe	Long. 79° 21′ 44″;	Lat. 44° 36′ 16″

"A similar traverse in 1893 from Kingston to Sharbot Lake gave the following result:—

Sharbot Lake Station	Long. 76° 41′ 29″;	Lat. 44° 46′ 18″

"The maps published during the past year and in the course of preparation, are appended herewith.

Maps Printed in 1895.

	Area in square miles.
556. British Columbia—Kamloops Sheet—Geology.—(Dr. Dawson). Scale 4 miles to 1 inch	6,400
557. British Columbia—Kamloops Sheet—Topography, economic minerals and glacial striæ. (Dr. Dawson). Scale 4 miles to 1 inch	6,400
567. British Columbia—Sketch-map of the Finlay and Omenica rivers.—(Mr. McConnell). Scale 8 miles to 1 inch	7,000
560. Western Ontario—Sheet No. 6—Seine River Sheet.—(Messrs. McInnes and Smith). Scale 4 miles to 1 inch (preliminary edition)	3,456
558. New Brunswick, Prince Edward Island and Nova Scotia.—Sketch-map showing area occupied by Pleistocene glaciers at their maximum extension.—(Mr. Chalmers). Scale 40 miles to 1 inch	132,800
559. New Brunswick, Prince Edward Island and Nova Scotia.—Sketch-map showing striation from local glaciers and floating ice during closing stage of the Pleistocene.—(Mr. Chalmers). Scale 40 miles to 1 inch	132,800
561. New Brunswick and Nova Scotia—Sheet 4 N. W.—Cumberland Coal-field Sheet—Surface Geology. (Mr. Chalmers). Scale 4 miles to 1 inch	3,456
562. New Brunswick—Sheet 2 S. E.—Richibucto Sheet.—Surface Geology. (Mr. Chalmers). Scale 4 miles to 1 inch	3,456

563. New Brunswick and Prince Edward Island—Sheet 5 S. W.—Buctouche Sheet.—Surface Geology. (Mr. Chalmers). Scale 4 miles to 1 inch....................................	3,456	Maps—*Cont.*
387. Nova Scotia—Sheet No. 33—Cape George Sheet.—(Mr. Fletcher). Scale 1 mile to 1 inch....................................	216	
388. Nova Scotia—Sheet No. 34—Antigonish Town Sheet.—(Mr. Fletcher). Scale 1 mile to 1 inch..........................	216	
389. Nova Scotia—Sheet No. 35—Lochaber Sheet.—(Mr. Fletcher). Scale 1 mile to 1 inch....................................	216	
390. Nova Scotia—Sheet No. 36—West River St. Marys Sheet.—(Messrs. Fletcher and Faribault). Scale 1 mile to 1 inch....	216	
550. Nova Scotia—Sheet No. 37—Liscomb River Sheet.—(Mr. Faribault). Scale 1 mile to 1 inch..........................	216	
551. Nova Scotia—Sheet No. 38—Mosers River Sheet.—(Mr. Faribault). Scale 1 mile to 1 inch............................	216	

MAPS, ENGRAVING OR IN PRESS.

Western Ontario—Sheet No. 9—Lake Shebandowan Sheet.—(Mr. McInnes). Scale 4 miles to 1 inch..........................	3,456
Ontario—Sheet No. 125—French River Sheet.—(Dr. Bell). Scale 4 miles to 1 inch......................................	3,456
Ontario—Sheet No. 126—Manitoulin Island Sheet.—(Dr. Bell). Scale 4 miles to 1 inch..................................	3,456
Ontario—Sheet No. 131—Lake Nipissing Sheet.—(Mr. Barlow). Scale 4 miles to 1 inch..................................	3,456
Quebec—Lièvre River and Templeton Phosphate Mining District. Sheets I. and II.—(Messrs. Ingall and White). Scale 40 chains to 1 inch..	220
Quebec—South-west quarter-sheet of the "Eastern Townships" map—Montreal Sheet, Scale 4 miles to 1 inch............	7,200
Nova Scotia—Sheet No. 39—Tangier Sheet.—(Mr. Faribault). Scale 1 mile to 1 inch..................................	216

MAPS, COMPILATION COMPLETED.

Athabasca Territory and British Columbia—Sheets I., II. and III. (to illustrate the work of Mr. McConnell, 1889-90, and extending from long. 110° W. to 120° W. and lat. 54° N. to 60° N. Scale 8 miles to 1 inch..........................	150,000
District of Keewatin and Province of Ontario—Vicinity of Red Lake and part of Berens River—(Mr. Dowling). Scale 8 miles to 1 inch..	8,240
Ontario—Kingston and Pembroke Mining District.—(Mr. White). Scale 4 miles to 1 inch..................................	1,700
Quebec and North-east Territory, Labrador Peninsula, extending from the Atlantic Ocean to Hudson Bay and from the River St. Lawrence to Hudson Strait, four sheets.—(Mr. Low). Scale 25 miles to 1 inch..................................	525,000

Maps—*Cont.*

Nova Scotia—Sheets Nos. 40 to 42 and 49 to 52.—(Mr. Faribault). Scale 1 mile to 1 inch	1,512
Nova Scotia—Sheets Nos. 43 to 48.—(Mr. Fletcher). Scale 1 mile to 1 inch	1,296

MAPS, COMPILATION INCOMPLETE.

British Columbia—Shuswap Sheet.—(Mr. McEvoy). Scale 4 miles to 1 inch	6,400
British Columbia—West Kootanie Sheet.—(Mr. McConnell). Scale 4 miles to 1 inch	6,400
North-eastern Manitoba—Lake Winnipeg Sheet.—(Messrs. Tyrrell and Dowling). Scale 8 miles to 1 inch	20,000
Ontario—Sheet No. 129—Mississagui River Sheet.—(Dr. Bell). Scale 4 miles to 1 inch	3,456
Ontario—Sheet No. 138—Lake Temiscaming Sheet.—(Mr. Barlow). Scale 4 miles to 1 inch	3,456
Quebec—North-west quarter-sheet of the "Eastern Townships" Map.—(Messrs. Adams, Giroux and Low). Scale 4 miles to 1 inch	7,200
Quebec—Sketch-map of part of Joliette, Terrebonne, Montcalm, Argenteuil and Ottawa counties.—(Dr. Adams). Scale 4 miles to 1 inch	3,620
New Brunswick—Sheet 1 N. W.—Fredericton Sheet.—Surface Geology. (Mr. Chalmers). Scale 4 miles to 1 inch	3,456
New Brunswick—Sheet 2 S. W.—Andover Sheet.—Surface Geology. (Mr. Chalmers). Scale 4 miles to 1 inch	3,456
Nova Scotia—Sheet No. 10A—Cape Dauphin Sheet.—(Mr. Fletcher). Scale 1 mile to 1 inch	216
Nova Scotia—Sheet No. 12A—Sydney Sheet.—(Mr. Fletcher). Scale 1 mile to 1 inch	216
Nova Scotia—Sheet No. 12B—Little Glace Bay Sheet.—(Mr. Fletcher). Scale 1 mile to 1 inch	216
Nova Scotia—Sheets Nos. 53, 54, 55 and 66, 67, 68 and 69.—(Mr. Faribault). Scale 1 mile to 1 inch	1,548
Nova Scotia—Sheets Nos. 56 to 65, 76, 82, 100 and 101.—(Mr. Fletcher). Scale 1 mile to 1 inch	3,024

LIBRARY.

Library.

Dr. Thorburn, Librarian of the Survey, reports that during the past year ended December 31, there were distributed 12,583 copies of the Survey publications, comprising reports, special reports, and maps. Of these 9,924 were distributed in Canada, the remainder, 3,375, were sent as exchanges to other countries. Library—*Cont.*

There were sold during the year 1,711 publications, consisting of reports and maps, for which the sum of $388.49 was received.

There were received, as exchanges and donations 2,247 publications.

There were purchased 44 publications and the periodicals subscribed for were 31.

The number of volumes bound was 154.

In connection with the library 745 letters were received, in addition to 1,367 acknowledgments.

The number of letters sent out from the library was 553, besides 578 acknowledgments.

It is estimated that there are now in the library about 11,000 volumes besides a large collection of pamphlets. These relate mainly to the various branches of Geology, Mineralogy, Botany and Zoology.

It may be stated that the books in the library are available for consultation by any one wishing to obtain information in regard to any scientific subject in which he is interested, and a number of persons from time to time, take advantage of this provision.

VISITORS.

The number of visitors to the museum continue to increase, notwithstanding the imperfect manner in which a large part of the collections are displayed in the present building. During the year 1895, 26,785 names were registered in the visitors' book. Visitors.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is 47. Staff.

During the calendar year the following changes in the staff have taken place:

Dr. A. R. C. Selwyn, superannuated.

Mr. H. P. Brumell, resigned.

Dr. G. M. Dawson, appointed director and deputy head, *vice* Dr. Selwyn.

Mr. D. B. Dowling, appointed to the second class.

Mr. C. O. Sénécal, appointed to the second class.

Mr. James McEvoy, appointed in the technical class.

Mr. R. A. A. Johnston, appointed in the technical class

Appropriation and expenditure.

The funds available for the work, and the expenditure of the Department during the fiscal year ending the 30th June, 1895, including appropriations for boring in Alberta, were:

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	51,925 00	
Geo ogical Survey appropriation	61,129 51	
Artes an boring "	16,000 00	
Civil list, salaries		48,763 39
Exploration and survey		14,767 93
Wages of temporary employees		16,723 88
Boring operations, Deloraine		88 22
" " Athabasca Landing		7,688 82
Printing and lithography		18,424 23
Purchase of books and instruments		1,416 09
" chemicals and chemical apparatus		224 02
" specimens		175 56
Stationery, mapping materials and Queen's Printer		1,640 01
Incidental and other expenses		1,967 41
Unpaid balances, 30th June, 1894		1,142 92
Advances to explorers on account of 1895-96		4,773 87
		117,796 35
Less—Paid in 1893-94 on account 1894-95		214 63
		117,581 72
Unexpended balance Civil list appropriation		3,161 61
" " Artesian boring appropriation		8,311 18
	129,054 51	129,054 51

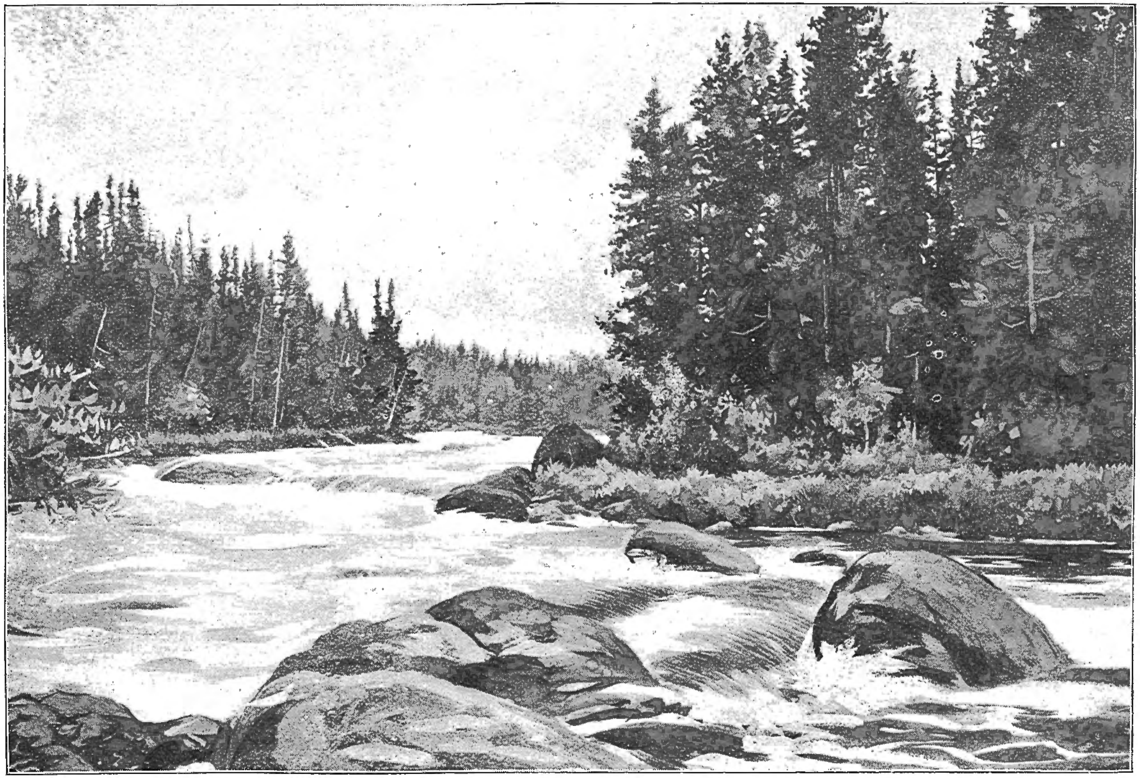
The correspondence of the Department shows a total of 7999 letters sent, and 8271 received.

I have the honour to be, sir,

Your obedient servant,

GEORGE M. DAWSON,

Deputy Head and Director.



J. B. TYRRELL.—Photo., Aug. 27, 1892.

WHITE SPRUCE FALLS, GEIKIE RIVER.

Drift-covered country, North of the watershed between Stone and Churchill Rivers.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE COUNTRY BETWEEN

ATHABASCA LAKE AND CHURCHILL RIVER

WITH NOTES ON TWO ROUTES TRAVELLED BETWEEN THE CHURCHILL AND SASKATCHEWAN RIVERS

BY

J. BURR TYRRELL, M.A., F.G.S., ETC.

ASSISTED BY

D. B. DOWLING, B.A.SC.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1896

GEORGE M. DAWSON, C.M.G., LL.D., F.R.S., &c.,

Director Geological Survey of Canada.

SIR,—I have the honour to present herewith a Report, accompanied by a map on the scale of twenty-five miles to one inch, on the country extending from Athabasca Lake to Churchill River, with brief descriptions of the routes followed between the Churchill and Saskatchewan rivers. The report has been somewhat delayed by my long absence during two seasons in the far north, since the completion of the work to which it relates.

I have the honour to be, sir,

Your obedient servant,

J. BURR TYRRELL.

Geological Survey Office,
19th May, 1896.

NOTE.—*The bearings given throughout this report refer to the true meridian.*

REPORT

ON THE COUNTRY BETWEEN

ATHABASCA LAKE AND CHURCHILL RIVER

BY

J. BURR TYRRELL,

ASSISTED BY D. B. DOWLING.

INTRODUCTION.

The present report is chiefly the result of an exploration carried out in the summer of 1892, to which is added the survey of the north shore of Lake Athabasca, made in the summer of 1893.

During part of the summer of 1892, while we were travelling along the same routes, Mr. D. B. Dowling acted as my topographical assistant. During the remainder of the summer he travelled over and surveyed independent routes, and his reports on these are included between quotation marks. Assistance

The geographical survey of the north shore of Lake Athabasca was made by James W. Tyrrell, C.E., in 1893, acting as my assistant. When unaccompanied by either of these gentlemen the surveys were made by the writer.

The map accompanying this report has been compiled by Mr. Dowling from the above surveys, with the addition of the survey of Churchill River by Mr. T. Fawcett, D.L.S. The position of Fort Chippewyan, near the west end of Lake Athabasca is taken from Mr. W. Ogilvie's map of Athabasca River. Map.

The Churchill River was first ascended from Frog Portage by some of the enterprising fur-traders from Montreal, who afterwards combined to form the North-west Company, and since that time it has formed one of the principal canoe-routes into the more distant country Early trade routes.

on the banks of the Athabasca and Mackenzie rivers. Sir Alexander Mackenzie, Sir John Franklin, Sir John Richardson and Sir George Back, all travelled along this stream on their way to and from the north and have given many glowing accounts of the beautiful scenery on its banks, while maps of the river, chiefly based on the surveys made by David Thompson, afterwards astronomer on the International Boundary Commission, are published in their works.

T. Fawcett. In 1888, T. Fawcett, D.L.S., made a micrometer survey of the river from Methy Portage to Frog Portage, but the geological character of its banks, and of the surrounding country have, up to the present, remained unknown, except for the brief description by Sir John Richardson.*

P. Turner. In 1790, Philip Turner was sent by the British Government to Fort Chippewyan to determine the truth of some reports about the nearness of that place to the Pacific Ocean. In the following year, after determining the latitude and longitude of the fort, he made a survey of the north shore (or perhaps of both shores) of Lake Athabasca, as far eastward as the mouth of Stone River. His survey was doubtless incorporated in Arrowsmith's map of British North America, but no account of his journey is known to be in existence.

D. Thompson. In 1796, David Thompson left his Trading House on Churchill River, and ascended Reindeer River to Reindeer Lake, followed and surveyed the west side of this lake to Canoe River, ascended Canoe River, crossed Wollaston Lake, and descended Stone River to its mouth in Athabasca Lake, stopping at a "lobstick," cut by Phillip Turner at the end of his survey five years before. His map of the route is incorporated in his large manuscript map of the North-west Territories now in the possession of the Crown Lands Department of Ontario.

A. S. Cochrane. In 1880 and 1881, the late Mr. A. S. Cochrane, then a topographical assistant on the Geological Survey, made a track-survey from Cumberland House on the Saskatchewan, northward by Frog Portage to Reindeer Lake, thence northward and westward up the Cochrane or Ice River, down Stone River and along the north shore of Athabasca Lake to Fort Chippewyan, thence southward up Athabasca River to Fort McMurray, and thence eastward up Clearwater River and down Churchill River to Frog Portage, thus travelling round the area treated of in this report. No report of this expedition was prepared or published, but Mr. Cochrane's note books were of considerable service as

*Arctic Searching Expedition by Sir John Richardson, vol. I., pp. 92-102, London, 1851.

a guide during the ascent of Stone River, and the upper portion of Cochrane River is laid down on the map from his survey.

Of the geography of the interior of the country within Mr. Cochrane's line of travel, embracing an area of about 60,000 square miles, nothing was definitely known before the present exploration was undertaken.

In carrying out the surveys here reported on, the party travelled chiefly in Peterborough canoes. The bearings throughout were taken with prismatic or by solar compass, observations being made daily, when possible, for variation. The distances on lakes and quiet water were measured with a Massey's floating boat-log, those on the Stone and Reindeer rivers with a Rochon micrometer, and the remainder were estimated by the rate of travel. Observations for latitude were taken almost daily with a sextant of 8-inch radius. A short itinerary of the journey of 1892 is given in the Summary Report of the Geological Survey for that year (pp. 12A-25A.) Modes of survey.

The total length of Athabasca Lake, surveyed in 1893, was determined by means of a pocket chronometer (Frodsham, No. 9697), which had been carefully rated both at the Meteorological Observatory in Toronto, and during our stay at Fort Chippewyan.

In regard to the microscopic determination of some of the rocks mentioned in the sequel, I desire to acknowledge the assistance of Prof. F. D. Adams of McGill University, and Mr. W. F. Ferrier of this Survey. Determination of rocks.

Physical Geography.

The present report refers chiefly to an area of about 60,000 square miles, bounded on the south by the Churchill and Clearwater rivers; on the west by the lower portion of Athabasca River; on the north by Athabasca Lake, Stone River, with its expansions, Black and Hatchet Lakes, Wollaston Lake and Cochrane or Ice River; on the east by the lower part of Cochrane River, Reindeer Lake and Reindeer River. It lies between north latitudes 55° 20′ and 59° 37′, and east longitudes 101° and 111° 30′. Area.

Between the Churchill and Saskatchewan rivers two lines were examined, one from Prince Albert north-westward by Green Lake to Ile à la Crosse, and the other from Stanley Mission south-westward by Montreal Lake to Prince Albert.

North of the Saskatchewan basin the country is drained by two main streams; the Churchill River, which flows eastward, and finally, River system after a course of about 1100 miles, discharges its waters into the west side of Hudson Bay at old Fort Prince of Wales; and the Athabasca-Mackenzie River, which carries its waters northward to the Arctic Ocean. These two drainage systems inosculate in Wollaston Lake, which discharges by almost equal streams into both.

Churchill River.

Churchill River, from its northern source at Portage la Loche, following its windings, has a length of 480 miles to the mouth of Reindeer River. It is a long series of very irregular lakes filled with clear blue water, connected by short and usually rapid reaches. The banks are low and thickly wooded with spruce and poplar. Some of the rapids are produced by rocky barriers, while others are over boulders and between banks of till, such as underlies much of the surrounding country. For a considerable part of its course it appears to flow near the line of contact of the Archæan and overlying unaltered rocks, though the topography is modified by the occurrence of strong glacial features.

The absence of a valley, even where the channel might be easily eroded, and the occurrence of the numerous lakes and rapids, shows that the river is, geologically speaking, very new.

The largest tributaries flowing into Churchill River from the south are Beaver, Sandy and Rapid rivers.

Beaver River.

Beaver River rises on the Cretaceous plateau, not far from Lac la Biche, and flowing first eastward for two hundred and fifty miles, and then northward for a hundred miles, empties into the south end of Ile à la Crosse Lake. Its course northward was alone surveyed. Here it is a rapid stream from 100 to 200 feet wide, flowing between low clay banks beautifully wooded with spruce and poplar. Much of the land along its course appeared to be well adapted for agricultural purposes, and the rank vegetation gave promise of abundant harvests.

Of Rapid or Forks River, Mr. Dowling writes as follows:—

Rapid River.

"This river enters the Churchill at Forks Lake, below the lake-expansion at Stanley Mission. It is the outlet at Lac La Ronge, a large oval-shaped lake having a length of nearly thirty-five miles, situated at a short distance to the south-west. This short stream has a heavy fall or series of rapids near the confluence with the English River. One of the tributaries entering the southern end of Lac La Ronge is the Big Stone River, from a lake of the same name a short distance above, and having for its chief branch the Montreal River, coming from the northern slope of the plateau crowned by

Montreal Mountain. It drains Montreal Lake which has an extent of thirty miles in length by about eight broad, as well as Deer Lake and several others of lesser size to the south-west. From Montreal Lake to near Big Stone Lake the stream cuts a valley through sandy deposits, but below this there is no well-defined valley. The general surface of the upper part is sandy, sustaining a growth of small pine, but in the vicinity of Lac La Ronge the prevailing character is more rocky, with spruce in the low ground."

The principal tributaries of the Churchill River from the north are the Mudjatick, Haultain, Foster and Reindeer rivers.

Mudjatick River is a swift, winding stream about eighty miles in length, generally flowing in a shallow channel through a sandy plain, in the bottom of a wide depression between ridges of granite. It is obstructed by comparatively few rapids, and these are for the most part over ridges of boulders. Its banks are thinly wooded with Banksian pine and spruce, and there is no soil of any value for agricultural purposes. Mudjatic River.

Haultain River was not examined, but at its mouth it seems to be about as large as Mudjatick River. Haultain River.

Foster River is very similar in size to the Mudjatick River, but it is altogether a wilder and rougher stream. Rising in the Foster Lakes it plunges down a series of heavy rapids over ridges of granite and gneiss until it approaches within a few miles of Churchill River. Here it enters a country more thickly covered with drift, and more densely wooded. Abandoning its direct course south-westward, it sweeps round in a long curve and finally empties into a northern arm of Black Bear Lake, one of the expansions of Churchill River. Foster Riv

Reindeer River is a wide, quiet stream seventy miles long, flowing southward from Reindeer Lake. It is obstructed by but four rapids. Its banks are generally low, and the stream rarely impinges against the rocky hills which compose the surrounding country. Reindeer River.

Reindeer Lake, from which Reindeer River flows, has an area of about 2200 square miles, and an elevation above the sea of 1150 feet. Its water is very pure and clear. It has a very irregular contour, and is dotted with innumerable rocky islands, these and the rocky shores being generally thinly covered with a sparse growth of small black spruce. Cochrane or Ice River is the largest stream flowing into Reindeer Lake. It takes its rise in Wollaston Lake, and flows at first eastward and then southward through a thinly wooded country, much of which is characterized by irregular sandy and stony hills. Reindeer Lake.

Wollaston Lake.

Wollaston Lake, though smaller than Reindeer Lake, is very similar to it in general character. Its irregular shores are chiefly composed of thinly wooded rocky hills, while very many rocky islands rise abruptly out of its clear blue water.

Geikie River.

Geikie River is, as far as known, the principal tributary of Wollaston Lake. It rises in some small lakes near the source of Foster River, and flows north-eastward through a thickly drift-covered country between low sparsely wooded banks. For long stretches it is straight and without current, giving it the appearance of a wide, quiet river or chain of long narrow lakes.

Watershed.

Wollaston Lake is the dividing line between the waters flowing to Churchill River and those flowing to the Mackenzie, for it is not only drained by the Cochrane River, but Stone River flows from its north-western angle.

Stone River.

This latter stream flows generally westward, at first through several small lakes in a country underlain by granite and gneiss and then, in a shallow channel, through a gently sloping country underlain by horizontal sandstone. In this portion of its course it is a swift stream, obstructed by many rapids, in which the water rushes over ledges or irregular masses of sandstone. The banks are sandy and poor, supporting but a short growth of small spruce and Banksian pine. In the lower part of its course it passes through Black Lake, below which it falls in a series of heavy rapids into the east end of Athabasca Lake.

Cree River.

Several tributaries join the Stone River from the south, but only one, the Cree River, was examined. This stream is very similar in character to Stone River itself, flowing from Cree Lake in a shallow channel, through a level sandy country. It is obstructed by many rapids, where the water passes over rough broken masses of sandstone. The surrounding country is sandy and very barren, supporting but a scanty growth of black spruce and Banksian pine, with very little underbrush.

Athabasca Lake.

Athabasca Lake is a long and comparatively narrow sheet of water, extending westward from the mouth of Black River to where the Athabasca-Mackenzie River drains the country towards the north. It lies in the bottom of a great valley excavated along the line of contact of the Archæan granites, etc., to the north, and the undisturbed Palæozoic sandstone to the south. On its south side is a great sandy plain, rising at its east end to a height of 500 feet above the lake, and gradually sloping westward towards the Athabasca-Mackenzie valley. The country to the north is composed of rugged, rocky hills, with a general slope in the same direction, but seen from the lake the slope is not so pronounced as in the level country to the south. Towards the eastern end of the lake the water is clear and pure, but at its western end it is rendered turbid by the muddy water discharged into it by the Athabasca River.

The district at present under consideration, lying north of the Churchill River, may be divided into two parts having different surface characteristics—that underlain by Archæan gneisses, granites, etc., and that underlain by horizontal Palæozoic rocks. The former consists of low, rocky hills and ridges from fifty to a hundred and fifty feet in height, between which are more or less extensive areas characterized by sand or by boulder-clay, thickly wooded with stunted spruce, containing small irregular lakes of beautiful transparent water. The latter is a monotonous sterile plain which, in its better drained portions, is thinly wooded with Banksian pine, without underbrush. Lakes are conspicuously absent, while the small streams flow over the surface in shallow channels. In both subdivisions the surface contour is low and little pronounced, the lower lands around the margin of the area, for the most part lying at an elevation of more than 1000 feet above the sea, while the lakes and plains in the vicinity of the watershed, in the centre of the area, are from 1500 to 1600 feet above sea-level, and some of the surrounding hills may be 150 feet higher. No deep valleys that might have been cut by the present streams or their preglacial representatives were seen. If such valleys existed previous to the glacial epoch they have been filled by glacial débris, and the streams now flow in shallow channels. In places, some of the streams seem to flow in the bottom of valleys from 100 to 200 feet deep, but on investigation the steep banks are discovered to be the sides of narrow ridges of glacial débris, described on a later page as Ispatinows.

Archæan area.

Palæozoic area.

Low contour.

No valleys.

The country between the Saskatchewan and the Churchill rivers is very different from that north of the latter stream. From Prince Albert, situated on the banks of the North Saskatchewan, at an elevation of 1400 feet above the sea, the surface rises with a gentle slope northward to a heavy stony morainic ridge, the highest point of which, on the Green Lake trail, was found to have an elevation of about 2220 feet. From this high ridge the country slopes gradually northward, at first with a gently rolling, and afterwards with a more even surface, to the chain of lakes and extensive swamps that lie along the edge of the district directly underlain by Archæan rocks. Most of the streams south of the high morainic ridge flow in deep valleys excavated in the boulder-clay and the underlying soft Cretaceous rocks, while to the north

Cretaceous plateau.

of the ridge, Green Lake lies in the bottom of an old valley which is not improbably of preglacial age. This country has very much the general appearance of that portion of north-western Manitoba to the west of lakes Manitoba and Winnipegosis, including the Duck and Riding mountains, previously described by the writer.*

Elevations.

The following is a list of elevations of some of the more important points, determined by aneroids, compared with standard mercurial barometers read at Prince Albert and Chippewyan :—

	Feet.
Summit, Green Lake Trail	2220
Green Lake	1440
Ile à la Crosse Lake	1330
Knee Lake, Churchill River	1250
Cree Lake	1530
Black Lake	1000
Wollaston Lake	1300
Foster Lake	1600
Black Bear Lake, Churchill River	1200

Forest trees.

The country is generally forested, though most of the timber is small black spruce (*Picea nigra*) and tamarack (*Larix Americana*). Banksian pine (*Pinus Banksiana*) forms thin park-like woods on the sandy plains. White spruce (*Picea alba*) forms some groves of fair size in the bottom lands near the Churchill River, but farther north it is rarely seen except in some particularly favourable localities. One small isolated grove of white spruce was found on a high sandy island in Hatchet Lake, standing out conspicuously in the midst of the surrounding forest of small black spruce. Poplar (*Populus tremuloides*) and birch (*Betula papyrifera*) are the only remaining forest trees of any importance. They are found chiefly in the vicinity of Churchill River, though small scattered trees were seen on the banks of Stone River.

Berries.

In places some of the more northern berries grow in great profusion, chief among which are the common huckleberry (*Vaccinium Canadense*) and the small cranberry (*Vaccinium Vitis-Idœa*). The former grows in the deciduous woods along the Churchill River, while the latter covers the dry slopes from the Saskatchewan northward. The blue huckleberry (*Vaccinium uliginosum*) grows on the banks of Cree and Stone rivers, but the bushes did not seem anywhere to bear much fruit. The raspberry (*Rubus strigosus*) grows on the richer ground by some of the streams. The yellow swamp-berry (*Rubus chamæmorus*) is found abundantly in the moss of the wet spruce and

* Annual Report Geol. Surv. Can., vol. V., part E., 1890-91.

tamarack swamps. The crowberry *(Empetrum nigrum)* occurs on the drier land towards the north, and the Pembina berry *(Viburnum pauciflorum)* grows in the deciduous woods beside the streams, especially in the southern portion of the district.

The fauna of the district is represented by a considerable number of species, but in many cases the number of individuals is not large.

The moose (*Alces Americanus*) roams through the more thickly wooded parts of the country as far north as Stone River, which is probably near the northern limit of its range. Seven individuals in all were seen during the course of the summer. The woodland caribou (*Rangifer caribou*) is said to occur in the more southern portion of the district, near Churchill River, but none were seen. The barren ground caribou (*Rangifer Grœnlandicus*) comes south in winter to the south end of Reindeer Lake and the upper portion of Mudjatick and Foster rivers. It travels north in spring to the Barren Grounds, but a very few animals are occasionally left behind, one having been shot in July near the north end of Cree Lake. The Canada lynx (*Lynx Canadensis*) is moderately abundant in some seasons in the more southern part of the district. The gray wolf (*Canis lupus occidentalis*) roams over the country, but is not plentiful. The coyoté (*Canis latrans*) is found occasionally as far north as the height of land, one having been shot by the writer on one of the small lakes near the source of Foster River. It is, however, certainly not common in the district.* Mammals.

Red, black and cross foxes (*Vulpes vulgaris*), wolverene (*Gulo luscus*), marten (*Mustela Americana*), weasel (*Putorius vulgaris*), mink (*P. vison*) and skunk (*Mephitis mephitica*) are all found in greater or less abundance in the rolling wooded country underlain by Archæan rocks. The otter (*Lutra Canadensis*) was found on all the streams north to Stone River. The black bear (*Ursus Americanus*) roams over the whole country. A few beavers (*Castor fiber*) may still be met with in many of the streams. A considerable colony was found in the untravelled country near the source of Geikie River, but our canoemen brought back word of this (to the Indians) important discovery, and doubtless the beaver were killed during the following winter. The muskrat (*Fiber zibethicus*) was seen swimming in all the streams. The rabbit or American hare (*Lepus Americanus*) is found everywhere in the denser woods, but it did not seem to be anywhere abundant. The porcupine (*Erethizon dorsatus*) was plentiful

* Further west, it finds its northern limit at Athabasca Landing. G. M. D.

around Cree Lake, and in those portions of the sandy country that had not recently been hunted over by Indians. The red squirrel (*Sciurus Hudsonius*) and the northern chipmunk (*Tamias Asiaticus*) were found everywhere in the wooded country. Doubtless many other of the smaller species of mammals occur, but they were not observed.

Birds.

The time at our disposal did not permit us to make a close examination of the birds seen, but generally speaking, except along the banks of Churchill River, where ducks breed in great numbers, birds are not at all numerous in the district explored. With the exception of one or two species of merganser, but few ducks were seen, as there is very little food for them in the clear lakes and rivers. The great northern and red-throated divers were moderately abundant on the lakes. No swans and very few geese of any species were seen. Coveys of ruffed grouse and spruce partridge were found in the thicker woods everywhere. A few snowy owls and bald-headed eagles were observed, and a large golden eagle was shot beside its nest on a rocky cliff overlooking Stone River.

Fish.

Fish seem to be everywhere abundant in the lakes and streams, but the number of species is very limited. The lake trout (*Cristivomer namaycush*) is, however, the largest of the finny tribes. One was caught near the mouth of Stone River weighing twenty-five pounds. The white fish (*Coregonus clupeiformis*) is found everywhere throughout the district, but more especially in the shallower lakes. The blue fish or Back's grayling (*Thymallus signifer*) was caught in Stone River at the foot of the heavy falls below Black Lake. Pike (*Esox lucius*), pickerel (*Stizostethium vitreum*), methy (*Lota lacustris*) and two or more species of suckers (*Catastomus teres* and *Myxostoma macrolepidota*) were found in almost all the water stretches.

Natives.

The number of Indians who live in and travel through the country, obtaining a precarious existence by hunting and fishing, is very small. They are centred around four trading posts, namely, Methy Portage, Ile à la Crosse, Rapid River or Stanley, and the south end of Reindeer Lake. Those that trade at the last two posts are chiefly Crees or Nahathaways, while those at the two former posts are mostly Chippewyans. A few Chippewyans also come south-west into the country from Du Brochet Post, at the north end of Reindeer Lake. The total number hunting in the district is probably not more than three or four hundred in all, or about one person to every 150 square miles.

GENERAL GEOLOGY.

The rocks examined in the district covered by the present report, and described in detail in its later portion, may be tabulated as follows :—

RECENT.

Present lake beaches, and flood-plains of the present streams.

PLEISTOCENE.

Sand plains near the height of land, along Mudjatick River, &c.
Ancient shore-lines around Hyper-Cree Lake, Hyper-Black Lake, &c.
Till, drumlins, moraines, kames, eskers, ispatinows.

CRETACEOUS.

Pierre —Dark gray shales.
Niobrara-Benton.—Calcareous shales.
Dakota.—Sandstones, mostly incoherent.

CAMBRIAN.

Athabasca Sandstone (Keewenawan).—Red sandstones and mottled sandy shales, in more or less horizontal position.

HURONIAN.

White quartzites, fine red calcareous sandstones, hälleflintas and thinly foliated green schists, seen on the north shore of Lake Athabasca.

LAURENTIAN.

Hornblende- and mica-granites and granitoid gneisses, norites and gabbros, often showing signs of severe crushing and contortion.

LAURENTIAN.

The name Laurentian is applied in the aggregate to the crystalline, altered, crushed and contorted rocks of the basement complex, consisting in this region of hornblende-granites, biotite-granites, muscovite-granites, and granitoid gneisses of the same composition, with gabbros Basement complex.

and norites. These are all welded closely together, and, although some are clearly intrusive in the others, and therefore younger, they are necessarily classed in one great group in default of evidence rendering it possible to arrange them in any definite time-series, in this region.

Extent of area underlain by gneiss.

These rocks are found outcropping on Churchill River, from two miles below the mouth of Mudjatick River eastward to the mouth of Reindeer River, beyond which the river was not examined. Thence northward they occupy the whole, or almost the whole of the eastern part of the district, while further west they extend northward to Cree Lake, where they disappear under the overlying Athabasca sandstones. North of the sandstone area they occupy most of the northern shores of Athabasca and Black lakes. Throughout the greater portion of the area, the rock consists of light reddish-gray hornblende-granite, and biotite-granite or granitoid gneiss, worn into low rounded hills and ridges. The gneiss does not appear to have any very persistent strike. In thin sections under the microscope, much of the gneiss exhibits cataclastic structure, showing it to have been subjected to severe strain and crushing. Some areas were found to be underlain by a white muscovite-granite. This is typically developed east of Hatchet Lake and in some islands in Wollaston Lake, and is doubtless intruded through the surrounding hornblende-granite-gneiss. On Mudjatick River the rock is for the most part a similar whitish granite, which, however, is often found to be more or less distinctly foliated.

Gabbro.

On the north shore of Athabasca Lake, west of Fond du Lac, is an area of medium-grained reddish gabbro, in places crushed and showing a distinct foliation, but how it is related to the surrounding gneisses was not determined. On the same shore, twenty miles east of Fond du Lac, a range of dark-gray, rocky hills rises to a height of several hundred feet above the water, and continues eastward for fifty miles, to the north-west shore of Black Lake. The rock, which doubtless represents an intrusive mass, consists essentially of a pleochroic, orthorhombic pyroxene, probably hypersthene (often altered to brown hornblende), plagioclase, some quartz and ilmenite. It may therefore be classed as a norite. In some places it is heavily jointed and almost massive, while in other places it shows a well marked gneissic structure. Near the shore it is occasionally seen in contact with reddish-gray biotite-gneiss, and near the line of contact garnets have been developed in the norite in great abundance. They are also found, though not quite so abundantly, in the biotite-gneiss.

Norite.

Huronian.

As far as is at present known, the Huronian is represented in this district solely by three small areas on the north shore of Lake Athabasca. The most important of these is just east of the long point east of Black Bay, and extends for sixteen miles along the shore. It consists of a hard, white, crushed quartzite, in which heavy bedding can often be detected. It lies on the gneiss in a wide syncline and strikes in a more or less northerly direction, apparently covering a large Λ shaped area. On its eastern border, near the line of contact with the adjoining gneiss, is an extensive development of hæmatite, often associated with a coarse quartzite breccia. From the top of a hill, this ridge of hæmatite was seen to extend a long distance inland along the strike of the quartzite.

Area underlain by quartzite.

Near the north-west angle of Black Bay, on Slate Island, the Huronian is represented by dark-brown thinly foliated ferruginous chlorite schists, associated with a band of coarse green conglomerate, with well rounded pebbles and a scanty chloritic matrix; and two miles further west, on the main shore, is an exposure of thickly foliated light-green hälleflinta, interlaminated with bands of granite. Similar green schists were also seen on the shore for several miles to the south-west of the mouth of Cypress River.

Ferruginous schists at Slate Island.

Between twenty-five and thirty miles north-east of Fort Chippewyan, the shore is bordered for several miles by green and red calcareous quartzose schists, striking parallel to the edge of the lake, with nearly vertical dips. They lie at the foot of a rather high ridge of Laurentian gneiss, and towards the south they seem to pass into a fine-grained, highly altered, red calcareous sandstone.

Calcareou schists.

Cambrian.

Athabasca Sandstone.

This is an extensive series of generally horizontal red sandstones and conglomerates, resting on the uneven surface of the Archæan granites and gneisses. The sandstone was previously seen by Mr. McConnell at two places on the south side of Lake Athabasca, and placed by him in the Cambrian, with the local designation of "Athabasca Sandstone."*

*Report on a portion of the District of Athabasca, by R. G. McConnell. Annua Report Geol. Surv. Can., vol. V. (N.S.), 1890-91, p. 51 D.

In 1892, no further information respecting the age of these sandstones was obtained by the writer, but in the following year, while exploring the country northward towards Chesterfield Inlet, similar sandstones were found overlying the Archæan, associated with quartz-porphyries, diabases, &c., like those of the Keewenawan rocks of Lake Superior. The likeness is so pronounced throughout, that there would seem to be little doubt that the two sets of rocks belong to the same geological horizon.

Horizontal red sandstone.

The formation is everywhere much the same in this district, consisting chiefly of a reddish, moderately coarse-grained quartzose sandstone. At some places near the base of the series, especially on the north shore of Lake Athabasca, the rock becomes a coarse conglomerate, with well-rounded pebbles of white clastic quartzite like that of the neighbouring Huronian rocks. In other places, as on Wapata Lake, it is a fine-grained, thin-bedded red shaly sandstone, mottled with rounded spots of a greenish-gray colour.

Diabase dyke.

It is almost everywhere nearly horizontal, the exceptions to this rule being slight and local. It was not found to be cut by eruptive rocks except at one point on the west shore of Cree Lake, where a dyke of coarse, light-green uralitic diabase has cut through it, and altered the sandstone on both sides to a hard quartzite.

Area underlain by sandstone.

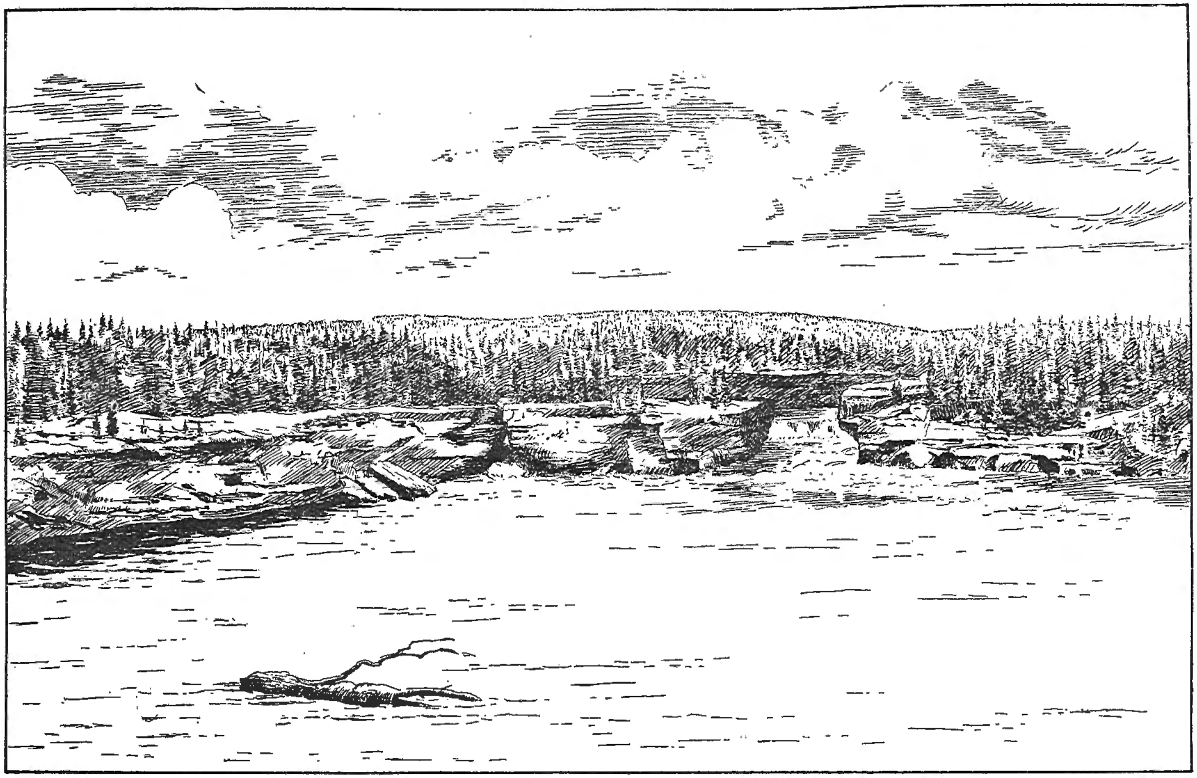
The total area underlain by this sandstone formation is very large, extending from Cree Lake on the south to Athabasca Lake on the north, and from Wollaston Lake on the east, doubtless to the vicinity of the valley of Athabasca River on the west, and perhaps much further under the covering of later rocks. Cree Lake lies largely within the area underlain by these rocks, and Athabasca Lake seems to lie entirely within it, for the red sandstones compose many of the islands and more prominent points of its northern shore.

Thickness of sandstone.

On account of the generally horizontal position of the beds, and their similarity in character throughout, it was impossible to determine its greatest or total thickness, but near the east end of Lake Athabasca cliffs of sandstone rise on the south shore to the height of between 400 and 500 feet, giving a vertical section of over 400 feet at this point.

Rocks newer than Cambrian.

East of the basin of Athabasca River, in the region explored, no rocks of later age than the Athabasca sandstone were seen north of the Churchill. If any such were deposited they have long since been denuded away. That at some uncertain period previous to the Glacial epoch the country stood at a much higher level, or sloped much more



J. B. TYRRELL.—Photo., Aug. 12, 1892. L. M. LAMBE, delt.

MANITOU FALLS, STONE RIVER.

Showing Athabasca sandstone, with hills of drift in the background.

steeply westward, than it does at present, is shown by the existence of the great valley occupied by Athabasca Lake. Possibly this valley was eroded while the Cretaceous sandstones and shales were being deposited in the seas then stretching away to the south, or afterwards in the Tertiary period, during part of which clays and sands were being deposited on the bottom of a gulf then occupying the position of the present valley of the lower reaches of Mackenzie River. Old valley.

On Churchill River, between Ile à la Crosse and the mouth of Mudjatick River, the country is thickly covered with drift, so that none of the underlying rocks were seen, but it is highly probable that Palæozoic and probably Cambro-Silurian, Silurian or Devonian limestones, or all three, similar to those of the Winnipeg basin, might be found beneath the drift, overlying the Archæan gneisses. As evidence of the presence of these rocks, boulders of Palæozoic limestone, carried with the drift from the north, were found on Ile à la Crosse Lake and southward. At Grand Rapids, on Beaver River, a limestone boulder was seen, holding fossils, one of which appeared to be a *Trochonema* of the type of *T. umbilicatum*. On the banks of Big River another boulder was found holding *Receptaculites Oweni*. Both these boulders were evidently derived from rocks of Cambro-Silurian age, and indicate the presence of such rocks to the north, along the southern edge of the Archæan. Some of the boulders on Ile à la Crosse Lake are of dolomitic limestone, containing such fossils as *Atrypa reticularis*, *Fenistella vera (?)*, a large Stromatoporoid, etc., and were, doubtless, derived from Devonian rocks.

Country drift-covered.

Boulders of Palæozoic limestone.

In the north-west portion of the district, Devonian limestone was seen outcropping for several miles in the bottom of the valley of Fire-bag River, one of the small tributaries of Athabasca River.

CRETACEOUS.

South of the Churchill River, the country is almost entirely underlain by Cretaceous rocks, ranging in age from the Dakota sandstone up to the Pierre shales.

On the south shore of Ile à la Crosse Lake, a few miles west of Ile à la Crosse post, there is a low outcrop of soft, horizontally bedded, light-yellow sandstone, associated with thin beds and nodules of calcareous ironstone. It contains many carbonized plant remains. Though no recognisable fossils were here found, it is confidently believed that these beds belong to a horizon not far from the bottom of the Dakota sandstone.

Sandstone on Ile à la Crosse Lake.

Dakota.

On Beaver River, just above the mouth of Doré River, are some banks ninety feet high of soft incoherent white or light-yellow sandstone, very similar in character to much of the Dakota sandstone of north-western Manitoba, and probably also of Dakota age. In the valley of Fire-bag River, four feet of 'tar sandstones' (Dakota?) were seen overlying the Devonian limestone.

On Beaver River, no Cretaceous rocks were recognised above the horizon of the Dakota, but at the Grand Rapids a boulder of Cretaceous limestone was found holding fragments of a *Cypina*-like shell, perhaps derived from some of the lower beds of the Niobrara in the vicinity, or a short distance farther north.

Niobrara shale.

Near the south end of Green Lake, typical Niobrara shale, containing large numbers of Foraminifera, fragments of shells of Inoceramus, bones of fishes, &c., was seen near the edge of the water, having slidden out from the foot of the high bank. The recognition of Niobrara rocks on Green Lake carries the knowledge of the occurrence of this horizon 275 miles north-westward from the nearest point at which it had previously been found, near the north-west corner of the province of Manitoba, and more than half way from that point to the Athabasca River. From Green Lake southward to the Saskatchewan River, the country appears to be entirely underlain by Pierre shales, though very few exposures were seen.

After the close of the Cretaceous period, a time of continental elevation must have set in, and appears to have continued throughout the Tertiary and down to the present time.

PLEISTOCENE.

Glaciated surfaces.

Wherever the surface of the underlying rock is seen, it has been severely glaciated, and any rocky prominences are rounded on the side looking towards the direction from which the glacier flowed, and rough and broken on the opposite side. The surfaces are not smooth and polished as they are in many places further south, for the till that had been dragged over them by the glacier contained very little clay or other fine polishing material, but was rather composed of sand or rock-flour. Coarse grooves and striæ were often seen, though they are not everywhere present. Their direction is shown by the arrows on the accompanying map. The most of them belong to one period of glaciation, and were made by the south-western extension of the great glacier centring west of the northern part of Hudson Bay, and for which I have proposed the name Keewatin glacier. They indicate that this

Keewatin Glacier.

last great glacier flowed between S.S.W. and S.W. across the greater portion of the area, being diverted westward in the valley of Lake Athabasca. No general glaciation, distinct from the above, could be detected.

The following is a list of the glacial striæ observed in the area of the map:— Glacial striæ.

Place.	True Bearing.
Mudjatick River, near mouth	S. 17 W.
" lat. 56° 18′	S. 22 W.
" below Grand Rapids	S. 52 W.
" Forks	S. 22 W.
" above Forks	S. 17 W.
River flowing N. to Cree Lake	S. 27-17 W.
Cree Lake, camp at S. end	S. 37 W.
" Small Island	S. 27 W.
" sandstone cliff at S. W. side	S. 37 W.
" " at north end	S. 17 W.
Black Lake, west shore, south of Stone River	S. 72 W.
Woodcock Portage	N. 73 W.
" west end	S. 71 W.
Black River	N. 58 W.
"	N. 63 W.
" below lowest portage	S. 77 W.
" " "	N. 83 W.
"	S. 63 W.
Athabasca Lake (from east to west)	S. 55 W.
" " earlier striæ	S. 74 W.
" "	S. 87 W.
" "	N. 70 W.
" "	S. 20 W.
" " earlier striæ	S. 66 W.
" "	S. 51 W.
" "	S. 53 W.
" "	S. 62 W.
" " later striæ	S. 34 W.
" "	S. 61 W.
" "	S. 41 W.
"	S. 58 W.
" "	S. 71 W.
Fond du Lac	S. 51 W.
	N. 82 W.
east of Beaver River	S. 60 W.
west of Beaver River	S. 42 W.
near Red Hill	S. 45 W.
S. E. of Black Bay	S. 75 W.
near Cypress River	S. 50 W.
Lat. 59° 6′ 30″	N. 75 W.
" Standing Sand Point	S. 65 W.
Fort Chippewyan	N. 75 W.
Black Lake, Sandstone Island	N. 76 W.
point of granite	S. 48 W.
" later striæ	S. 68 W.

Place.	True Bearing.
Black Lake, Island	S. 56 W.
"	S. 71 W.
" point on north shore	S. 58 W.
"	S. 70 W.
Hatchet River, lowest portage	S. 87 W.
" ascending the stream	S. 76 W.
" "	S. 76 W.
" "	S. 61 W.
" "	S. 78 W.
" Perpendicular Rock	S. 51 W.
"	S. 44 W.
Hatchet Lake	S. 23 W.
"	S. 26 W.
Wollaston Lake, (from north to south)	S. 11 W.
" "	S. 14 W.
" "	S. 29 W.
" "	S. 31 W.
" "	S. 33 W.
" "	S. 27 W.
Geikie River, 1 m. above Poor Fish River	S. 30 W.
"	S. 87 W.
"	S. 18 W.
" north of Big Sandy Lake	S. 28 W.
"	S. 37 W.
" above lake	S. 35 W.
" lake near source	S. 23 W.
" " "	S. 23 W.
" " " older striæ	S. 35 W.
Lake west of Foster Lake	S. 40 W.
Little Whitefish Lake, narrows	S. 31 W.
" "	S. 32 W,
Lake below Little Whitefish Lake	S. 22 W.
Jumping-in-the-Water Lake	S. 40 W.
Mouth of Foster River	S. 36 W.
Churchill River, near Foster River	S. 39 W.
" west end of Needle Lake	S. 24 W.
" mouth of Souris River	S. 43 W.
" " " "	S. 50 W.
" near Hay River	S. 43 W.
" Lowest Deer Rapid	S. 20 W.

Till.

Over the country directly underlain by Archæan rocks, there is but a scanty coating of till, chiefly lying in the bottoms of the depressions, but on the more even surface of the Palæozoic rocks the till is present in much larger amount, often assuming a gently undulating contour.

Moraines.

Large well defined morainic ridges are seldom seen towards the north, and those which can be made out consist of an accumulation of a great number of boulders; but further south a great rugged morainic area extends along the crest of the country between the Churchill and Saskatchewan rivers, forming a region similar to the summit of the Duck and Riding mountains in Manitoba.

Drumlins occur in a number of places, as in the valley of Mudjatick River, where many of them have cores of the underlying rock. Drumlins.

Kames, or disjointed ridges of sand and gravel, were seen in some of the morainic areas, especially on the upper part of Stone and Geikie rivers. Kames.

Sandy eskers occur, running with the striæ, in a few places, as on Hatchet and Wollaston lakes, and on the banks of Geikie River. Eskers.

The most conspicuous and interesting drift hills in the whole region, however, occur in the basin of Cree Lake, around Black Lake and on the banks of Stone River. They are steep, narrow ridges, parallel to the direction of glaciation, with the sides joining in a crest that may be less than a yard in width. They average from a quarter of a mile to one mile in length, and round down gently to both ends, with a characteristic drumlin-like contour, and vary from 70 to 250 feet in height, the average being about 120 feet. Unlike eskers, or kames, which they resemble in some respects, they are not composed of assorted material, but rather of unassorted rock-flour mixed with boulders. Unlike drumlins, they do not seem to have been ever compacted or overridden by the ice, as the material is loose, and the summit is not rounded off from side to side, but rather from the crest downwards, they descend in as steep a slope as the material will stand at. Further, they all lie in the basins of large post-glacial lakes, the principal ones examined being in Hyper-Cree and Hyper-Black lakes. As they seem to differ from any drift hills that have been definitely described, I would suggest for them the name ispatinow, the Cree word for a conspicuous hill. Ispatinows.

Their shape, and the character of their material, with their position, induce one to believe that they were formed in narrow gorges in the ice-sheet, when the front of the glacier was bounded by a deep lake. Streams flowing on or near the surface plunged into those ice-bound gorges and carried their load of detritus into the quiet water at the bottom of the gorge. In some such way as this these narrow ispatinows might have been formed of loose unassorted material, and as the icy walls receded or melted away and the lake was drained, the sides would assume a slope as steep as possible. Mode of formation.

North of the watershed between Churchill and Stone rivers, most of the lakes appear to have stood at a higher level than they do at pre- Glacial lakes.

sent, in the time immediately subsequent to the retirement of the great ice-sheet. The natural inference is that they lay between the face of the waning ice-sheet and higher land over which the water flowed to form the great rivers of the glacial period. In order to avoid a multiplicity of names that are difficult to remember, and none of which can be located from an ordinary geographic map of the present day, it is here proposed to add the prefix *hyper* - to the name of the present lake or river to designate the former high-level lake that occupied its basin or valley. For example, around the southern and western shores of Cree Lake, well-defined shore-lines were found up to eighty feet above the present water-level. It is proposed to call the lake that formed these old shore-lines Hyper-Cree Lake. This lake extended from the height of land northward to about the north end of Cree Lake, where its waters probably laved the foot of the Keewatin glacier. Towards the east and the west its extent is unknown, but it covered what are now wide sandy plains, extending out in these two directions.

Hyper-Cree Lake.

The lake did not exist for any great length of time, as its shores are but slightly marked, its gravel beaches being small, and its coast-cliffs but slightly cut, even in soft material. On its south side, forming the present height of land, is a wide sandy plain, in which are many deep closed depressions, probably indicating the position of heavy masses of ice. Stretching southward from this plain, down the course of Mudjatick River, is a large amount of sandy material, often stretching out into wide sandy plains. This extent of sand doubtless marks the line of one of the water-courses draining the face of the glacier at about the time that Hyper-Cree Lake came into existence.

Hyper-Black Lake, &c.

In the same way Hyper-Black Lake stood one hundred and twenty-five feet above the present level of Black Lake, and extended for a long distance up Cree and Stone rivers. Hyper-Athabasca Lake rose above the present level of Lake Athabasca, as is shown by the beautiful raised beaches on Beaver-lodge Island, and the wide sandy plains seen by Mr. Dowling on William River; but whether it at any time was confluent with Hyper-Black Lake was not determined. Hyper-Wollaston Lake occupied the basin of Wollaston Lake, and extended a considerable distance up Geikie River. Hyper-Churchill Lake lay in the present valley of Churchill River, and, when at its greatest height, seems to have extended southward as far as the sand-hills around Clearwater Lake on the Green Lake trail.

It is highly probable that some of the great post-glacial lakes of the region were at times connected, but much further exploration would be be needed to define their coast-lines, and to determine their relationship to each other.

Recent.

The shores of the present lakes are nowhere strongly marked by deeply cut cliffs or heavy beaches. In the northern area the streams flow in shallow channels, having only in rare and local instances, even when flowing through clay or incoherent sand, cut down their beds to a base-level of erosion. On the Cretaceous plateau, the small diminished streams often wind through the bottom-lands of deep, wide valleys, never even impinging against their high grassy banks. The present streams are not deepening these valleys to any appreciable extent. Present shore lines.

DESCRIPTION OF ROUTES.

Green Lake Trail.

North of the Saskatchewan, the road from Prince Albert passes for several miles over a range of barren sandy hills at the same elevation as the sand-hills between Prince Albert and the Forks (about 1425 feet above the sea), and doubtless formed as dunes on the same old shore, beyond which, to the crossing of Sturgeon River, is a pleasant country with large prairie openings, and dotted with groves of poplar. Sturgeon River, where crossed, is a stream fifty feet wide and three feet deep, flowing swiftly in a channel ten feet deep. West of Sturgeon River bridge, thinly wooded sandy hills are again crossed for several miles, and then the road passes for twelve or fifteen miles over rich level alluvial land wooded with poplar, to the bank of Shell Creek, a branch of Sturgeon River. This stream winds in a shallow channel, in the bottom of a wide valley with gently sloping sides from fifty to a hundred feet high, and from half a mile to a mile and a-half apart. The level bottom-land is chiefly of sand or fine gravel and bears a close growth of short grass. The trail follows this bottom-land westward through three ranges of townships, and then turns northward, still keeping to the bottom of the same valley, which is here very wide. Old shore line. Shell Creek.

Shortly before reaching Sandy Lake, which lies to the west of Shell River, hills of loose sand and boulders begin to rise above the surrounding plain, and boulders begin to be scattered over the bottom of the valley. The hills are doubtless morainic, and the valley of Shell River, as well as others in the vicinity, were apparently formed by the water flowing from the face of the glaciers at the close of the glacial period. Morainic hills.

A few miles north of Sandy Lake, Shell River is crossed, in the middle of a wide sandy flat, at an elevation of 1700 feet above the sea. This sandy flat, apparently the bottom of a deep wide valley, is followed by the trail northward, along the east side of Devil's Lake, to the crossing of Big River, at a distance of six miles beyond Shell River, and at an elevation of 1715 feet above the sea.

Big River.

Old valley.

Big River is here fifty feet wide, with a gravel bottom. It is said to flow into Crooked Lake a few miles below this ford, which lake discharges by Doré River into Beaver River—a tributary of Churchill River. The watershed between the Saskatchewan and Churchill rivers was therefore crossed on a sandy plain in the bottom of a deep valley running north-west and south-east. Big River enters the west side of this valley not far above the ford, but the valley continues on towards the north-west for an unknown distance, its bottom being occupied by a series of shallow lakes. Beyond Big River ford, the trail keeps to the bottom of this valley for nine miles, until it rises to an elevation above the sea of 1850 feet. Then the trail leaves the valley and ascends its west bank, which has here a height of two hundred feet, beyond which, for five miles, are high sandy morainic hills, scattered with boulders. The highest point on the trail is in a heavy spruce forest in these hills, the elevation being about 2220 feet above the sea. Beyond these hills is a gravel plain at an approximate elevation of 2060 feet, through which Big River flows, in a beautifully terraced valley, half a mile wide and 180 feet deep. Its sides are steep and grassy, not strewn with boulders, and are apparently underlain by Pierre shales, but no scarped banks were observed, for the present stream does not appear to be eroding or deepening the valley to any appreciable extent. As the valley is ascended it becomes gradually shallower, not so much through the rise of the bottom as on account of the westerly slope of the country away from the high stony hills lately passed over. Finally it widens out into an extensive spruce and tamarack swamp, at an elevation of about 1900 feet above the sea, and only thirty feet below the surrounding country.

Watershed.

Summit on morainic ridge.

Leaving the valley at a small tributary creek, the trail for eight or ten miles crosses a rolling, bluffy prairie, underlain by a sandy till, with an elevation of about 2000 feet above the sea. The country then begins to have a definite slope northward, and rough, steep, sandy hills, thinly wooded with Banksian pine, make their appearance, and continue along the line of the trail for sixteen miles, in which distance the country has declined about 250 feet. These sand-hills do not seem to be morainic in character, but rather to represent one or more

Sand-hills.

old coast-lines on the shore of a great lake that extended away to the north in post-glacial times.

North of these hills a gently sloping even plain, wooded with poplar, spruce and balsam, and underlain by a slightly sandy clay, with very few boulders, extends to the edge of the valley of Green Lake.

Green Lake and Beaver River.

Green Lake is a narrow body of water eighteen miles long, lying at an elevation of 1440 feet above the sea. It nestles in the bottom of a valley two hundred feet deep at its southern end, and gradually shallowing to forty feet deep at its northern end. The sides are sloping and densely wooded with poplar and spruce. From the lake the valley extends southward an undetermined distance. The beach of the lake is largely composed of rounded transported boulders of granite, white quartzite, white limestone, &c. The depth of the water was not determined, but fishermen living in the vicinity report depths of from twenty to thirty fathoms, probably towards its northern end. The lake gets its name from the thick coating of floating green algæ which collects on the surface in the autumn. Old valley.

On the west bank, a short distance north of the end of the trail, typical calcareous Niobrara shale is scattered along the beach behind a line of small boulders, and at the edge of the grass a line of the same shale was found extending for about fifty yards, standing more or less on edge, as if it had slidden from the bank behind, and evidently not far from the parent rock. It contains a large number of foraminifera, including *Globigerina cretacea* and other forms found in the Niobrara of Manitoba, together with fragments of fish remains and of the thick prismatic shells of *Inoceramus*. On the beach in the vicinity were also a number of freshly broken fragments of lignite and nodules of ironstone, doubtless also derived from the Cretaceous shale of the bank. Niobrara shale. Foraminifera.

On the east shore, three miles north of the end of the trail, the bank is one hundred and fifty feet high, and thirty feet from the summit is a scarped face showing thirty feet of soft stratified sand, interbedded with fine sandy gravel with well rounded pebbles. Its exact relationships were not determined, but it is probably of glacial or post-glacial age. Stratified sand, &c.

Three miles and a-half further north and ten feet above the lake, is a scarp showing four feet of light unstratified till, composed largely of Cretaceous shale, but holding pebbles, some striated, of granite, white quartzite, vein quartz, limestone, ironstone, &c. Till.

Green Lake River.

Green Lake River, a small sluggish stream five miles long and sixty feet wide, with reedy banks, connects the north end of Green Lake with Beaver River, the current sometimes running out of the lake and sometimes into it. A low grassy meadow extends on both sides of this river, underlain by ten feet, more or less, of stratified sand and clay. Beneath this clay is a bed of peat extending beneath the level of the water, and often containing large numbers of small fresh-water shells. Doubtless the stratified sand and clay is composed of material brought down from the west by Beaver River in times of high water, and spread out at the mouth of Green Lake.

Beaver River.

Beaver River rises more than 200 miles further west, in the vicinity of Lac la Biche, and flows eastward to the Green Lake River. Here it turns at right angles, assuming the course of the latter stream, and flows northward to the south end of Ile à la Crosse Lake. At first the banks are low and composed of stratified alluvial clay without boulders. The surrounding country seems to be a level plain, from ten to twenty-five feet above the river, and well wooded with poplar.

Hyper-Churchill Lake.

Banks of stratified sand soon begin to rise on both sides of the river to heights of forty or fifty feet, and the stream is broken by rapids over a bed of boulders. The surrounding country appears to be level or gently sloping northward, and the more sandy parts probably represent shore-lines of Hyper-Churchill Lake, the post-glacial lake that covered a great tract of country south of Churchill River. The banks again decline towards the mouth of Water-hen River, a considerable tributary from the west. They continue low and consist of clay for several miles, and then change to stratified sand and rise to a height of eighty feet, probably along another ancient shore. Just below this is the last and heaviest rapid on this portion of the river, known as Grand Rapid, with a fall of about twenty-five feet. The bed is of boulders, and the banks, about thirty feet high, are of dark-gray, slightly jointed, unstratified sandy till holding pebbles and boulders. The boulders are chiefly of a rather fine-grained reddish granite, but very many are of green Huronian (?) rocks, a considerable number are of compact white Palæozoic limestone, one of which contained *Trochonema*, or an allied form; a few are of hard white quartzitic sandstone, two or three small ones of soft brown Dakota (?) sandstone, and one large slab of porous Cretaceous limestone containing *Cyprina subtrapeziformis*, or a somewhat similar species.

Grand Rapid.

Boulders.

Below Grand Rapids, the stream flows with an easy and gradually slackening current, and boulders soon disappear from the banks, which are generally low and wooded with balsam poplar. However, just above the mouth of Lower Doré River, a tributary from the east, cliffs of white and light yellow, well bedded, soft sandstone, probably of Dakota age, rise to a height of ninety feet on the west bank. On the top of the sandstone is a line of pebbles and boulders, over which is a foot or two of sandy till. No trace of fossils was found, and this sandstone is merely provisionally assigned to the age of the Dakota from its position near the base of the slope underlain by Cretaceous shales, &c., from its being overlain by a capping of till, and from its close similarity to many of the incoherent beds of Dakota sandstone in north-western Manitoba. Below the mouth of Lower Doré River the banks are generally alluvial, varying in height from twelve feet down to a low marsh, all but the latter being wooded with a beautiful growth of poplar. Occasionally we could see that we were winding through the bottom of a wide valley with banks about seventy feet high. Towards its mouth the river becomes a series of marshy lake-like expansions, with many of the points covered with boulders. Rounded hills of sand and boulders rise here and there, but no rock in place was seen.

Dakota sandstone.

Low banks.

Ile à la Crosse Lake.

Four miles from the mouth of Beaver River is Ile à la Crosse or Lacrosse Island. Its summit is a level sandy plain about forty feet above the lake, while its sides are steep and for the most part covered with coarse sand. At its south end, where the bank is but twenty feet high, the upper ten feet is a fine light-brown evenly stratified sand. At the north end of the island the beach is composed of small rounded boulders, about three-quarters of which are of red and gray granite, while most of the rest are of hard white and red sandstone. Some are of a soft highly ferruginous sandstone, probably of Dakota age, while a few are of Devonian dolomitic limestone holding *Atrypa reticularis*, &c. This sandy island is very conspicuous, as the surrounding shores are composed almost entirely of till. Its geological history was not clearly apparent, but it may represent a sandy delta deposit formed at the mouth of a super-glacial stream.

Lacrosse Island.

Two miles and a quarter from this island, on the west shore of the lake, is a large Roman Catholic mission establishment, and near it is the fur-trading store of the Hudson's Bay Company. These are built on a gentle slope of light-gray sandy till holding pebbles and a few boulders. More than half of the boulders are of hard white sandstone, indicating the presence of this sandstone in the immediate vicinity, though it was not seen in any natural outcrops.

Lacrosse mission and trading post.

Some ash-leaved maples had been planted in the garden of the Hudson's Bay Company's post, which are now from ten to fifteen feet high, quite healthy, and bearing abundant seed.

Dakota sandstone.

Five miles and a half north-west of the Mission, on the south-west shore of the lake, behind the beach of boulders, is a low outcrop of light-yellow, brown-weathering, friable sandstone, horizontally bedded, but often showing clear false bedding. It contains many small nodules of ironstone, and is overlain by a thin band of ironstone, mixed with a sandy clay shale. It contains many fragmentary remains of plants, now entirely carbonized. Although the geological age of this bed could not be definitely determined, it is probable that it represents some of the lower layers of the Dakota sandstone.

It is overlain by a cliff of soft sandy clay, with boulders, most of which are of gray gneiss, but some are of limestone, while others are of green trap, hard gray sandstone, fine conglomerate, etc. The land behind is moderately level and well wooded with poplar.

At Ile à la Crosse three canoemen were engaged for the summer, and on the 29th of June, 1892, we started northward.

Ile à la Crosse Lake.

Ile à la Crosse Lake extends northward from the Mission for thirty-nine miles. For the first twenty-nine miles we followed its west shore, which is generally low and indented by deep bays, the beach being of sand or boulders. The east side is much straighter, and rises in a high wooded ridge parallel to the lake. This ridge is said not to be sandy, but to be composed of clay and boulders, and the thick forest covering it would confirm this statement.

East shore.

At the end of the above distance is a long gravel point, from which we crossed the lake, here only about a mile and a-half wide, to the east shore, which was found to be composed of gravel and boulders, almost all of granite, though some are of sandstone. None of limestone could be found, indicating that we were now further north than the edge of the possibly underlying limestone. The country behind the east shore is here generally low. No rock in place was seen around this part of the lake.

Churchill River.

Shagwenaw Lake.

From the north end of Ile à la Crosse Lake, Churchill River flows eastward as a rapid stream from fifty to seventy yards wide, over a bed of boulders, with low banks of sandy till. Below this rapid the river opens into Shagwenaw Lake, a beautiful sheet of clear water, dotted with many wooded islands.

For seven miles below this lake, the river is wide and deep, with a gentle current. The banks are low and wooded to the edge of the water, or overgrown with grass and sedge, except at some of the points where there is a bare string of boulders. Below this quiet water are three rapids, with descents respectively of about six, eight and five feet. The banks throughout are low and of till, and the beds of the rapids seem to be entirely of boulders, no rock in place being visible.

Mudjatick River.

Mudjatick or Bad Cariboo River, rises in several small lakes and streams in the low rocky country a short distance north of latitude 57°, and flowing almost directly southward for eighty miles, empties into Churchill River, thirteen miles below Ile à la Crosse Lake. For most of the course it flows in a shallow winding channel between level banks of stratified sand. Rocky hills may be seen on both sides, but they seldom close in on the river, and the stream is obstructed by but few rapids, and most of these are caused by accumulations of boulders. Rocky hills

Up to the date of the present exploration nothing was known of it beyond what is indicated on the face of Sir John Franklin's map of 1819 and 1820, by the following note : "Stated to afford a passage to the Athabasca Lake by crossing a height at its source."

On the 1st of July, 1892, we entered the mouth of the river, which was then at extreme high water, and began the toilsome ascent of its rapid current. The water was up in the willows, which almost everywhere overhung the channel, so that it was impossible to track the canoes with a line from the banks. Poling was also out of the question since the bed of the channel is composed of shifting quicksand. It was, therefore, necessary to ascend entirely with paddles, keeping close to the banks, and occasionally clutching the low bushes. Each time that we were obliged to cross the winding channel in order to avoid the rush of the current on the outer sides of the bends, we were swept back further down the stream. In lower water, when many of the sand-bars would be dry, the river would probably be easy to ascend, but then its upper stretches might be too shallow to permit of the passage of a large canoe. High water

Three miles up the stream, or just above the mouth of a brook flowing through the hills to the west, the river flows for a mile near the foot of some ridges of rather fine and even-grained red biotite-granite-gneiss, which rise to a height of from thirty to a hundred feet on the east side Ridges of gneiss.

of the valley, and extend towards Churchill River in a direction S. 15° E. Their surface is generally somewhat rough and weathered, but many of the higher points are beautifully smoothed and polished and show fine, but well marked glacial striæ, trending S. 15° W. The direction of glacial motion is shown by the rounding down of the southern sides of many little pits; while at the same time the north-east sides of the hills are rounded and the south-west sides are broken and strewn with fragments of rock.

Glacial striæ.

Two miles above the last and highest of these granite hills, a portage is stated to run eastward to a lake which connects with Churchill River. The Indians often use this route to avoid the laborious ascent of the lower part of the river.

Sandy plain.

A short distance above this portage, on the west bank of the river, is a grove of Banksian pine on an open sandy plain, forming the first pleasant piece of dry land that we had seen since leaving Churchill River. From this grove to Bear Rapid, the river flows with an even current of about four miles an hour, through willow covered flats, with here and there groves of open pine woods. No rock could be seen from the canoe.

Bear Rapid.

Bear Rapid is a swift chute with a fall of about two feet, past which is a portage track, one hundred yards in length, on the west bank. The rapid is probably caused by a ledge of smooth rock crossing the channel, but the water was so high that none could be seen.

Above Bear Rapid, the river continues to wind through a sandy plain to the foot of a series of rapids caused by accumulations of boulders in the bed of the channel. Boulders are also scattered in considerable abundance over the flats on both sides of the river, though very few or none were seen below this point. At some places the boulders are piled in long ridges, which probably represent a moraine formed by the last glacier that extended southward in this region. The rapids are four in number and extend for two miles and a-half, but none are so impetuous as to render it impossible to track the canoes up them with a stout line.

Probable moraine.

East of the lowest of these rapids is a ridge of red biotite-granite, including lenticular masses of well foliated gneiss. One isolated boss was composed of dark gray, fine-grained, highly hornblendic gneiss, associated with a fine-grained diorite charged with sulphides.

West of the uppermost of the four rapids is a more or less rounded boss, thirty feet high, of dark, green, fine-grained, highly altered trap.

A mile further north, on the east bank, and at the north end of a ridge of sand, is a small outcrop of whitish quartzite striking N. 85° E., and with an almost vertical dip. This quartzite is very highly charged with pyrrhotite, and the compass was strongly deflected towards it. Quartzite.

A mile and a-half further north, a rounded hill fifty feet high rises on the west side of the river, composed of light-gray granite-gneiss, cut by many veins of red pegmatite. From the hill a long sand ridge stretches away in a direction S. 20° E. A boss of similar gneiss, a mile further up the stream, shows a fine foliation striking N. 80° E., while on a smooth surface close to the water, glacial groovings are beautifully shown trending S. 20° W.

Above this hill the stream for several miles winds through a sandy plain, cliffs of stratified sand from thirty to forty feet in height appearing on the banks.

Old Wives Rapid occurs at a sharp curve in the stream as it passes through a narrow gap in a granite ridge. A portage over a scrubby ridge leads past it on the west side, but it was possible to haul our canoes up the rapid with a long line. Old Wives Rapid.

Among the boulders scattered over the surface here, are a few of white Athabasca sandstone, which have been transported from the north, and have apparently been derived from the sandstone area lying north of Cree Lake.

The adjoining hills rise to a height of about 130 feet, and are composed of a red, highly felspathic granite-gneiss, foliated in a direction S. 80° E. The tops of the hills are weathered so that no striæ could be detected, but there were many short grooves trending S. 20° W., and on the face of the hill, near the edge of the water, are polished glaciated surfaces showing grooves trending in the same direction. Hills of gneiss.

For the next eight miles the river has an average width of about 200 feet, an average depth of six feet, a current of about five miles an hour, and passes between high sand ridges trending in a general north-and-south direction. At the north end of each ridge there is usually a boss of whitish mica-diorite-gneiss, but the sand rises above it, and the highest point of each ridge is south of the rock. Small poplar and birch trees are growing by the river, and the hills are wooded with Banksian pine. At the end of this distance is a portage forty yards in length, across a dry sandy ridge, wooded with large pines. This portage is made to avoid a long bend of the river, into which Porter Creek is Sand ridges.

said to empty. This creek was stated to flow from Porter Lake, which lies six or seven miles east of Mudjatick River.

Heddery Creek.

A mile and a half above this portage, Heddery Creek, a stream twenty-five feet wide, with a swift current, flows in from the west, and is said to rise in Heddery Lake.

Whitish mica-diorite-gneiss.

Above the mouth of this creek is a rounded hill eighty feet high, of whitish mica-diorite-gneiss, very irregularly foliated, but with a general trend east and west.

The river continues in a depression between hills of this gneiss for the next four miles, and then the hills fall away on either side, and it traverses a sandy plain in a valley which gradually increases to a depth of 100 feet. The bed of the river is sand, without boulders, but a few boulders may occasionally be seen on the surrounding plain, many of them being white Palæozoic sandstone. Poplar has now almost entirely disappeared, a few trees of black spruce and tamarack are growing by the river, but the banks and uplands are wooded with pine.

In latitude 56° 35′, hills of gray biotite gneiss rise above this sandy plain, and in latitude 56° 38′ the river sweeps against the eastern side of a hill of reddish-gray, highly biotitic gneiss, well foliated and striking N. 20° E. The surface shows a number of strong glacial grooves, trending S. 50° W.

Grand Rapids

A mile and a-half north of this hill, we reached the foot of the Grand Rapids, where the water falls eight feet over a ledge of gneiss, broken into two steps. A portage, ninety yards in length, over a sandy flat, runs past it on the east side. The rock is a gray biotite-granite-gneiss, well foliated, striking N. 15° E., and dipping at a high angle to the east. A quarter of a mile above the portage is a long rapid over rock and boulders, with a fall of six feet, past which we tracked the canoe with a line on the west side. Above Grand Rapids the river, now about thirty feet wide, flows from a moderately well defined valley, about a quarter of a mile wide, the banks of which are often a hundred feet in height, very steep, and composed largely of sand, through which are scattered a few boulders and pebbles, all of the latter being water-worn. The surface above is undulating, rising into hills about 200 feet above the river.

High sand banks.

Three rapids.

In this valley are three rapids, the lowest of which has a fall of five feet, over a ledge of gray gneiss with a general strike N. 25° E. An almost vertical cliff of gneiss rises on the east side. The middle rapid is very similar in character to the first, past which there is a portage ninety yards in length on the west side. At the third rapid the river falls three feet over a ledge of gray gneiss, while a portage sixty paces long leads past it on the east bank.

At a bend in the valley, a mile and a-half above the last rapid, Girard River, a swift, shallow stream fifty feet wide, joins the main stream from the east. Girard River.

On the west bank, above the mouth of Girard River, and behind a sandy plain, rise rounded hills of medium-grained dark reddish-gray biotite-granite-gneiss, often intricately folded in with a coarse red granite.

The river flows through the pine-covered sandy plain up to the Forks of the Gwillim and Mudjatick rivers, where the two streams run together from opposite sides of a long sandy point, the former being forty and the latter sixty feet wide. On the west bank at the forks is a bare hill of fine-grained, red biotite-granite-gneiss, striking S. 15° E. and dipping N. 75° E. at an angle of 60°. The surface, close to the edge of the water, is well glaciated, striæ trending S. 20° W. Gwillim River.

The Mudjatick River is said to flow from the north-east, passing through three small lakes in its course.

The country now becomes more level and swampy, and the streams are interrupted by lakes and stretches of quiet water. More level country.

At the Forks, we left the main stream and entered the Gwillim River, which flows for eight miles from a north-westerly direction, passing the mouth of Ithingo River about the middle of the distance. For four miles it winds through a level marshy plain, surrounded, at a distance, by high rocky hills. The banks are often low and ill-defined. Near the mouth of Ithingo River, sandy hills, or a high sandy plain, approaches on both sides ; but still the bottom of the valley is marshy, with many abandoned river-channels, and the sluggish stream, fringed with yellow water-lilies, extends up to Little Sandy Lake, which is surrounded by high wooded sandy hills. On the evening of July 8th we camped in open pine woods at the north end of this lakelet, a lovely sandy beach extending before our tents. Ithingo River. Little Sandy Lake.

One small, bare, rocky island rises out of the centre of the clear water of the lake, consisting of a dark-gray, thinly foliated granite-gneiss striking N. 45° W. and dipping at a high angle, S. 45° W., interbedded with a light-gray coarse-grained garnetiferous biotite-granite-gneiss. Rocky island.

In the river, three-quarters of a mile above the lake, is a small island of similar highly garnetiferous gneiss.

A short distance above this island, the river turns almost at right angles towards the north-northeast, and the valley, which has been narrow and deep from the lake, becomes wide and more diffuse. The wide stretch is two miles and a-half long. Near its northern end the west bank of the stream is overhung by a high rugged cliff of gray granite-gneiss, interlaminated with bands of highly ferruginous and quartzitic gneiss. In general the lamination is nearly horizontal, but in detail it is much contorted.

Cliff of gneiss.

In north latitude 56° 53′, the valley turns sharply eastward and bare cliffs of sand rise to a height of eighty feet on its northern side. The valley maintains this eastward direction for two miles, gradually decreasing both in width and depth, while both the hillsides and the bottom of the valley become covered with boulders. The stream is thirty-five feet wide, with a current of three miles an hour. From the end of this stretch the river again turns to a north-northeasterly direction through low land, to the south end of Gwillim Lake.

Gwillim Lake.

Gwillim Lake is a pleasant open body of clear water lying in a north-and-south direction, with a greatest length of five miles and a-half and a greatest width of a little more than a mile. The eastern shore is generally low and sandy, though behind an abandoned trading post of the Hudson's Bay Company are some rather high lightly wooded hills that seem to be covered with boulders. Behind the western and north-eastern shores are somewhat prominent hills of gneiss.

The Gwillim River flows into the north-western end of the lake, but the canoe-route leaves the lake at a low sandy beach at its northern end, and our canoes were carried for 300 yards on a sandy plain through open woods of small Banksian pine, to the bank of the narrow winding stream.

Variation of the compass.

At this portage the compass was found to have a variation of 27° east.

Crooked stream.

Above Gwillim Lake, the diminished stream is very crooked, winding at first between low sandy willow-covered banks, through swamp thinly wooded with spruce and birch. The banks gradually rise to heights of thirty feet, being composed of stratified sands, and at the end of two and a-half miles, measured in a direct line up the valley, the river is broken by a rapid over boulders, in which there is a total drop of about fifteen feet. Past this rapid is a portage on the

Sand banks.

west side 230 yards long. The portage is through thin woods of small Banksian pine, and over a slight sandy knoll strewn with boulders, some of which are of white sandstone, probably of Athabasca sandstone. From the top of this knoll the river is seen to flow in the bottom of a rich but rather shallow trough, with rocky sides, extending northwards towards Solitude Lake. South of this knoll is the point of a hill 100 feet high, composed of a coarse, red biotite-gneiss with undulating vertical foliation striking S. 20° E. The sides of this hill are also strewn with boulders.

Solitude Lake, a mile and a-half north of this portage on the same stream, is a rounded body of clear water a mile and a-half in length, with low even wooded shores, in front of which are occasional stretches of sandy beach. No boulders, or rock in place, are seen anywhere around it, but in the background are high rounded hills covered with forest. The canoe-route traverses the lake to its northern end, where the canoes and goods are landed. They are then carried by a portage 150 yards long in a north-northeasterly direction, over a sandy plain wooded with small Banksian pine. This portage cuts across a long bend of the river, reaching it at a point where it has a width of about twenty-five feet. Solitude Lake.

From Solitude Lake the river was followed in our canoes northward for three miles, as it wound in a very tortuous channel ten to fifteen feet deep, across an almost level plain of fine white sand covered with light green lichen, and thinly wooded with small Banksian pines. At one point some low, rounded, rocky hills rise above the west bank, consisting of rather coarse, rusty, reddish-gray hornblende-gneiss, irregularly foliated. Strike S. 75° E. Plain of fine white sand.

At the end of the above distance, Gwillim River, which continues to flow from the north-northeast, was left, and the canoes and goods were carried for a mile in a north-westerly direction over the level sandy plain by the south bank of a small tributary brook. Near the west end of the portage the country begins to rise a little, and the brook, here from five to eight feet wide, flows swiftly in the bottom of a valley twenty feet deep. Leave Gwillim River.

At the west end of the portage is a lake, a third of a mile in diameter, with water of a light-brown colour, and low weedy shores, behind which are sand-hills thirty to forty feet in height. This small lake, in north latitude 57° 7′, and west longitude 107° 29′, and with an elevation of 1650 feet above sea-level, lies just south of the watershed between the drainage basin of Churchill River, and that of Lake Small lake.

Watershed. Athabasca. From it a portage 200 yards long leads up a steep sandy slope forty feet high, across a sandy ridge, and into a basin-shaped depression fifty feet deep, in the bottom of which is a small lake of clear blue water, without outlet.

Height-of-land portage. This lake, a little more than a quarter of a mile in width, was crossed in canoes to the southern end of another portage, 1100 yards long. The path ascends a slope fifty feet high at one end, and descends a similar slope at the other. In the middle it is over an irregular country, with deep basin-shaped depressions and high hills, composed of moderately fine, white sand, without pebbles or boulders. The north end of the portage is in a small grove of Banksian pine at the south end of a lake of clear water which discharges northward towards Cree Lake and Stone River. Thus the two last portages cross the height of land, but no rock in place was seen in the vicinity or nearer than the granite knolls on the west bank of Gwillim River.

Sand-hills.

Cree River and Lake.

The lake north of the height of land lies among wooded sandy hills a hundred feet in height. On the morning of July 13th the party left camp among the pines at the south end of this lake, and travelled north-eastward for two-thirds of a mile across the lake to a marsh, over which the canoes were dragged for a hundred and fifty yards to a small stream, which was descended a quarter of a mile between banks fringed with yellow water-lilies, to another lake with low marshy shores, wooded with small spruce, larch and Banksian pine. It lies in a north-westerly direction, and is a mile and a third in length. From its north-western end flows a winding stream thirty feet wide, and five feet deep, with a current of two miles and a-half an hour, between low marshy banks, at first well defined, but afterwards very irregular and broken. After flowing eastward for two miles and a-half, the river runs along the north side of a hill composed of large boulders of red granite-gneiss, while on the opposite side of the valley is a ridge of apparently similar gneiss in place. For the next two miles and three-quarters, the river is wide and indefinite, in the midst of an extensive marsh. On a low wooded ridge composed of sand and rounded pebbles, many of which are of white sandstone, the latitude was found to be 57° 10′ 51″. The sides of the valley are steep escarpments of sand, rising to a sandy terrace eighty feet above the river, at about the same altitude as the summit of the height-of-land portages.

Small lake.

Hill of boulders.

Sandy terrace.

In latitude 57° 11′ 30″ the valley contracts and the river flows between high cliffs of red biotite-granite-gneiss striking N. 65° W. The highest points of the surface are polished and faintly striated in a direction S. 70° W.

After passing through this rocky gap, the river enters an open basin, on the sides of which are sand terraces rising twenty-five feet above the water, and a mile and a-half north of the gap it passes between a number of low boggy islands into Cree Lake. Many large fresh-water sponges (*Meyenia fluviatilis*, Linn.) could be seen through the clear water growing on submerged twigs and sticks beside these islands. Cree Lake.

Cree Lake is a large elongated body of pure transparent water lying in a general north-east and south-west direction, with a greatest length of forty-nine miles and a width as yet undetermined, but sketches obtained from Indians who had travelled round the lake, would indicate that it has a total area of about four hundred square miles. The soundings taken in open water along the line of travel, gave depths varying from fifty-five to a hundred and fifty feet. The altitude of the surface, as determined by numerous aneroid readings, is 1530 feet above sea-level. The temperature of the water in the open lake on July 14th was 53° F. Area.

The course followed from its southern extremity to its outlet near its northern extremity, was generally along its west side, and the following description applies exclusively to the country seen on this line of travel. Course followed.

From the mouth of the river, a bay about a mile and a-half in diameter, is crossed in a northerly direction, to a strait a hundred yards in width between steep sandy hills. The surrounding country is composed chiefly of low rounded hills of sand, with occasional points of a rather coarse, reddish-gray gneiss. Sand-hills.

Our first camp on the shore of the lake was pitched a mile east of this strait, at the foot of a hill of coarse gray gneiss, that rises to a height of 120 feet above the water. On the top of the hill is a large boulder of gneiss seven feet long, the southern side of which is perched on a smaller boulder. Under it glacial grooves are strongly marked, trending S. 35° W. Many of the other boulders around the hill are of white sandstone. Since the hill is the highest in the vicinity, a magnificent view may be had from its summit, of the lake and the surrounding country. From east to south, wide sandy plains, wooded with small Banksian pines, stretch away to the limit of vision. In other directions the country is composed of gently rounded Hill of gneis Surrounding country.

hills wooded with small pines, with occasional sandy escarpments facing the lake. The lake shore is very irregular, and six small wooded islands break the surface of the blue-green water. A few small scattered trees of white birch grow by the shore, but no poplar had been seen since leaving Solitude Lake.

The variation of the compass was here determined at 25° 30′ E.

Islands.

A mile and three-quarters north of this camp is a group of three small wooded islands, the most southerly of which is composed of a rather coarse, gray, highly felspathic biotite-gneiss, with, in places, a moderately well marked sinuous foliation striking S. 55° E. Part of the island is covered with till, consisting of sand and boulders, many of which are of sandstone. The surface of the gneiss is smoothed, and shows glacial groovings trending S. 25° W.

Hill of gneiss.

Three miles and three-quarters in a direction N. 36° E., over open water averaging 110 feet deep, across the mouth of a deep bay, is a point on the west shore, behind which is a hill 120 feet high, the south side of which is composed of gneiss very similar to that seen on the island, while the top and east side are composed of sand and boulders. The lake here contracts to a width of about three-quarters of a mile, and behind the eastern shore is a hill, formed, apparently, of gneiss. These hills of gneiss, on both sides of this strait, appear to form part of a ridge that runs N. 65° W. across the country, and they were the last exposures of Archæan rock seen, on this line of travel, south of the northern shores of Black and Athabasca lakes. Between these two places the country is underlain by Athabasca sandstone. Cree Lake, therefore, adds one more to the list of the large bodies of water which, in Canada, lie along the line of contact of the comparatively unaltered Palæozoic and the highly altered Archæan rocks.

Northern limit of Archæan rocks.

For the next two miles, the west shore is low and is protected by a wall of rounded boulders, beyond which our course turned north-westward to the north shore of a low island, wooded with black spruce and birch, the point of which is piled six feet high with boulders of white sandstone. A meridian altitude of the sun observed here gave the latitude as 57° 19′ 30″ north.

Deepest sounding.

A mile and three-quarters across open water brought us to a long low point of land surrounded by boulders of sandstone. South of this line high cliffs of sand were seen to skirt the shore. About the middle of the distance, a depth of 150 feet was found, being the deepest sounding obtained in the lake, though perhaps the water may be much deeper farther from land.

From this stony point we again crossed the mouth of a bay about five miles deep, in a direction N. 45° W., past several islands apparently of till, to the west shore of the lake, where a cliff of light red Athabasca sandstone rises twenty-one feet above the level of the water. The sandstone is horizontally stratified in beds varying in thickness from two to six inches, and often shows distinct false-bedding. It is not very compact, and quite unaltered, and the individual quartz grains are moderately well rounded. Some soft calcareous spots have possibly been fossils, but they now show no trace of structure. The surface of the rock is polished and marked by distinct glacial striæ trending S. 35° W. Athabasca sandstone.

From this cliff the shore was followed northward for a mile and three-quarters, past some low cliffs of sandstone, and points surrounded by boulders, to the bottom of a bay where camp was pitched, in heavy rain, on the evening of the 14th of July, on a level sandy plain thinly wooded with small Banksian pines.

A third of a mile north of camp is a narrow elongated hill or ispatinow 120 feet high modified by subsequent wave action, with its longest diameter stretching S. 35° W., parallel to the glacial striæ in the vicinity. Its summit, which is rounded and from thirty to sixty feet in width, is composed both of rounded and more or less angular cobbles or fragments of sandstone imbedded in sand or rock-flour. It rises from the level of the plain to the south-west, and then undulating slightly for two hundred yards, drops more suddenly again to the plain. The north-west side slopes to a valley, beyond which is another similar ridge, while in the distance are others, probably also of a similar character. The south-west side is rather abrupt. Ispatinow.

The two ancient shore-lines, marked by the sandy terraces south of the lake, are also distinctly shown on the side of this ispatinow. On approaching the hill from camp a gently rising sandy plain is crossed, until a compact pavement of large sandstone boulders is reached, with a scarp six feet high behind it. The foot of this scarp, marking the height of the lowest old shore line, is forty feet above the present level of the lake. Above this scarp the slope is steeper and is rather thickly strewn with boulders. At a height of seventy feet above the lake, a line of well rounded cobbles marks another distinct shore. It is best shown at the north-east end of the hill, round which it curves as an arched beach-ridge of water-worn pebbles. Ancient shore lines.

No signs of the upper shore-line at approximately the same altitude were seen around any of the many hills farther north. There is no Hyper-Cree Lake.

land in that direction sufficiently high to form the northern shore of a lake seventy feet above the level of the present lake, and there seems to have been very little warping of the crust since the glacial times. It would therefore seem moderately certain that we have here portions of the ancient shore-line of a lake that lay between the front of the Keewatin glacier not very far to the north and the higher land to the south. At its highest stage it must have discharged over the height of land south of Cree Lake, the ancient river flowing down the wide valley in the bottom of which now winds the Mudjatick River.

From the camp near the foot of this hill, we paddled S. 30° E. for a mile, to a low point, and then for a mile and a quarter eastward across the mouth of a deep bay to another low point, piled around with an ice-shoved wall of sandstone boulders five feet in height.

Shore of boulders.

From this point north-eastward, the north-west shore of the lake is generally thickly strewn with boulders, with occasional low hills of boulders a short distance inland. At a place where we stopped for lunch in north latitude 57° 25′ 00″ a grove of large Banksian pines covers a sandy plain in front of a hill of boulders, and under the trees were growing many flowers of the beautiful ladies' slipper (*Cypripedium acaule*, L.), calling to mind the lovely woodland glades then far to the south. Half a mile farther north, a hill 150 feet high rises from the edge of the water. The central portion of the hill consists of a dyke about two hundred feet wide, of a coarse light green uralitic diabase, apparently running S. 65° W. Examined microscopically, this rock is seen to consist of plagioclase, much of which is altered to calcite and sericite; hornblende, which has probably resulted from the decomposition of augite, and some of which is altering to chlorite; biotite in small amount; quartz in granophyre structure; and ilmenite, altering to leucoxene.

Diabase dyke.

Altered Athabasca sandstone.

The hill is thickly covered with boulders, but near its summit, about twenty feet of highly altered pinkish Athabasca sandstone is exposed north-west of the diabase dyke. It dips at an angle of four degrees away from the dyke, and becomes less altered as it recedes from it.

The canoes here left the shore and struck out into the lake in a north-easterly direction among a number of high thinly wooded islands which, seen from the end, appear as sharply pointed cones rising from the water, and seen from the side as diffuse domes. One of these islands, at a distance of three miles and a-half from the trap dyke, was named Prospect Hill. It is a narrow hill rising to a height of 170 feet above the lake, and as a depth of seventy feet of water was

Prospect Hill.

found not very far from it, it may be said to have a total height of 240 feet. It trends N. 35° E., parallel to the direction in which the glacier last moved across this region. The summit is nearly level for a width of a hundred feet, the sides are as steep as the earth will stand, while the ends round down easily to the shore. As far as can be seen it is composed entirely of sand and boulders, without rounded gravel. It shows no sign of stratification or of being composed of well waterworn material, but consists rather of loose, unassorted till, and like the hill near the last camp, and hundreds of other similar hills around and farther north, it is a typical example of the elevations described on page 23 as ispatinows.

View of Cree Lake.

From the top of Prospect hill a beautiful view may be had of the lake and the surrounding country. Toward the north-west, a wide almost open plain stretches away towards Whitefish Lake. Cree Lake is seen to be studded with thinly wooded islands, all apparently of the same nature, more or less oval in shape, and rounding up from each end to a highest point near the middle. All lie in the same direction parallel to the course of the last glaciation, and none show any outcrops of the underlying rock. These ispatinows are seen to be more numerous on the lower areas, now covered by the water of the lake, than on the surrounding higher land. In the absence of any sections, and on the hasty examination which the writer was able to make, it is very difficult to determine the exact mode of formation of these hills, but the conditions that seem to have prevailed at the time of their formation may be here briefly stated. The glacier, spreading out from a great gathering-ground in the vicinity of Yath-kyed Lake, was here moving south-westward, parallel to the long axis of Cree Lake. Its front had receded from the Archæan rocks to the south, and was, therefore, some distance north of the present height of land, and its foot was washed by Hyper-Cree Lake, whose strands are so distinctly marked around the southern end of Cree Lake. Towards its front this gradually retiring glacier would be much reduced in thickness. Streams would flow on its surface, but when these streams plunged into the narrow crevasses or moulins the water would at once reach the level of the adjoining lake, the current would cease, and the material carried by the stream would accumulate in one place between the narrow walls. As the walls melted away these accumulations would thus remain as narrow elongated ridges of unassorted material, without any external sign of stratification. The above explanation of the formation of these high ispatinows between narrow walls of ice, in quiet water, would seem to apply throughout the north wherever these hills were seen, while where the water from the glacier had a free course

Ispatinows.

Conditions of formation.

towards lower ground, ridges of this character do not seem to have been formed, and where the water flowed freely between icy walls, eskers were produced, some magnificent examples of which may be seen in the country further north.

Four miles north-east of Prospect Hill, camp was pitched on the east side of a thinly wooded sandy island, at the foot of a similar hill, sixty-five feet high, the summit of which was thickly strewn with boulders of sandstone. The variation of the compass at this place was determined as 26° 30′ east.

The next morning the journey was continued in the same north-easterly direction, across the lake, between the numerous islands, on many of which rose similar narrow hills. At about nine miles (in N. latitude 57° 25′ 9″) we stopped for lunch at a rather high point of a large island, behind which is a hill of loose sand sixty feet high, with a few boulders scattered over its sides and summit. Beyond it are other similar hills, with basin-like depressions among them. Similar hills again stretch away to the north-eastward and form islands in the lake. They have very much the appearance of being wind-formed dunes.

Sand-hills.

From this point we paddled in a direction N. 10° E. for two miles and a-half across open water, to the west shore, at a point piled with boulders of sandstone. The greatest depth of water found when crossing the lake here was 120 feet. The character of the country had now changed, the ispatinows and numerous islands having been left behind; but low stony ridges were still to be seen, the land rising in a moderately regular slope to a height of about eighty feet above the water. This gradually declines to the north-eastward to a height of forty feet. The shore in front of this slope is irregular, with low stony points. The lake here contracts to a width of about half a mile, but whether the east side of the narrows is a large island or the main east shore was not determined.

Low stony ridges.

On the west shore, at the north end of the strait, there is an exposure above the edge of the water of three feet of thick-bedded soft white Athabasca sandstone. The principal lines of stratification are horizontal, but in places a false-bedding can be detected. The surface is smoothed and shows glacial grooves trending S. 15° W. This is the third and last exposure of sandstone seen on Cree Lake, but the general appearance of the adjoining country would indicate that it is all underlain by similar rock.

Athabasca sandstone.

Four miles N. 25° E. from this sandstone outcrop, and a mile south-west of the outlet of the lake into Cree River, we camped on a sandy plain among thin woods of Banksian pine, though behind the camp was a low rise thickly strewn with boulders. Among these are many of reddish garnetiferous and gray gneiss, and of compact green Huronian (?) schist. No boulders of limestone had been seen since leaving Churchill River. The sand on the beach here is composed of well-rounded grains of quartz of very regular size. When walked on it emits a sharp ringing note. A meridian altitude of the sun observed here gave the latitude at 57° 42′ 30″.

Boulders.

Musical sand.

Where the Cree River flows from the north end of Cree Lake it is about 200 yards wide, with sandy bottom, and low banks wooded with small Banksian pine and spruce. The stream soon becomes very rapid, with a current of from six to eight miles an hour over a bed of broken fragments of sandstone. Six miles below the lake we reached the head of a long rapid, known as Hawk Rapid, in which the river has a total descent of from thirty to forty feet in a distance of about two miles. Near the head of the rapid a small exposure of white horizontal sandstone is seen on the east bank, while the low plain to the north-east is composed almost entirely of rough masses of this sandstone. Half a mile farther down, on the same bank, is an escarpment showing ten feet of horizontally bedded, hard, coarse-grained sandstone, of a light salmon colour. Its surface is well polished but without glacial striæ. Just below it, is a cliff thirty feet high of unstratified till, holding a large number of boulders of sandstone imbedded in a matrix of sand. Very few boulders of gneiss and none of Huronian rocks were present. Half a mile further down, the river rushes in a wild torrent between abrupt walls of sandstone ten feet in height, and around the vertical or overhanging sides of Hawk Island, which stands up in the midst of the foam. The sandstone is coarse-grained and well stratified, white on fresh fracture, but weathering to a light brown colour. Above the sandstone is a cliff of till twenty feet in height, rising to the level of the surrounding country. The flood-plains of the river near the rapids are composed of rough broken masses of sandstone, up to a foot in diameter.

Cree River.

Hawk Rapid.

Athabasca sandstone.

The rapid is a long and bad one, without any channel. It cannot be tracked with a line and wading in the water is very difficult on account of the swiftness of the current, the sharpness of the stones, and the irregularity of the stony bars. Paddling is generally impossible, and it is difficult to obtain a proper set for the poles, as they slip down and catch between the large stones. On this account the Indians rarely ascend this river, our Chippewyans telling us that but one man had ascended it in the past seven years.

One of the canoes had been badly broken in the rapid, and the men's feet and legs were cut with wading over the sharp stones in the water.

Canoe broken.

We therefore camped a mile below the rapid, among scattered Banksian pines on a sandy plain on the west bank of the river. Some low hills in the vicinity are covered with boulders. Into the bottom of a little bay near the camp a small stream, twenty-five feet wide and three feet deep, with a current of a mile an hour, flows from the south-west.

For several miles below the mouth of this brook, the river at times expands into wide quiet stretches, and then rushes down heavy stony rapids, flowing through an undulating sandy country. At a distance of eight miles below the brook and about a mile below a sharp bend to the west, six feet of similar pink horizontal sandstone is exposed on the west bank. A short distance below this sandstone, the lightly rolling sandy country is left behind, and the now uneven surface rises in irregular morainic hills of boulders a hundred feet in height. On the sides of these hills some small aspen poplars grow, the first that had been seen north of the height of land. These morainic hills continue for a short distance, and then the more sandy country is again entered.

Morainic hills.

Character of rapids.

For twenty miles the heavy rapids succeed each other in quick succession. They are all very similar in character. The stream first becomes very narrow and swift, often with a current of ten or twelve miles an hour, and then gradually expands, until it is spread thinly over a wide bed of gravel and boulders, over which it is almost invariably necessary to wade, and grasping the canoe by the gunwales, lift it slowly along. The river nowhere flows in a deep valley, though the banks are mostly composed of easily ercsible sand and sandy till, which would be quickly carried down by the impetuous current. The reason that at once suggests itself for the absence of valleys in this, as well as in most of the other rivers in the far north, is that the ice sheet has but comparatively recently retired, leaving the surface free to be remodelled by the streams that now flow over it; but it must be borne in mind that the streams are frozen over for most of the year, and when the ice breaks up in early summer it shoves the boulders and loose masses of rock into compact boulder walls and pavements in the bank and bed of the stream, forming surfaces that resist stream erosion almost as effectually as the solid rock itself.

Absence of valley.

Reason of such absence.

In north latitude 58° 00′ 00″ a low exposure of similar stratified sandstone may be seen on the west bank near the foot of a rapid, and in latitude 58° 5′ 30″, cliffs six feet high, of precisely similar coarse sandstone form the east bank. Midway between these two outcrops, rounded hills of sand, from fifty to eighty feet high, rise on each side of the river, probably representing dunes on an ancient shore of Hyper-Black Lake. Just below the lower cliff, Little Cree River, a stream of brownish water, with a strong current, joins the main stream from the south-east, its mouth being hidden by many low wooded islands, which here break the Cree River into numerous swift shallow channels. After a long and hazardous day of incessant toil, camp was pitched on the evening of July 19th on the east bank, two miles below the mouth of Little Cree River, at the foot of a low sandy terrace. A meridian observation on Altair gave the latitude here as 58° 8′ 00″.

Ancient dunes.

Little Cree River.

The next morning, we had been in our canoes but a few minutes when we were in the middle of a deep heavy rapid three-quarters of a mile in length, at the bottom of which sandy terraces rise on both banks to heights of forty feet above the river. Nine miles below camp, at the foot of a similar rapid, the terrace is still forty feet high, and meagrely wooded with small Banksian pines. A scarped face shows it to be composed of stratified sand. The surrounding country consists of rolling stony hills, the angular masses of rock, so prevalent higher up the stream, being no longer seen.

Sand escarpments.

From the sand escarpments, the river takes a very straight general course in a north-northeasterly direction, between low marshy banks in the bottom of a valley a third of a mile wide and forty feet deep. At the foot of this straight course, and a quarter of a mile above the mouth of Rapid River, a meridian observation of the sun gave the latitude as 58° 18′ 22″. Rapid River is a swift shallow stream, seventy feet wide, flowing from the east.

Rapid River.

Two miles and a-half below the mouth of Rapid River, low cliffs of peat rise on the west bank of the river, below which the banks are flat for a couple of miles. Then begins a series of heavy, though moderately deep, rapids, separated by stretches of quiet water. Much of the surrounding country is a sterile sandy plain, varied with equally sterile hills of boulders.

Cliffs of peat.

In approximate latitude 58° 28′, the canoes entered a heavy rapid three miles in length, in which the river has a fall of about forty feet. Hills of boulders from a hundred to a hundred and fifty feet high rise on each side, and the bed of the stream is formed of boulders that have fallen from both sides. The upper part of the rapid is deep and narrow, while the lower stretches are wide and shallow. Just at the foot of this rapid, as the river expands to quiet water, on the west side, a scarped bank twenty-five feet high shows, at the bottom, fifteen feet of

Hills of boulders.

Red and white sandstone.

horizontally stratified, rather fine-grained sandstone, both white and bright red in colour. The red sandstone does not form regular beds, but runs down irregularly into the white. It is, however, usually thin-bedded and shaly, while the white is often moderately thick-bedded. The weathered surface of the red beds is blotched with rounded lighter spots. No fossils of any kind could be found in these sandstones. It is doubtless of Keewenawan age, the same as the coarse sandstone seen higher up the river.

For three miles below the heavy rapid, the river is wide, with low banks. Our camp was pitched on the east bank in a grove of small pines by this quiet portion of the stream. For a mile and a half below camp the river flows with an even current, and then a series of rapids begins and extends for four miles, to the mouth of Bad-water River.

Bad-water River.

Bad-water River is a hundred feet wide at its mouth, shallow, with a muddy bottom. Its water is clear and it is said to flow from a lake about eight miles long, lying to the east, in the midst of an extensive swamp. From the mouth of Bad-water River, Cree River continues to flow northward for three miles, through low undulating sandy country, and then it turns sharply westward to the mouth of Trout River, descending the last rapid in its impetuous course. A short distance above the bend, a number of cut-banks, on the sides of wooded hills, show sections of sand and gravel, consisting of rounded waterworn pebbles and cobbles of sandstone. The banks are wooded with Banksian pine or willow scrub to the edge of the water.

Trout River.

Trout River is a stream of light brown water about two-fifths the size of Cree River, though it is sluggish at its mouth, so that it is difficult to estimate its exact size. The Indians travelling southward formerly used to ascend it and portage across from its head into Cree Lake, rather than ascend Cree River.

Six hundred yards to the west a lightly wooded hill rises, close to the river, to a height of 120 feet. It is composed almost entirely of sand, though a few boulders are scattered over its summit. From its crest a very extensive view can be had of the surrounding country.

Surrounding country.

To the west, a great level sandy or boggy plain, thickly wooded with pine, stretches away towards some low distant hills. To the north a similar country extends to the hills south of Black Lake. A small lake lies a couple of miles to the south-west, beyond which are some low hills. To the east, the view is not so extensive, and the country not so level.

From the mouth of Trout River, which was found to be in latitude 58° 37′ 40″, Cree River flows N. 30° E. for sixteen miles, measured in a straight line, to the mouth of Sandy River. It has a moderate current, a general width of from 150 to 200 yards, and a sandy bottom. In one place, a cliff thirty feet high of unstratified till with boulders, forms the east bank, but otherwise the banks are low. Elongated, narrow sandy hills or ispatinows, similar to those on Cree Lake, make their appearance at the mouth of Trout River, and become very numerous as the river is descended. One clothed with Banksian pines, opposite the mouth of Sandy River, rises to a height of a hundred and eighty feet. It slopes lightly towards both ends, and is very steep on both sides, standing up like a knife-edge trending S. 65° W. It is composed almost entirely of sand, but a few boulders are scattered over its top and sides. From it many other similar hills may be seen, one, probably 300 feet high, lying in a direction N. 85° E. Ispatinows.

From the mouth of Sandy River, Cree River turns sharply westward, around the north end of the hill just described, and after a course of five miles, past several other high sandy ispatinows, empties into the south-west side of Wapata Lake, in the midst of a wide willow-covered marsh. We here crossed the lake for three quarters of a mile to the east end of Wapūs Island, where camp was pitched on the evening of July 21st, and where an observation of the sun determined the variations of the compass as 29° E. Wapata Lake.

The mouth of Cree River had now been reached, four days having been occupied in its descent. Its length is 108 miles, and its total fall is between 500 and 600 feet. Its upper part, to north latitude 58° 8′ is a roaring, foaming torrent, rushing along in many places at the rate of from ten to twelve miles an hour. The lower part is not quite so bad, though much of it is very swift and shallow. The current gradually slackens to the lake. General character of Cree River.

Wapūs Island is a low narrow ridge nearly two miles in length, lying S. 60° W. It is thickly wooded with spruce, birch, white poplar and a little larch. The north-west shore of the lake is also low and thinly strewn with boulders. Wapūs Island.

Two miles north-west from Wapūs Island is a strait in which is a rapid with a fall of a foot. Many fragments of mottled and thin-bedded, often shaly, sandstone are lying in the water, and the bottom of the strait seems to be composed of this rock, which is undoubtedly of the same age as that previously seen on the river. Below the strait, Wapata Lake again opens out to a body of water about six miles long and a mile and a-half wide. A high hill on an island and another on the north shore are apparently similar to those on the lower part of the Strait in Wapata Lake.

river. The shore is generally sandy or strewn with small boulders. Pine River empties into the south end of this lake. It is said to be a large rapid stream, which cannot be ascended far in canoes on account of rapids and fallen timber.

The river, flowing from the west side of the lake, is at first wide, with a scarcely appreciable current. A mile and a-half down stream a hill rises on the north bank to a height of 110 feet. It is composed of sand and some boulders. A cliff, standing forty-five feet above the lake, shows a section of sand, cobbles and boulders, all fairly well rounded. On the sides of the hill, at heights of seventy, eighty and ninety-five feet above the lake, respectively, are three well marked beach-ridges of rounded gravel, and the summit is composed of rounded cobbles, all showing distinct shore-lines of Hyper-Black Lake, which must have covered a large area of the surrounding country.

Old beaches.

At the point of this hill the river turns sharply northward, and flows for a mile as a rapid deep stream a hundred and fifty feet wide, between low cliffs of light-pink sandstone. It then expands, and in a mile and a-quarter opens into the south end of Black Lake. At this point the west shore is low, and gently sloping to a beach of boulders, while hills rise on the east shore. The country is thickly wooded with small spruce.

Black Lake.

Area.

Black Lake is a long narrow body of clear water lying in a general north-east and south-west direction, with a greatest length of forty-one miles, a greatest width of nine miles, a shore-line of about 110 miles, and a total area, including islands, of two hundred square miles. On July 6th, 1893, its water had a temperature of 58° F. Its present name seems to have been given to it by David Thompson, perhaps from the dark hills of norite which overlook its north-west shore. By the Chippewyan Indians of Fond du Lac it is called Dess-da-tara-tua, or Mouths of Three Rivers Lake, alluding to the mouths of Cree, Stone and Chipman rivers which empty into it.

Name.

From the funnel-shaped mouth of Cree River, our course lay for two miles and a-quarter in a north-northeasterly direction across the most southern bay of the lake to a narrows with low bouldery shores, and thence onward in nearly the same direction for two miles and a-half, past a low sandy shore to the east end of a narrow channel running between a large island and the main shore. This channel is a hundred and fifty yards wide, with steep sand escarpments from eighty to a hun-

Deep narrow channel.

dred feet high on both sides, and runs quite straight in a direction S. 80° W. The water in it is deep and without current. It was followed for three-quarters of a mile, beyond which it appeared to continue on across the island, but the time at our disposal did not permit us to examine it further. On the sand-hills some white spruce grows, being the first seen north of the Churchill River. This sand ridge may, for a short time, have formed the north shore of that part of the lake to the south, and have held its waters higher than their present level, in which case this valley would mark the channel of the ancient river which has rapidly cut through the easily eroded sandy ridge.

For six miles north of this deep narrow channel the shores are very irregular, usually low, and more or less thickly wooded with small black spruce and pine. High sand-dunes form conspicuous hills at some of the points on the east shore. At the end of the above distance the lake expands to a width of nearly three miles, and its outline becomes much more regular. Its south-east shore is sandy, with high rounded hills of sand or boulders towards its north end. Its north-west shore runs for several miles along the foot of a sandstone escarpment 230 feet in height, which extends away towards the south-west, beyond the end of the lake, and north-east to within a short distance of Stone River. Where the west shore leaves the foot of the escarpment, it is bounded by sand-plains or terraces of greater or less height. The escarpment is composed of horizontally bedded white or light-pink, rather coarse quartzose, ripple-marked sandstone, often changing to a fine conglomerate. Other finer beds may occur in the upper seventy feet, but the sandstone throughout the lower 160 feet is all exposed on the face of the cliff. The smooth rock on the summit of the cliff is distinctly striated in a direction S. 70° W. At a height of 125 feet, an ancient, but post-glacial, shore-line is distinctly marked by a cliff twenty feet high, the foot of which is carved into caves, pillars and other fantastic shapes by the action of the water. It would appear probable that this beach was formed at the same water-level as the gravel bar on the summit of the hill between Wapata and Black lakes.

High sand-dunes.

Sandstone escarpment.

Athabasca sandstone.

Old shore line.

After following the foot of the rocky escarpment for several miles, the shore swings more to the east. It is at first strewn with boulders, and then for two miles is bounded by a cliff of sand rising to a sandy terrace. North-east of this again, is a low shore strewn with boulders, to a prominent point on which is an exposure ten feet in height of thick-bedded, coarse white sandstone or fine conglomerate. North of this point Stone River flows out of the lake along the line of contact of the Archæan and the Palæozoic rocks. Half a mile N. 30° E. from

Contact of Archæan and Palæozoic rocks.

the last point, and on the opposite side of the river, is a rounded boss, fifty feet high, of reddish-gray, well foliated, slightly biotitic granite-gneiss, striking N. 35° E. and dipping N. 55° W. at an angle of 75°. Its surface is rounded and covered with black lichen. In thin sections this rock is seen to be composed of quartz, considerably crushed; plagioclase, altered to some extent into sericite; orthoclase (?); and biotite slightly altered to chlorite.

From here Black Lake opens out into its largest expansion, the south-east shore turning sharply to the east, and the north-west shore continuing in a north-easterly direction. No sandstone is seen on the latter shore, it being composed of a high ridge of Laurentian gneiss.

The south shore was followed by Mr. Dowling, who gives the following description of it:—

South shore

"From the narrows, to which the long portage from Middle Lake leads, the shore eastwards is comparatively straight, broken only by a few salient points. Stratified sands, deposited in an ancient lake-basin, are exposed in a bay near the mouth of Stone River, showing in all a thickness of forty feet. A prominent feature on the shore to the south is the presence of a series of oval hills about 150 feet high, all lying in a broken chain, parallel to the shore or about east-and-west.

"The shores are mostly boulder-strewn, with sand behind, and the underlying rock is exposed in only one place, just west of the upper Stone River. There sandstone slabs are piled up on the point, and about two feet of sandstone in place is exposed at the water's edge. The beds are uneven and ill-defined, but are about a foot thick, of coarse grain and stained with red.

"The Stone River discharges into Black Lake by two mouths, inclosing an island of dark gneiss. Thus the boundary between the Archæan and the Keewenawan sandstone here is at the western mouth of this river."

North-west shore.

From Stone River, the north-west shore of the lake has a general trend N. 40° E., for fifteen miles, keeping close to the foot of a ridge from 200 to 400 feet in height, of a dark amphibolite, sometimes almost massive, and sometimes varying to highly hornblendic gneiss or hornblende-schist, striking with the trend of the ridge and dipping at a high angle away from the lake. Old shore-lines were not so distinctly marked here as on the face of the sandstone escarpment further south, but thirteen miles from Stone River, one ancient beach was seen fifty-five feet above the present water-level, marked by a horizontal line of rounded pebbles.

Fir Island. Fir Island lies off this shore. It is a large rudely triangular island with an area of about twelve square miles, doubtless underlain throughout by horizontal sandstone. At its south-west point, cliffs of this white horizontally bedded sandstone rise to a height of fifteen feet above the water, and along its north-west shore are cliffs of sand forty feet high. Its northern extremity is a long point of boulders. Its other sides are low, but were not closely examined. The surface of the sandstone at its south end is strongly glaciated on a bearing N. 75° W.

About fifteen miles from Stone River, Chipman River, a rapid torrent fifty feet wide, tumbles over masses and points of gneiss and schist to join the lake. From the mouth of Chipman River, the shore leaves the foot of the high rocky ridge and swings more to the east, though it is still composed of very similar Archæan gneiss and hornblende-schist. Portage route to Telzoa River. Two miles along the shore, in observed north latitude 59° 17′ 34″, one of our Indian canoemen pointed out a place among the overhanging willows, where he stated that a portage left the lake on the canoe-route by which the Chippewyan Indians annually travel to their hunting grounds at the head of the Telzoa River; adding that the Telzoa River flows an unknown distance towards the north, into the country of the Eskimos and the musk oxen. On the information here gained the expedition of the following year was largely planned, when, without guides, the Telzoa River was descended for 800 miles to its mouth at the head of Chesterfield Inlet.

Ridge of boulders. Just back from the shore and parallel to it, is a ridge seventy feet high, composed almost entirely of boulders, some of which are very large. These consist chiefly of a fine and even-grained red granite-gneiss,—none being seen like the dark hornblende-rock in the ridge to the west.

Granite and gneiss. The shore to the eastward is composed of granite, at first massive, and then with distinct gneissic foliation, and the bay north-east from the entrance to the portage seems to run along the line of contact between this rock and the hornblende-schist to the west. A point on the west side of the bay is composed of a very coarse, massive white muscovite-granite. Behind this point is a hill sixty-five feet high, of irregular masses of similar rock.

A mile and a-half to the south, past some low granite islands, is a long low point of even-grained red granite. The general surface is

Glacial grooves.

well smoothed and marked by glacial grooves trending S. 72° W., while some lee surfaces show distinct grooves trending S. 52° W., probably made by the same glacier at an earlier date than the others.

Three-quarters of a mile east of this point, is another low point composed of similar granite, with a strike N. 75° E., and a dip N. 15° W. < 25°. For the next mile and a-quarter we travelled by a low shore strewn with boulders, to a small low island of very irregularly foliated gray gneiss, cut by veins of red pegmatite. Its surface is well smoothed, and marked by glacial grooves trending S. 60° W.

Islands of red gneiss.

For the next six miles numerous rounded islands, thinly wooded with black spruce and birch, lie off the moderately straight shore, which rises in places to a height of a hundred feet. The rock is all a reddish gneiss, mixed with similar granite, or cut by granite veins. It is occasionally jointed, breaking down into little cliffs, but the islands generally descend more or less gently on all sides to the water. Glacial striæ all run between S. 60° W. and S. 75° W.

East shore.

From this point, where we left the north shore, the lake continues eastward for a couple of miles, to the foot of a high ridge of rocky hills. We turned southward, passing the point of an island of foliated hornblende-granite, to the east shore in north latitude 59° 13′ 28″ at a sand beach in front of high rocky hills of very similar gneiss, striking east and dipping south at an angle of 40°. A mile and a-quarter further south is the mouth of Stone River, which is here 300 feet wide. On each side rise little rounded hills of sand, wooded with spruce, pine and birch.

Athabasca Lake.

This lake lies in a general east-northeasterly and west-southwesterly direction, along the line of contact of the comparatively undisturbed and unaltered Palæozoic sandstones to the south, and the much disturbed and highly altered Archæan gneiss, schist, &c., to the north.

Area.

It has a greatest length of 195 miles, a greatest width of 35 miles, a shore-line of 425 miles, and a total area of 2850 square miles. According to Mr. McConnell* it has an elevation of 690 feet above the sea. Its depth has not yet been determined.

Tributaries.

Its principal tributaries are the Athabasca River from the south, and the Stone River from the east, while several other smaller streams,

*Report on a Portion of the District of Athabasca, by R. G. McConnell, Ottawa, 1893. Annual Report, Geol. Surv., Can., vol. V. (N.S.), 1890-91, p. 27 D.

mentioned or described later on, drain into it from the surrounding country.

The south shore of the lake, with the lower courses of some of the tributary streams, was examined and surveyed by Mr. Dowling in the summer of 1892; the north shore, east of Fond du Lac, was examined and surveyed by the writer in the same year; the remaining portion of the north shore was examined by the writer, and surveyed by his assistant, James W. Tyrrell, C.E., D.L.S., in the summer of 1893, and the results then obtained are included here in order to represent and state in more concise form the information at present available with reference to the geology of the lake. Surveys.

On the north shore of the lake, near its west end, the fur trading post of Fort Chippewyan has stood since the early part of the present century. To the west of it, facing the lake, a row of small houses has grown up, occupied by natives who are more or less dependent on the fur-traders for support, and at the end of this row is an Episcopal church and mission house. About a mile to the west, across a small bay, the Roman Catholics have a church and large mission establishment, around which is a small but well tilled farm, on low gently sloping land a few feet above the level of the lake. The surrounding country consists of evenly rounded rocky hills thinly wooded with small black spruce. The rock is generally a red and dark regularly banded hornblendic gneiss, and its surface is strongly marked by glacial striæ running N. 75° W. Fort Chippewyan.

From Chippewyan, the north shore of the lake runs north-eastward for twelve miles to Poplar Point, along the foot of a rather high ridge of hills, composed of similar banded gneiss striking parallel to the general direction of the shore, and more or less nearly vertical. At Poplar Point, the gneiss contains many green epidotic bands. In front of the cliffs of gneiss are exposures of sand, containing pebbles and rounded boulders, most of which are of sandstone or conglomerate. North shore.

At Fishing Point, two miles further along the shore, the rock is a light and dark-gray gneiss, very irregularly foliated, and cut by many veins of opaque white quartz, with some veins or narrow dykes of dark-green chloritic and epidotic schist, which would seem to be a crushed and highly altered eruptive. Fishing Point.

For the next mile, the shore is very rocky, and at the long point is composed of a light-green chloritic gneiss, consisting of quartz, plagioclase, chlorite, biotite and epidote. The quartz, which is present in large amount, is very much crushed and broken. The felspar is present, often in large grains, which project on the weathered surface. This gneiss forms the shore some distance northward, and then recedes from the lake, after which the beach is sandy. A deep rounded bay is next passed, in the bottom of which are some rather high cliffs of sand, while towards the north it is terminated by a long, low sandy spit.

Cliffs of sand.

Some large islands lying off this portion of the shore are low and thickly wooded. They are probably underlain by Athabasca sandstone.

Huronian? sandstone.

Camp was pitched on the 21st of June on the north side of the sandy spit, near its base. Close to this place is a low boss of highly altered calcareous sandstone, possibly of Huronian age. It is banded in reddish and greenish bands, strikes west, and dips north at an angle of 30° In thin sections it is seen to be composed of quartz, orthoclase, plagioclase, calcite, muscovite, (?) chlorite, pyrite and magnetite. In places it is cut by thin irregular veins of quartz, and often shows an imperfect slaty cleavage. Its surface is strongly marked by glacial grooves, trending S. 65° W.

Half a mile further north-east, is a rock of very similar composition, but finer grained and highly schistose, the strike of the schist being along the shore, and the dip almost vertical. Behind the rocky beach a sandy terrace rises to the height of twenty-five feet above the lake, and half a mile back is a ridge of granite hills from 150 to 200 feet in height. For the next seven miles, the shore is formed of vertical or overhanging cliffs of schist, rising in places to a height of forty feet, but a stiff onshore wind, with a dense fog, prevented a closer examination.

Sandy terrace.

In observed latitude 59° 6′ 32″, a little sandy beach offered a safe landing place, and we went ashore near the mouth of a brook four feet wide, around the mouth of which a good deal of ice was still clinging. The beach is in front of a low terrace, and close to it is a boss of light reddish-gray gneiss, striking N. 15° E., for the schist has now given out. The surface of the gneiss is beautifully smoothed and striated in a direction N. 75° W. The variation of the compass was here found to be 31° 30′ E.

Reddish-gray gneiss.

From here the shore turns more to the eastward and becomes lower and more irregular. It consists of points of reddish-gray biotite-granite or gneiss, without any persistent strike, between which are sandy bays, where the sand is often piled into high dunes.

Fishing Creek.

Camp was pitched at night on the bank of Fishing Creek, on a pleasant flat covered with short grass and wooded with small Banksian pines. A heavy storm detained us in this camp throughout the following day. Fishing Creek is 200 feet wide, but without current, and a mile from the lake it contracts to a small brook ten feet wide, flowing from a swamp. The hills behind are composed of reddish-gray biotite-granite, similar to that on the shore. From the mouth of Fishing Creek the shore was followed for sixteen miles, past Cypress Point to Gray-willow Point. The granite hills recede from the lake, forming a high ridge some distance inland, and the shore is low and sandy, with a sandy plain, fifteen or twenty feet above the water, stretching back towards the hills. A mile and three-quarters beyond Gray-willow Point, Scorched-dog Island lies a short distance off the shore, and is composed of sand and boulders, most of the latter being of red Athabasca sandstone and conglomerate.

Gray-willow Point.

From Scorched-dog Island we travelled in a direction N. 65° E., for nearly seven miles across the mouth of a shallow bay to Maurice Point. The shore of the bay is sandy, except at one point, where there seemed to be a low boss of rock. The ridge of granite hills continues to recede until it is out of sight, and a sandy plain stretches back from the lake. On this plain rise some rounded wooded hills, but their character was not determined.

Sandy shore.

Maurice Point is piled to a height of twenty feet with irregular angular blocks of reddish Athabasca sandstone, some ten feet in diameter, that have doubtless been derived from rock in place near at hand. This irregular mass of sandstone blocks extends back to a distance of 200 yards from the lake, and from it a gravel bar stretches westward into the woods, with a height of fifteen feet above the water, formed when the lake stood at a somewhat higher level than at present.

Maurice Point.

From Maurice Point, we travelled N. 30° E., across the mouth of a deep bay, for seven miles to Spring Point, just north of which camp was pitched on the evening of June 24th. Behind camp, within the woods of small Banksian pine, are two well rounded old gravel beaches, respectively twenty and thirty-five feet above the present water-level, indicating higher stages of the lake. The point is composed largely of slabs of reddish Athabasca sandstone and conglomerate, which, on the south side, cover all the upper portion of the slope. All are angular and must have been broken from rock close at hand and piled up by the ice. Scattered along the shore, with the masses of sandstone, are a large number of rounded boulders of gneiss, green schist, massive green amphibolite, and red or green Huronian conglomerate, with moderately well rounded pebbles of granite and gneiss up to eight inches in diameter.

Spring Point.

The next day was stormy, but with considerable difficulty a distance of eleven miles was made. Several low wooded islands were passed, and the beach was for the most part low and sandy. At camp the shore was composed of a hard, evenly foliated schist, varying from green to reddish-brown in colour, and probably of Huronian age. In this section it is seen to be a confused mass of decomposition products such as serpentine, chlorite, etc.

Chlorite schist.

At a point a mile and a-quarter down the shore, similar schist outcrops, much reddened with iron. It is cut by many irregular veins of quartz, holding hæmatite. Its surface is smoothed and striated, S. 50° W.

At the next point, two miles distant, similar dark green schist is exposed striking north, and dipping west at an angle of 70°. It lies against a boss of red highly felspathic granite, and is very much contorted.

From here onward to the mouth of Cypress River, the shore seems to be composed of similar schist. Beyond Cypress River is a ridge of rounded wooded hills between 300 and 400 feet in height, possibly of gneiss, but we were not able to visit them, and their exact nature is uncertain.

Half-way Point.

South 75° east, two miles and a-half, across the mouth of the bay into which the Cypress River flows, Half-way Point consists of a hard and compact, fine-grained, thinly foliated green Huronian schist, interlaminated with bands of fine-grained crushed granite or gneiss, all with a very irregular strike, but generally dipping more or less towards the shore.

Clastic schist.

In this section the schist is seen to be a clastic rock composed of more or less rounded grains of orthoclase, plagioclase, quartz, and a fine-grained sericitic groundmass. The fine foliation is due to the parallel disposition of numerous minute scales of light-coloured biotite, undergoing alteration to sericite. With these are associated small particles of spheen, and small black dust-like inclusions, probably of iron oxide. That the rock has been submitted to great pressure is shown by the uneven extinction of the larger crystals and the alteration of the groundmass.

Granite.

The granite is composed of quartz, orthoclase largely replaced by microcline, plagioclase, augite, muscovite, biotite largely altered to chlorite, titanite, epidote and calcite. Generally speaking the granite is very poor in ferro-magnesian constituents, and the quartz and felspar have been granulated by pressure.

At the southern point of Slate Island, two miles eastward of Half-way Point, fifty feet of thickly foliated dark-brown Huronian schists outcrop, striking westward, and dipping southward at an angle of 60°. To the north of these schists is a band of coarse green Huronian conglomerate, with well rounded pebbles and a matrix of green chloritic material. Slate Island.

The variation of the compass was here determined to be 27° 10′ E.

At the south-east point of the same island, is a cliff of thinly foliated red schist, very similar to the last, but not so finely jointed. It is very evenly banded, and not much contorted, with a strike north, and vertical dip.

Five miles south-eastward from Slate Island, 59° 34′ 18″ was the latitude obtained from a meridian observation of the sun, on the east point of a small island lying off the south-west side of a large low wooded island. Near by was a low exposure showing three feet of typical gray or reddish coarse-grained horizontal Athabasca sandstone, occasionally containing a few rounded quartzite pebbles. The large island also seems to be composed of the same sandstone. Athabasca sandstone.

North-east of this island Charlôt River flows into the north side of the lake. Up this river the Chippewyan Indians have a canoe-route to a series of lakes, from which they descend another stream to the south side of Great Slave Lake. While crossing Athabasca Lake some Indians were met who had just descended Charlôt River from Charlôt Lake, near the watershed, where they had been hunting during the winter. Charlôt River.

From Charlôt River the shore for several miles southward is very rocky, high hills sloping steeply to the water. One point, in latitude 59° 32′, consists of a red and green gneiss, rather thinly foliated, striking N. 60° E. and dipping S. 30° E., at an angle of 30°. It is cut by many irregular veins of white, opaque quartz. In thin section the rock is seen to have been crushed and recrystallized, having been subject to great pressure. The quartz and orthoclase are arranged in elongated much broken augen masses, though a few of the felspar crystals have survived the crushing. The original bisilicates have disappeared, and are replaced by hornblende, which is now largely altered to biotite and chlorite. It also contains some muscovite, a few large zircons, and a good deal of secondary iron ore. Red and green gneiss.

The next point, four miles further south, is also composed of similar gneiss, here striking east and dipping south at an angle of 65°.

The variation of the compass was here found to be 32° 30′ east.

Cracking-stone Point.

We next crossed a deep bay, in a direction S. 31° E., for seven miles and a-half to Cracking-stone Point, east of which a steep rocky wall extends along the south side of the bay. This point is composed of massive, light-red and green coarse altered hornblende-granite, which rises in rounded glaciated knobs, on the summits of which are strong glacial striæ trending S. 75° W.

From Cracking-stone Point, we turned sharply eastward, and kept in narrow channels between islands of granite similar to the last. At about three miles distant, camp was pitched on the evening of June 26th, in a little sandy cove overshadowed by aspens. The rock on the adjoining hills is a well foliated reddish-gray hornblende-gneiss, the heavy bands striking N. 70° E., and dipping S. 20° E. at an angle of 35°.

Huronian quartzite.

For the next four miles, we wound among islands wooded with spruce, poplar and birch, in a direction a little south of east, to a point composed of a hard white recrystallized Huronian quartzite, which in thin section shows clear evidence of pressure and crushing. No stratification could be seen in the rock at this point. It is overlain, probably unconformably, by a nearly horizontal, coarse, red conglomerate composed of rounded pebbles of white quartzite in a coarse sandy matrix. It was impossible to make a thorough examination of this rock, but though it is much more highly altered than most of the Athabasca sandstone and conglomerate around the lake, it is probably of the same age.

For a considerable distance eastward from this point the shore is composed of the white Huronian quartzite.

Dip and strike.

At a point two miles and a quarter east, in latitude 59° 21′ 50″, the quartzite is reddish in colour, highly altered and very compact, but it is clearly seen to strike N. 40° E. and to dip S. 50° E. at an angle of 50°. The quartzite continues to form the moderately straight shore to a point six miles and a-half distant, where it is beautifully white and so much jointed and fissured that it is impossible to be sure of the true stratification, though it appears to strike N. 20 E. and to dip S. 70° E. at an angle of 70°.

Beaver-lodge Island.

A mile and a-half out in the lake, Beaver-lodge Island rises as a high rounded dome of white quartzite. The west side of the island is beautifully terraced, the plains of quartzite gravel extending step above step to the summit.

On the north shore of the lake, the Beaver Hills rise to a height of from 500 to 600 feet.

Four miles and a-half further east, we landed on a small island of quartzite, greatly crushed and recrystallized, and containing, besides grains of quartz, a small amount of chlorite and sericite. It is interlaminated with thin bands of light-green coarsely crystalline pyroxene rock. The rock has thus a well foliated appearance, the strike being N. 25° W., and the dip S. 65° W., at an angle of 10°.

Hill of quartzite and iron ore.

At a distance of a mile and a-half from this island, in a direction N. 66° E., a conspicuous red hill rises 125 feet above the water, its abrupt red cliff standing out boldly towards the south-west. On its north-eastern side, at its base, it is composed of thinly fissile quartzose schist, very much reddened, striking N. 30° W., and dipping S. 60° W., at an angle of 10°. Farther up the side of the hill the rock is a quartzite, interbedded with layers of hæmatite, which in some places forms the larger part of the mass. The summit of the hill, several hundred yards in length, is composed of a highly hæmatitic quartzite, mingled with a large quantity of limonite, especially on the higher points. In places the rock is a conglomerate, with quartz pebbles, and a matrix of limonite. Other similar red hills can be seen in the distance on the strike of the rocks, and the total amount of iron here and in the vicinity is doubtless very large.

Biotite-schist, probably a crushed gabbro.

Camp was pitched two miles and a-half farther east, on a little clay flat on the bank of a small brook, among a few poplars and willows. Near at hand is a boss of thinly foliated dark-gray biotite-schist striking N. 40° E. and dipping S. 50° E., at an angle of 50°. In thin sections this is seen to be a very much squeezed rock, with the quartz grains all granulated, a large amount of secondary biotite, and cores of serpentine, which probably represent porphyritic crystals of augite. It is, therefore, probably a crushed gabbro. Just to the north is a hill of reddish fine-grained gneiss, with the same strike and dip.

For the next seven miles, to Old Man Point, the journey was continued in a dense fog through narrow channels between small islands. A stop was made at one island about half way, which was found to be a rounded boss of red granite. The surface is well smoothed and strongly marked with glacial grooves trending S. 45° W.

Old Man Point.

Old Man Point is composed of a dark, regularly foliated hornblende-schist, striking N. 15° E., and, at the old house, with vertical dip; but on the west side of the point the dip is S. 75° E., at an angle of 30°. East of Old Man Point the islands are composed of reddish-gray heavily laminated gneiss, but a point, four and a-half miles distant, was found to consist of a laminated gabbro striking N. 45° E. and dipping S. 45° E., at an angle of 70°. The gabbro consists essentially of plagioclase, augite and biotite, the augite being much altered to serpentine and chlorite. Pyrite, apatite and zircon are present as accessory constituents. It is cut by several veins of white quartz, carrying a considerable quantity of hæmatite and pyrite.

Gabbro.

For the next ten miles the shore is very rocky, with a few sand or gravel beaches. At a point three miles east of the mouth of Beaver River, the rock is a fine and even-grained holocrystalline, reddish foliated gabbro striking N. 25° W. with vertical dip. The gabbro consists of bytownite, diallage and a considerable amount of brown biotite. The diallage shows incipient alteration to hornblende and is stained with hydrated oxide of iron, which is chiefly deposited along the planes of parting. The surface is marked by strong glacial grooves, trending S. 60° W.

Garnetiferous gneiss.

Eight miles farther, camp was pitched on a rocky island behind a beach of coarse gravel. The rock is a coarse garnetiferous gneiss, striking east, and with almost vertical dip. The timber in the vicinity is chiefly Banksian pine, but there is also some small white and black spruce, small balsam poplar, and aspen up to six inches in diameter. The next morning we travelled eleven and a half miles through heavy seas to the now deserted trading post known as Fond du Lac.

This was the most westerly point reached on the lake in 1892, and the description of this point and of the remaining portion of the north shore of Lake Athabasca is drawn from the writer's survey and examination made in that year.

Fond du Lac.

The lake is here but two miles wide, and the trading post is situated on a low point of sand and rock on its north shore. It consists of a number of well-built log houses, with a yard surrounded by a pallisade of stout posts. In 1892 it was in charge of José Mercredi, a venerable old French half-breed seventy-five years of age, who had lived there continuously for the past forty-seven years. In the immediate vicinity is a Roman Catholic mission church, where a priest lives during the winter. Mr. Mercredi informed me that in the early part of the century the Hudson's Bay Company had a trading post on a point on the south side of the lake, lying in a direction S. 20° W., and that the three inhabitants were killed by Chippewyan Indians. At the same time the North-west Company had a post on a point on the north shore a short distance farther east, but after the murder of the Hudson's

History of the post.

Bay Company's men they moved across to the point on the south shore. The place was afterwards abandoned until 1845, when Mercredi arrived and built the present post. It is on one of the principal lines of travel of the Barren Ground cariboo, in their regular migrations north and south.

The variation of the compass was here found to be 31° E., and the mean of two observations taken in the yard of the post determined the latitude at 59° 18′ 59″.

The rock is a gray quartzose garnetiferous gneiss with rather irregular strike, but generally about S. 70° E., and a dip about S. 20° W. at an angle of 45°. It is cut by a number of veins of red pegmatite. The surface is well scored by glacial striæ, trending S. 51° W.

Here on the 28th of July, 1892, the writer was joined by Mr. D. B. Dowling, bringing provisions for the remainder of the journey. He had descended the Athabasca River, and had surveyed the south shore of the lake to this place. His report will be found on a later page. The collections made up to this time were sent to Fort Chippewyan, to be forwarded up the Athabasca River and thence to Ottawa. Joined by Mr. Dowling.

On July 30th we again started eastward, Mr. Dowling taking the south shore as before, while the writer made a survey with compass and boat-log of the north shore.

From Fond du Lac eastward to the mouth of Grease Mountain River, a distance of nine miles and a-quarter, the shore, and the many low islands lying off it, are composed of gneiss of very uniform character, varying in strike from N. 45° to N. 70° E. Off the mouth of the river is an island of compact green gneiss, showing strong glacial groovings, trending S. 75° W. The point off the mouth of Grease River is composed of dark-green well foliated schist, striking N. 30° E. and dipping S. 60° E. at an angle of 80°. Grease Mountain River.

A Chippewyan Indian was here met and entertained to dinner, and from him we learned that his people had a canoe-route up this river to Rabbit Mountain Lake, on the edge of the Barren Grounds, and from this lake a large river flows northward into unknown country. Canoe route to the north.

A short distance east of Grease River Point, is a rounded rocky point, composed on its outer side of a dark-green garnetiferous biotite-gneiss containing a large quantity of plagioclase felspar, while on its inner side it consists of a red, much sheared gneiss, containing but Garnetiferous biotite-gneiss.

a small amount of biotite. The two are separated by a fairly sharp vertical line of contact, striking N. 65° E. parallel to the foliation of the gneiss on each side.

Half a mile further east, on a small island off a point, the rock is a dark-green thinly foliated garnetiferous biotite-gneiss, containing many phenocrysts of red orthoclase. The biotite is largely altered to chlorite. It is irregularly and sinuously foliated, and cut by many winding veins of fine-grained compact red granite. The surface is smooth and strongly grooved in a direction S. 58° W.

Two sets of glacial striæ.

Five miles and a-quarter east of Grease River Point, the surface of a small island of similar green thinly foliated gneiss shows clearly two distinct sets of glacial striæ, an earlier one trending S. 65° W., parallel to the other striæ seen almost everywhere along the shore, and doubtless made by the ice sheet from the north-east, and a later one trending S. 35° W., probably made by a local glacier descending from the high land to the north, after the greater ice-sheet had withdrawn. Half a mile further east, a portion of the moraine of this later local glacier may be seen as a great stretch of huge broken masses of rock, forming a prominent point, and covering the shore for a considerable distance beyond it. Half a mile still further east, on the surface of porphyritic biotite-gneiss, the same two sets of striæ are even better shown, the older one, seen on lee surfaces, running S. 65° W. as before, while the later one, which is strongly marked over the surface generally, trends S. 20° W. across the lake towards a valley on its south shore. Athabasca Lake is here five miles wide, and lies in a long narrow valley with a steep sandstone escarpment between 400 and 500 feet high on its south side. The later glacier from the north flowed into the valley at this point, and probably reached across to the south side, completely filling it and damming up the water from the east to the height of the sandstone plain on the south, which is at about the level of the high beaches previously described on the banks of Cree River and along the west shore of Black Lake. The occurrence of an ice-dam across the valley accounts fully for the former existence of a large lake in the present basin of Black Lake. Without the ice-dam, or some other dam of which no evidence can be found, the water of Black Lake could not have stood much above its present level in glacial or post-glacial times, for the great valley of Athabasca Lake, which extends eastward to Black Lake, dates back to a period long before the glacial epoch.

Moraine.

Ice-dam.

The rock on which the glacial striæ are shown, is a dark fine-grained biotite-gneiss, with small porphyritic crystals of orthoclase, striking

S. 60° E. and dipping S. 30° W. at an angle of 37°. At another point, half a mile farther east, a similar porphyritic gneiss has a wavy strike N. 70° E., and a dip S. 20° E. at an angle of 55°.

Two miles farther south-east, across a deep bay, is a high rocky point of very similar gneiss, striking N. 60° E., and dipping S. 30° E. at an angle of 75°. At the point of the cliff it becomes very coarse and heavily jointed.

From this point, a deep bay was again crossed, in a direction S. 35° E., to a small low bare island of highly garnetiferous orthorhombic-pyroxene-gneiss or foliated norite, weathering with a rough pitted surface, striking N. 70° E. and dipping S. 20° E. at an angle of 50°. Interbedded with the gneiss are some quartzite bands holding a large quantity of pyrite. A mile and a-half to the south-east is a low sandy island, on which camp was pitched for the night, behind a beach of rounded boulders, in open woods of birch, spruce and Banksian pine. Observations on the sun taken here determined the latitude as 59° 15′ 35″, and the variation of the compass as 37° E. To the south, a steep unbroken escarpment of horizontal Athabasca sandstone rises to a height of between four and five hundred feet; while the north shore is irregular and broken, composed chiefly of foliated norite, which rises into hills several hundred feet in height. Some good white spruce, up to fourteen inches in diameter, is growing on the points.

Norite.

Athabasca sandstone.

For twenty-three miles, the lake continues eastward with a general width of one mile, though towards the end it expands to two miles. The north shore is indented with small bays and is chiefly composed of norite, often highly plagioclastic, folded in an easy anticline, the strike at the different places being shown on the accompanying map. In places it is garnetiferous, and it is generally well foliated, the foliation being distinctly brought out on the weathered surfaces. In longitude 106° 20′, there is a high hill behind the shore, composed of a dark greenish gray, compact, fine-grained, heavily jointed granite. In thin section it is seen to be composed of quartz, orthoclase and biotite, the latter being fairly evenly disseminated, and all oriented in one direction. The quartz shows wavy extinction. It is therefore a typical biotite-granite-gneiss. On adjoining parts of the shore this gneiss cuts, or is interlaminated with, the greenish norite.

Granite hill.

The rocks are almost everywhere glaciated, the glacial striæ generally trending westward, down the valley of the lake.

Morainic hill.

At the east end of the lake, is a gently rounded hill or ridge twenty-five feet high, consisting of sand and a great number of well-rounded boulders, chiefly of sandstone, though a few are of gneiss. The hill, which now forms the east end of the lake, appears to be morainic, and probably is a small recession moraine of the glacier that flowed westward down the valley.

South shore of Lake Athabasca.

The south side of the lake, from the mouth of Athabasca River to here, and the lower courses of the streams that flow into it, were examined and surveyed by Mr. Dowling, and his report is as follows:—

Muskeg Hills.

"The streams entering Athabasca River from the east are small, with the exception of the Clearwater, which drains a considerable portion of the country lying to the north-east of Fort McMurray. The hills that form the watershed between the streams flowing northward to Lake Athabasca, westward to Athabasca River or southward to Clearwater River, are irregularly scattered over the surface of the plateau, but are spoken of generally by the Indians as the Muskeg Mountains or Hills. The source of the Clearwater River is near that of Old Fort River, which empties into Athabasca Lake, near its west end or just east of Athabasca River. In the spring of the year the Indians, with small canoes, have passed from one of these streams to the other, by a portage which takes them two days to cross. By a longer portage they can cross from the head-waters of Clearwater River to Fire-bag River, the largest stream entering Athabasca River between Fort McMurray and its mouth."

Fire-bag River.

General character.

"This stream, though not of any considerable size, has in the lower part of its course cut a deep valley through the modified drift and sands of the plateau, and in its bed are exposed rocks of Cretaceous and Devonian age. The surface of these rocks rise but slightly above the flood plain of the Athabasca River, so that low exposures only are seen, while the main exposures of the escarpments in the valley are of the overlying drift and stratified deposits extending southward from Lake Athabasca basin.

"For twelve miles above its mouth, the stream occupies a wide valley, winding from side to side, cutting into the banks, but exposing only sands and clays, apparently either redeposited river silts and sands or material slidden from the sides of the valley. Higher up the stream small exposures of Devonian limestone are found in its bed, causing rapids or small falls. The first one shows horizontal beds of hard thin-bedded limestone containing traces of *stromatopora*, but no other signs of fossils. In this vicinity, the top bed only is of coralline limestone, resembling somewhat the lower part of the Devonian of Lake Winnipegosis, and below this are thin beds in a shattered condition. Sulphurous springs were noticed issuing from these. The top beds are yellowish to orange in colour and the lower are bright yellowish to ashy gray. Devonian limestone.

"At a distance of eighteen miles in a south-easterly direction from its mouth, the stream divides, the smaller branch coming from the north-east and apparently draining nearly all the country as far as the head-waters of Jackfish River, which enters the delta of the Athabasca. The main stream continues in the same south-easterly direction, coming from the hilly country near the source of Clearwater River.

"At the Forks, the sections in the banks of the valley are perhaps the most clearly defined of any in the district. The stream, impinging against the east bank, has cut it away and formed a steep escarpment in the clays and sands, exposing over 140 feet of the stratified deposits forming the plateau. The Devonian limestone, which has formed the floor of the valley for five or six miles, is here overlain by four feet of 'tar sand.' Further down the river this sand seems to have been carried away by glacial action, leaving occasionally small patches on the surface of the limestone. Tar sand.

"The section at the forks of the Fire-bag River, is in descending order, as follows:— Section of lacustrine deposits.

1.	Stratified sand	90 feet.
2.	Stratified clay	40 "
3.	Tar sand (Dakota)	4 "

"(1) The bedding in this is accentuated by dark streaks of sand saturated with tar. In the upper part, nodules and small pieces of irregular shape are arranged on the lines of bedding, while the lower half is false-bedded, but the tar streaks appear as saturated portions of the beds and serve to strongly mark the nature of the bedding.

"(2) At the top a fine red clay, in streaks three inches deep, alternates with thin partings of gray clay. Gradually the red bands decrease in thickness and in three or four feet the whole mass is gray. The middle of the exposure is a hard clay slightly darker in colour and approaches shale in compactness. A few small pebbles were seen near the lower part and the clay smelt of petroleum, and probably rests on the 'tar sand.'

"At a short distance from this exposure, the limestone (Devonian) was again seen, showing the 'tar sand' (Dakota) resting on its surface, so that in the preceding section the limestone was probably at no great depth.

Glacial striæ.

"The surface of the limestone was striated in a direction about west-south-west and in the lower part of the valley boulder-clay was seen at the base of the sections or beneath the stratified clays and sands.

"The surface of the country is covered with a small growth of Banksian pine, while in the valley spruce and occasional black poplar and birch were seen."

The South Shore of Lake Athabasca.

Big Point.

"Just to the east of the delta of Athabasca River, a high ridge comes out to the lake on the point near the mouth of Old Fort River. The ridge is probably of morainic material, but is flanked by terraces of gravel and sand. Its trend is S. E. and N. W., and it forms a divide between the waters discharging by the Old Fort River and those of the Jackfish River, running on the west.

"The outlying islands are composed mainly of loose material. Goose Island is low, and is made up of sand and gravel with sandstone boulders on the shore. The islands in the bay east of Big Point are similarly composed of loose material.

Old Fort Point.

"Old Fort Point is formed by an oval hill of sand and gravel similar to the islands, but connected with the main land by a low strip of ground flanked on both sides by marshy and swampy tracts, forming bays on either side. In the eastern bay, which is much the deeper, a small stream enters. This is found to come from the south, and is reported as being much longer than any of the streams entering the south side of the lake. It is known locally as the Old Fort River, and seems to have a larger flow of water than the Fire-bag or William rivers. In its lower part it cuts through the later deposits and reaches the Athabasca sandstone, which here appears in beds lying about horizontal. The higher land south of Old Fort Bay, lies about four miles from the mouth of the stream, and the sections made in it by the river show seventy-five feet of stratified sand lying above ten feet of fine blue clay—a part of the similar section seen on the Fire-bag River, except that here, the red colour at the top of the clay is wanting, and no tar was noticed in the sand.

Old Fort River.

Stratified sands and clays.

"At a distance of eight miles from the lake, solid rock is met for the first time, in the bed of the stream. It is in the form of a fine-grained and very hard sandstone, similar in texture to the Potsdam sandstone of Eastern Canada. It is light coloured, weathering rusty, and in thick beds, lying about horizontal. The river has cut down to the surface of this rock, and for a considerable distance above this the stream falls over a number of steps, forming small cascades at each bed with a short strip of smooth water between. Athabasca sandstone.

"The hills, at the distance of eight miles and a-half from the lake, appear in ridges running W.S.W. and E.N.E., and where cut into by the river, show till and boulders with a colouring of red, doubtless due to a mixture of red sand and sandstone fragments, probably derived from the disintegration of a red sandstone in the vicinity. The stratified deposits seen in the lower part of the valley were laid down on the uneven surface of the till and the hills in some cases protrude above the stratified beds. Red boulder-clay.

"The sandstone is exposed again on the shore of Lake Athabasca at Stone Point, and loose blocks of large size are found on the next point five miles farther east. The shore between Old Fort Point and Stone Point, or Pointe de Roche, east of Old Fort Bay, is generally low and marshy, but a long spit or point extending to the south-west from Stone Point, incloses a part of the bay to the east of it. This spit is covered by sand-hills and on the lake side the waves have encroached so that there is a continuous low cliff of sand. Stone Point.

"The shore eastward to the narrows is very monotonous, generally a sand beach with sand cliffs just behind. William River, which empties about half way along the south shore, has formed a delta which is the most prominent feature on this side. The point thus formed is called Point William, and the mouth of the stream is found near its extreme north-western end. A small channel also comes out on the eastern side of the point." Character of shore east of Point William

William River.

"The Athabasca sandstone is met in this stream twelve miles above its mouth, and thence upwards for seventeen miles, which is as far as the river was explored. The river in this distance falls about forty-eight feet, in short cascades over the beds of sandstone. The delta is mostly a low flat sand-plain, covered with Banksian pine and occasional black spruce. The higher ground is found to commence on a line in continuation with the main shore, and consists of a great thickness of sand, forming a plateau extending to the south, past the limits of our exploration. The section in the river-valley shows horizontally Sandstone.

stratified sand up to about one hundred feet, but on the surface of the plateau, which is mostly bare, sand-hills rise in some cases nearly a hundred feet above the general level. Occasionally on the summits of these hills large boulders or angular fragments of a dark-gray gneiss are found.

Boulder ridges.

" A boulder ridge, which seems to be beneath and protruding through the sands, crosses the river about nineteen miles from its mouth. This ridge is made up of more rounded material, and seems to be a continuation of a high ridge or series of long hills which lie to the east, called the Fish Mountains. These hills are probably of the same character as the ispatinows around Cree and Black lakes. Above the ridge the surface is more even and covered with a small growth of Banksian pine.

Athabasca sandstone.

" At the first rapids the barrier is found to be a light coloured sandstone, in thick beds lying about horizontal. No trace of fossils could be found in any of the beds. Two and three-quarter miles above the first rapid about fifteen feet of sandstone beds are exposed. The lower beds are stained red and pinkish, while the upper ones are of coarser grain and lighter in colour, and six to eight feet thick. Above the boulder ridge, at a fall of five feet, the sandstone seems slightly disturbed and is dipping S. at an angle of 5° the beds show some local false-bedding, but the texture and general appearance is similar to the last. Glacial striæ run S. 75° W.

Fish Mountains.

" Between the mouth of William River and Beaver River the shore is very regular, broken in only one place by a prominent point. This is a small hill of gravel and sand which almost forms an island, but is connected to the mainland by two bars of sand inclosing a small pond. The country behind rises more abruptly. The Fish Mountains or Hills are seen as a wooded ridge 200 feet high about five miles inland, and are the edge of a higher plateau which gradually approaches the lake shore. At Beaver River this high country reaches to within a short distance of its mouth, and the lower part of the stream cuts a short gorge through it, in which are many falls and rapids. The Indians call this stream the Grand Rapids River, and it is probable the river here falls over a considerable series of sandstone steps, as the surface of the sandstone terrace seems to rise rapidly toward the east.

" A small section was seen on the lake, seventeen miles west of Beaver River, at the mouth of a small creek.

"The section is 12 ft. 10 in. in thickness, and is composed of:— Section of sandstone near Beaver River.

Light grayish-yellow to white sandstone, not very hard, in beds of 5 in. and 6 in., splitting thinner. Cleavage cracks have broken the beds into blocks 1 to 2 ft. square, so that the whole falls easily. A few green nodules are found scattered through the bed..	7 ft.
Thin shaly sandstone, green and red mottled, split readily into thin plates	5 ft.
At the base a bed of light-coloured fine-grained sandstone is found to contain many small disc-like nodules of irregular shape, of a light green cherty material..	10 in.

"From Poplar Point to its east end, the lake lies in a narrow channel, the south shore of which, for fifteen miles east of Fond du Lac, is low, mostly boulder-covered, with a high escarpment of sandstone behind. Occasionally small low exposures of sandstone are found. Poplar Point is underlain by sandstone and the shore is made up of a ridge of fragments of this rock. Coarse-grained sandstone beds are seen on a small island near the point. Poplar Point.

"The high escarpment rising to the south of the lake comes out on the shore east of Fond du Lac, and seems there to be nearly all of sandstone beds with possibly a cap of till. On the shore the sandstone is exposed in a series of steps, rising gradually back to a height of eighty feet. Near the top of the hill the beds are seen again and at this point (15 miles east of the post) the thickness exposed is 120 feet. The beds range from eight inches to two feet in thickness, and are of a hard pinkish sandstone with a few oval impressions which may be organic. This escarpment seems gradually to rise to the east as it approaches the east end of the lake, and with the high land to the north forms a narrow gorge in which the lake is confined to a narrow river-like stretch of water. Angles of elevation were taken on trees on the summit of the ridge in two places, giving heights of 431 feet and 300 feet. It would thus appear that the sandstone here attains a thickness of over 400 feet, and that the surface has a slight dip to the west so that at the mouth of the Athabasca River it has declined to about the lake level." Escarpment of sandstone. Thickness of Athabasca sandstone.

Stone River.

Stone River flows quietly into the east end of Lake Athabasca around the north side of the morainic ridge that forms the eastern boundary of the lake. It comes from the eastward in the bottom of the great valley between the highly altered Archæan rocks to the Great valley.

north, and the comparatively unaltered Athabasca sandstones to the south, a valley which, farther west, has been shown to be occupied by Athabasca Lake itself.

Hill of norite. Opposite the morainic ridge, the north bank of the river consists of a mass of boulders, behind which is a hill 270 feet high, of dark-gray foliated norite, the lamination of which comes out strongly in weathering, and is generally more or less horizontal. In thin section, this norite is seen to be composed largely of orthorhombic pyroxene. In places the surface is quite smooth, and shows strong glacial grooves trending N. 80° W. The sides of the hill are wooded with small birch and poplar, while its summit is bare of everything but a little black lichen.

Low banks. Proceeding eastward, the river is found to have an average width of from 200 to 300 yards; the banks are low and overhung with willows, and generally consist of alluvial clay, but a point on the south side, four miles above the mouth, is composed of similar foliated norite or pyroxene-gneiss, striking S. 80° E. and dipping N. 10° E. at an angle of 25°.

First portage. Above this point the current becomes gradually stronger, to the foot of a rapid with a descent of about eight feet. The canoes were landed at a sandy beach on the north bank just below the rapid, and from this beach a portage 660 yards in length was made through pine woods, over stiff clay and rock, to a bay behind a rounded boss of rock at the head of the rapids. The rock is a dark-gray fine-grained norite, weathering to a very light-gray colour, and in places slightly foliated S. 35° E. The summits of the knolls show distinct glacial grooves trending N. 60° W. Just west of the head of the portage, a rounded hill of similar gneiss rises boldly to a height of 150 feet out of the middle of the valley, its sides green with small poplar, birch, and pine through and over which the smooth rock, blackened with lichen, projects in rounded bosses. On both sides of the hill a wide bottom-land, wooded with pine and poplar, stretches away to sloping hills, the sky-line to the south being even, that to the north rugged and broken. The low banks of the river are overhung with willows.

Above the rapid the river opens into a wide lake-like expansion, into the north side of which Carp River empties. This stream is a hundred feet wide, and its water is white with suspended clay.

Above the mouth of Carp River, a prominent point projects into the north side of the lake. The rock composing the point is a dark fine-grained massive much-jointed garnetiferous amphibolite, consisting of hornblende and plagioclase, with a large number of garnets and some titaniferous iron ore. As the hornblende would seem to have been altered from pyroxene, this rock is probably a modified form of the norite composing most of this shore. It is cut by wide bands of quartzitic granite running S. 60° E. The surface of the rock, at the end of the long point, and close to the water, is well polished and grooved in the direction N. 55° W., the smooth rounded surface facing the south-east, and the jagged broken one the north-west. Amphibolite.

Above this point the river gradually narrows, and the current increases, until it changes to a swift narrow stream with steep rocky walls. At a point on the north bank, three miles further up stream, a red foliated gneiss, striking N. 65° E., and with vertical dip, is in irregular contact with the dark-green massive amphibolite. A mile farther up, just where the river turns sharply to the south, the stream is narrow and flows between bosses of Archæan rock. The rock on the north side consists of narrow dyke-like bands of dark-gray amphibolite, striking straight along the river. These bands are almost vertical, and run through a reddish gneiss, which is well banded in the same direction. They also cut the gneiss irregularly, and send irregular arms into it. A hundred yards back, across a little swamp, is a rugged vertical cliff 150 feet high, of the same dark greenish-gray amphibolite. Steep rocky banks.

Three-quarters of a mile above the bend, having passed through rapid broken water, we came to the foot of a series of very heavy rapids, in which the water has a total fall of about 160 feet. The lowest rapid is a beautiful cascade where the water tumbles over a ledge of irregularly jointed amphibolite, and then rushes in two narrow gorges on both sides of a rugged rocky island. A small island a short distance below consists of green and red foliated gneisses striking S. 75° E. and dipping N. 15° E., at an angle of 75°. Heavy rapids.

A quarter of a mile below the foot of the rapid, on the south bank, the canoes were pushed in among the willows over a soft muddy, swampy flat to the beginning of Woodcock Portage, so called because we roused a woodcock (*Philohela minor*), in one of the swamps as we crossed it, this bird being exceedingly rare so far north. Woodcock Portage.

Opposite the end of the portage is a rocky knoll consisting of dark, rather coarse-grained amphibolite, generally foliated in an easterly direction, and spotted with conspicuous clusters of crystals of hornblende. It is cut by veins of red gneissic granite, near which the amphibolite contains many large crystals of garnet.

Sandstone cliff.

Woodcock Portage has a total length of 1·91 statute miles. It is on the whole very bad, having long stretches of swamp, and steep hills, the sides of which are covered with broken masses of rough sandstone derived from the underlying rock. In the first quarter of a mile the almost imperceptible track leads up the face of a steep cliff of coarse Athabasca sandstone, strewn with sharp angular masses broken from rocky ledges, up which it was necessary to carry the supplies in half loads. A hundred feet up the face of the cliff is a moderately regular terrace, apparently representing an old shore line of Lake Athabasca, when it stood at one of its higher stages. From the top of the sandstone escarpment a magnificent view may be had down the wide valley which we had just ascended from Lake Athabasca. Towards the north rise the rounded Archæan hills, while to the south is the sinuous edge of the high escarpment of stratified sandstone. Between is the gently sloping wooded valley, in the bottom of which Black River winds as a long glittering line of water.

Marsh and swamp.

From the summit of the cliff of sandstone the portage-track descends into a deep marsh and then passes through a tamarack swamp. It then passes for two-thirds of a mile over a sandy plain in places lightly undulating, wooded with small Banksian pines, to some hills of white sandstone. On the summit of one of these the rock is beautifully smoothed, and shows glacial grooves, trending N. 70° W. From the foot of this hill, a sloping plain extends eastward for 350 yards, declining in this distance thirty feet. The plain is thickly scattered with boulders, chiefly of sandstone, and conglomerate, but some of gneiss. The edge of the plain drops suddenly in a little cliff of clay twelve feet high, to a narrow willow-covered flat on the margin of Middle Lake. About a quarter of a mile to the north, the river flows out of the north end of the lake to the heavy rapids below.

Middle Lake.

Elizabeth Portage.

Middle Lake was crossed in a southerly direction for two miles and a-quarter, to a sandy beach, where the canoes were again unloaded preparatory to carrying everything over Elizabeth Portage. The micrometer survey showed the length of this portage to be 3·52 miles, and the aneroids showed its southern end at Black Lake to be 120 feet above its northern end at Middle Lake. Generally speaking the track is sandy, dry and hard, so that, although it is nearly twice as long as Woodcock Portage, it may be crossed with less difficulty and fatigue, though in bright weather one is tormented by myriads of black flies. No rock of any kind is to be seen on the portage. The following paced survey will give a good idea of the character of the portage, 2000 paces being counted to each statute mile.

From the sandy beach of Middle Lake— Elizabeth Portage.

265	paces	over a sandy plain wooded with Banksian pine.
395	"	moderately level plain of sand and broken masses of sandstones, wooded with small pine.
250	"	across swamp underlain by broken angular masses of sandstone.
400	"	gently rising sandy plain, wooded with stunted pines two feet high, to a low sandy cliff, the bottom of which is about fifty feet above Middle Lake.
185	"	similar sandy plain about ten feet higher.
75	"	to a swift brook twelve feet wide and two feet deep with sandy bottom.
80	"	across swamp to sandy bank ten feet high.
1050	"	almost level or gently rising sandy plain, open or covered with stunted pines two feet high.
420	"	up a slight rise, and over a sandy plain through woods of Banksian pine.
430	"	up a similar rise, and over a similar wooded sandy plain.
225	"	in a small valley between sandy ridges.
1780	"	over a thinly wooded sandy plain, the last 400 paces being along the north side, and at the foot of, a steep wooded slope, at an elevation of about 150 feet above Middle Lake.
420	"	along a gravelly slope, with a hill to the south 100 feet high.
485	"	through woods of small Banksian pine over sand and pebbles, at the foot of the hill seventy feet high.
430	"	over wooded country thickly strewn with boulders. Has all the appearance of a morainic ridge.
160	"	down the side of a hill thickly covered with boulders, with a drop of about forty feet, to the bank of Stone River, just where it flows from Black Lake.

Post-glacial beaches.

The above description shows the existence of extensive post-glacial beaches and sand-plains, from twenty to a hundred feet above Middle Lake, marking higher stages of the whole or part of Lake Athabasca, and they would appear to be closely connected with the morainic ridge at the south-east end of the portage. But whether the glacier from the east stood at this ridge when they were formed, or whether it had then receded further towards the east or north-east, and what connection there is between these beaches and terraces, and the glacier which blocked the valley a short distance east of Fond du Lac, were questions that it was impossible to settle in the time at our disposal.

Elizabeth Falls.

Elizabeth Portage is made to avoid a long chain of impassable rapids, the lowest of which, near the foot of the gorge, I have called Elizabeth Falls, from having visited the spot on the birthday of a beloved sister of that name. The river here forms a wild rapid about a mile in length, broken by heavy cascades and falls, eight to ten feet in height. The north bank, thickly wooded with black spruce and birch, rises gently to some distant green hills, the slope being underlain by fine-grained dark, reddish, garnetiferous hornblende-gneiss. The south side of the valley is composed of red, horizontally stratified sandstone, which rises in abrupt bare cliffs, often vertical, to a height of 100 feet above the water. Rounded bosses of gneiss also rise in the bends of the south bank, and wooded islands and jagged granite rocks constantly impede and break up the foaming torrent. The total drop here is about eighty feet.

Chloritic gneiss.

A small island lies out in the river at the head of the rapids, and opposite it is a little cliff of greenish fine-grained gneiss, the biotite being much altered to chlorite. It strikes S. 30° W., and dips N. 60° W. at an angle of 75°. A hundred yards further down, the bank consists of masses of coarse amphibolite, for two-thirds of a mile. Beyond this the rock consists of vertical red gneiss, striking S. 30° W., interlaminated with lenticular bands of green amphibolite. Elizabeth Portage ends on the bank of the river close to Black Lake, which has already been described on pp. 50-54. We may therefore pass on to that part of Stone River above the lake.

River above Black Lake.

Where Stone River flows into the south-east side of Black Lake it is about 300 feet wide, and on each side are little rounded hills of sand and boulders wooded with spruce, pine and birch.

Portage.

After ascending the river for three-quarters of a mile, the foot of a heavy fall was reached, and the canoes were landed at a low wooded bank at the bottom of an adjoining bay on the north side, from which point everything was carried over a portage 1017 yards in length, to the bank of the river above, passing three falls in the distance and rising forty-seven feet. The track ascends a steep slope from thirty to forty feet high at each end, and in the middle rises to a height of 120 feet above Black Lake. It passes for the most part over sandy or slightly clayey land, wooded with Banksian pine. Its west end is on low land wooded with spruce and birch, while its east end is in a grove of willows. Opposite the head of the portage the river is about 150 yards wide, with low grassy banks chiefly wooded with black spruce. Just to the west of this willowy spot the banks are composed entirely of red and gray biotite-gneiss, sloping to the water on the north side and broken and craggy on the south.

Between two rocky points, the water first rushes in a smooth sheet over a ledge of reddish-gray gneiss, and then in a foaming cataract for 300 yards between high, bare walls forty feet apart, to a small island where it divides and the greater part of the water flows to the right in a narrow straight gorge with a drop of twenty-five feet. Below this again the rapids end in a lovely divided fall opposite the lower end of the portage. Seen on a clear bright day towards the end of summer, the falls were perhaps the most beautiful that I had ever beheld.

Light-gray gneiss.

For four miles above this rapid the banks are low and composed of light-gray gneiss, often irregularly foliated and containing many darker irregular inclusions. On both sides of the stream the rock juts out as smooth rounded points, connected with low sandy ridges covered by grass and willows, behind which are small lakes. To the south is a moderately even ridge, probably of sandstone, about a hundred feet high, while to the north are hills of gneiss 150 feet high, which gradually recede as the river is ascended.

Porcupine River.

At a distance of eight miles above the rapid, Stone River is joined from the north by Porcupine River, a large stream of dark brown water, 300 feet wide at its mouth, apparently deep, and flowing with a current of two miles an hour. It is said to take its rise in Selwyn Lake, from which Chipman River also flows, and to pass through a very rough rocky country in deep gorges, in the bottom of which are many swift impassable rapids. On this account, and because Chipman River offers an easier road to the same place, the river is rarely, if ever, used as a canoe-route by the Indians.

Leave the Archæan.

At the mouth of the Porcupine River the Archæan gneisses were left behind, and turning sharply toward the south-west we entered a comparatively level sandy country underlain by the red Athabasca sandstone, similar to the country through which we travelled on our way down Cree River, and like it wooded with Banksian pine and small birch.

Two miles above Porcupine River is a rapid, at the foot of which is an outcrop of three feet of heavily and horizontally bedded red sandstone or fine conglomerate. The rapid consists in all of four fairly distinct dips, between which is more or less swift water, with a bed either of flat-lying sandstone or small rounded boulders.

Heavy rapid.

Above this rapid is a mile of fairly quiet water, beyond which is another heavy continuous rapid, wide and shallow near the bottom, where it flows over a bed of small boulders, and very swift and white at the top, where its bed consists of large boulders. The flats on each side are underlain by rounded boulders, chiefly of sandstone, but some of gneiss, &c. A sloping grassy or stony beach extends from the edge of the woods down to the water, on which the men walked as they tracked the canoes with a line against the heavy current.

Chippewyan Indians.

About two miles above Perch River, a small tributary from the east, we met several canoes full of Chippewyan Indians descending the river, having come down from Wollaston Lake in three days. They were on their way from Reindeer Lake to Black Lake, where they intended to join other Indians and travel northward to meet the deer near the southern edge of the Barren Lands. As but one of our Indians had ever been on this river before, and that was so long ago that he had now almost entirely forgotten it, we camped beside our new friends from Reindeer Lake, to learn the present condition of the stream, the character of the portages, &c. They also told us something of a canoe-route northward from Reindeer Lake to Kasba or White Partridge Lake, and thence northward down the Kazan River.

Wide river.

The following morning, August 9th, we continued the ascent of the river. For eleven miles it is wide and lake-like, with a perceptible current only at the narrowest parts. The banks are everywhere low and sandy, with a very few boulders here and there. In the protected bays willows are growing to the water's edge. Back from the river a few lenticular hills, or ispatinows, from 100 to 200 feet high, follow the general direction of its banks. In the upper part of the distance these ispatinows close in on the river, and their burnt sides were seen to be thickly strewn with moderately well rounded boulders, chiefly of sandstone, but also of gray gneiss, dark and light green trap, green chloritic schist, &c.

Cliffs of sandstone.

Thirteen miles above Perch River is a rapid a mile in length, with a total fall of about fifteen feet. Like the others it is fairly deep at the top, but wide and shallow at the bottom. The bed of the rapid is filled with boulders. The flats above the rapid are composed of broken fragments of sandstone, mixed with rounded boulders of gneiss. The banks by the lower part of the rapid are vertical or overhanging cliffs from ten to fifteen feet high, of light red coarse sandstone or fine conglomerate, with well rounded pebbles. It shows strong flow-bedding, but the general stratification is horizontal. Here, as elsewhere, fossils were carefully searched for, but none could be found. The surface is for the most part rough, but in one place strong glacial grooves were found running S. 80° W. Above this rapid the river comes from the south for a mile, when it turns sharply and flows from the east between two high steep ridges, the more northern one having its side thickly strewn with boulders, and both being apparently long ispatinows. Looking eastward the cone-shaped ends of other ispatinows were seen in the distance.

Five miles above the bend, Hawk-rock River, a swift clear stream fifty feet wide and two feet deep at its mouth, flows into the south side of Stone River, down a rapid with a descent of two feet, discharging from a small lake a quarter of a mile across, into the opposite side of which it falls in a wide shallow rapid. It seemed to come from about S. 10° W. Ithingo, one of our Chippewyans, said that it has high banks of sandstone, and that there is a practicable canoe-route up it, across into the east branch of Mudjatick River, and down Mudjatick River to the Churchill. Many rounded boulders are lying on the beach at its mouth, most of which are of gray gneiss. Hawk-rock River.

Hawk-rock Rapid, just above the mouth of Hawk-rock River, has a fall of from eight to ten feet. In its upper part the banks are composed of ten feet of reddish sandstone similar to that already seen. Its surface is well marked by glacial grooves, trending S. 65° W. Hawk-rock Rapid.

From the head of this rapid, for a mile and a-quarter, is a stretch of quiet water, with banks of sandstone up to thirty feet or more in height. The next rapid is in two chûtes, both short. The canoes were tracked up the lower, and poled up the upper chûte. On its south side a narrow ridge of boulders from fifteen to twenty feet high runs parallel to the bank, and is scarped by the swift current. All the boulders are rather small and well rounded, and they are bedded in a very scanty matrix of sand. Probably the ridge is a small esker.

Moose Lake, is a quiet expansion of the river just above this rapid, with a length of six miles and a-half, and a width of from a-quarter to a-third of a mile, having the appearance of a large river. The immediate banks are generally low and sandy, but above them the steep wooded side of the ispatinows rise to heights of 100 to 200 feet, forming a regular even valley. These hillsides are usually sandy, scattered with rounded boulders of gneiss and sandstone. Moose Lake.

The river flows into the east end of Moose Lake in a heavy rapid, nearly a mile in length, and divided into two channels by a large island. It is called by David Thompson "Brassey Falls." At its foot is a wide bottom-land composed entirely of boulders, chiefly of reddish-gray gneiss, though some are of sandstone, and a few are of Huronian rock, probably transported from the area of Huronian rock in the vicinity of Kasba Lake, discovered in 1894. These Huronian boulders consist largely of coarse conglomerate, and white quartzite. Brassey Lake.

A point on the bank is covered with small balsam poplars, the first seen above Black Lake. Berries were very plentiful, the most abundant being the northern huckleberry (*Vaccinium uliginosum*) and the cran- Berries.

berry (*Vaccinium Vitis-Idæa*), while the common huckleberry (*Vaccinium Canadensis*), red and black currants (*Ribes rubrum* and *R. Hudsonianum*), gooseberries (*Ribes oxycanthoides*), crowberries (*Empetrum nigrum*), Pembina berries (*Viburnum pauciflorum*), etc., are also found.

Hill of sandstone.

To the south of Brassey Falls is a hill fifty feet high, consisting of white Athabasca sandstone, dipping N. 20° W. at an angle of 10°. Its summit is well smoothed and grooved, the grooves running S. 80° W. This ridge of sandstone strikes the river at the head of the rapid, and the banks and the bed of the stream below are composed of large rounded boulders, over which the men struggled with great difficulty, as they walked beside the canoes and hauled them up the current.

A mile above Brassey Falls, a cliff of sandstone fifteen feet high rises on the north bank to the edge of a wide sandy plain. Opposite to it, on the south side of the river, is a very steep bank 100 feet high of sand and boulders. On ascending this bank it is found to be the side of a knife-edged ispatinow about a mile long, composed of sand and large and small boulders, chiefly of gneiss. The summit is very narrow, and the sides are as steep as the material will stand.

Brink Rapid.

A short distance farther up the stream we ascended Brink Rapids, a mile long, with a total descent of about twenty-five feet, tracking and poling up the lower part, and making a portage on the north side past the upper part, where the water rushes over several ledges of sandstone. The banks are low cliffs of sandstone, and a ridge of sandstone stretches along the north side of the river.

Annoyance from black flies and mosquitoes.

On the evening of August 10th, camp was pitched near the east end of the portage. The black flies, which breed in the clear running water, had for some time past been swarming around us in countless numbers, and had turned every moment of warm sunshine into a moment of agony. At night, rolled in our blankets, under a tent of cheesecloth to keep off the mosquitoes, we secured a few hours' rest. Most of the rapids had been ascended by walking in the water and hauling the canoes, and in order to get a foothold on the smooth stones and to stem the swift current, the men were often naked up to their waists, and consequently suffered very severely from the black flies.

Above this camp the north bank of the river is formed by a high ispatinow, and others rise at a short distance back on the south side. The immediate banks are composed of flat-lying sandstone. At a distance of a mile and a-half up the river, on the south bank, is a hill of similar sandstone forty feet high, striking N. 30° E. and dipping N. 50° W. at angles from 20° to 40°. Two hundred yards farther up stream the sandstone is again horizontal. The river continues in a straight course from east-southeast for three miles, with a moderate current, between sandstone banks, and then turns sharply from the south, around a sandstone hill, on the east side of which is a beautiful cliff seventy feet high, where a pair of golden eagles (*Aquila chrysœtos*) have had a nest for a number of years.

The river flows from the south for a mile, between banks of sandstone from ten to twenty feet high, when it again turns and comes from the east for five miles, in the bottom of a wide swampy valley between long lenticular hills of boulders 200 feet high. No rock shows on its banks. At the end of the five-mile stretch of quiet water, the river again turns sharply and flows from the south down a swift rapid with a fall of fifteen feet, up which we tracked the canoes on the north side. The bed of the rapid is composed entirely of boulders, which are probably resting on a bed of sandstone. On the south side is a cliff showing forty feet of horizontal sandstone, while on the north side is a wide flat of large rounded boulders. From here, swift water or rapids extend for three miles up to the foot of Manitou Falls, high scarped banks of sandstone overlooking the stream here and there. Sandstone banks.

Manitou Falls was so called by the Indians because the water in one of its channels disappears under the rock for a short distance. The water tumbles over the face of a rocky sandstone ledge in two streams, into a narrow channel about twenty-five feet wide, from which part of the water rushes to the left in an open channel, while a part runs for about twenty yards under the rock, both streams falling into a wide, shallow, rocky basin below. The fall is fifteen feet in height, and past it is a portage 120 yards long on the south side. Here our camp was pitched, on the evening of August 11th. Towards the north-east an elongated oval hill of glacial débris rises above the sandstone to a height of 150 feet, wooded to the top. The estimated fall in the river showed the foot of Manitou Falls to be about 150 feet above Black Lake. Manitou Falls.

From the head of the falls we ascended the river with paddles, against a very swift current between perpendicular sandstone walls fifteen to thirty feet in height, to a portage on the south side 730 yards long.

The portage first ascends a rough sandstone hill thirty-five feet high, and then passes through pine woods over fairly level country. North Portage.

of it the river has a fall of about fifteen feet in a heavy rapid between sandstone banks.

Immediately above the portage the channel is very crooked, and there is a stiff rapid with a fall of about twelve feet, which we ascended with a line, above which is a stretch of moderately easy water, up which we paddled, with the assistance of a stiff breeze, to the foot of Thompson Rapid, one of the heaviest rapids on the river. The lower part, in which the banks are low, was readily ascended with a line to a short portage, thirty-five yards long, across a point on the north side, where we camped on the night of August 12th. Above this short portage, almost to the top of the rapid, the banks are from ten to fifteen feet high, and consist of flat-lying sandstone, generally undercut by the water. Past part of this cascade we portaged all our stuff for 300 yards on the north bank, merely tracking up our empty canoes. The total fall in the rapids is about thirty feet.

Thompson Rapid.

It was here, on the 9th of July, 1796, that David Thompson, the famous geographer and explorer of north-western America, and afterwards the British astronomer on the International Boundary Survey, was upset from his canoe, and lost all his guns, ammunition, food, clothing, and the records of his trip, and on the sandy beach in the little bay at the foot of the rapid he doubtless hauled out his broken canoe.

On the north side of the rapid is a thickly wooded high hill, probably an ispatinow.

Change in character of river.

Thompson Rapid is sixty miles above Black Lake, or almost midway on Stone River between that lake and its source in Wollaston Lake. To here the river has flowed with an almost constant current, in a well defined channel. From this point upwards there is less detrital material overlying the rock, the river widens out in places into small lakes, between which are shorter or longer stretches of narrow stream.

Small lake.

Above Thompson Rapid, the river opens into a small lake two miles long, with high hills to the north, wooded down to the water's edge, while pleasant sandy beaches extend along the south side, with hills of boulders from fifty to seventy feet high in the background. The only rock seen was in two little cliffs of sandstone near where the river flows from the lake.

From this lake we ascended the stream, at the mouth of which is a stiff rapid with a fall of six feet. We tracked up this rapid, and paddled up another light rapid with a drop of two feet, to the western arm of Otter Lake, and then for three miles and a half through this beautiful little lake, whose shores are low points or wooded hills, to the mouth of the river, where it flows into the south end of the lake over a bed of small boulders in a wide shallow stream. The boulders are almost all gray gneiss. Just within the mouth of the river, in a deep bay, empties a small stream eight feet wide, falling four feet in a little stony rapid. It flows from a lake half a mile long running N. 70° E. Otter Lake.

For a mile and three-quarters up the river, to Perpendicular Rock, the current is swift all the way, and most of the distance was ascended with the line. The banks are for the most part low, and composed of boulders, though at two places sandstone was seen.

Perpendicula Rock.

At Perpendicular Rock, the stream is moderately narrow and swift, with overhanging cliffs of sandstone fifteen feet high on each side. The cliff on the north side, is the face of a small isolated hill of sandstone, an old channel of the river extending behind it. The cliff on the south side is much longer, and back from its summit were found some smooth well glaciated surfaces, the glacial grooves on which run S. 55° W.

From Perpendicular Rock the rapid stream was ascended for three-quarters of a mile to a point where it breaks into several channels. In the channel followed, are two rapids with drops of ten and five feet respectively. At the first are overhanging banks of sandstone fifteen feet high, while at the second the banks are low. Above the latter is a fine stretch of good water for three miles and a-half, with a little rapid about the middle, to the Elbow. Here the main channel continues eastward into a deep bay, but the river falls directly into the south side of this channel in a heavy, though not very long rapid called Red Bank Falls. On the east side of this is a low scarped bank, showing six feet of more or less thin-bedded red sandstone and conglomerate with white quartzite pebbles. Above this heavy rapid are two short stiff rapids, at narrows in the stream, before Kosdaw Lake (so named after one of David Thompson's Indians) was reached, on the west shore of which we camped among pines on a little knoll of sand and boulders, on the evening of Saturday, August 13th.

Red Bank Falls.

Kosdaw Lake

Kosdaw Lake is about five miles long, and a mile and a-half wide, broken by several large islands, and with the river flowing into its south-eastern and out of its north-western side. It is surrounded by low wooded hills, the woods almost everywhere descending to the edge of the water. A few sand-beaches run along the shore near the mouth of the river, but none of the underlying rock is to be seen.

Stone River falls into the lake in a rapid a mile in length, with a total descent of twenty feet. Its lower part is rather shallow, and was ascended with poles; the upper part is deeper, and was tracked on the north-east side. The banks are for the most part low and composed of boulders, but near the top the left bank shows thick-bedded sandstone, with a very much broken surface. Just below this outcrop of sandstone a brook ten feet wide flows in from the east, over a bed of boulders.

Swift stream.

For the next two miles and a-half, to a lake, the current is very swift, and the stream was ascended by tracking or poling. The banks are generally low, with willows to the edge of the water, and no rock was seen, though broken sandstone is common near the bank.

The lake is narrow and three miles and a-half long. The most of the shores are low, with very low hills in the background, but at the south end is a high well-rounded elongated oval hill.

For a mile above the lake, to a portage, the river is rapid, and we ascended it with poles. At the portage the current is very swift, with heavy waves, and the Indians usually carry their canoes on the south side for 480 yards. However, we walked in the water, and hauled our canoes up along the south bank, inside the heavy waves. At the foot of the rapid, on the north side, is a little rounded *roches moutonnées* hill of white sandstone, while on the south side is a hill twenty feet high, composed chiefly of boulders of red and gray gneiss. The adjoining country consists of rounded hills thickly wooded with spruce.

Morainic hills.

Just above the rapid the traveller ascending the river enters a desolate country, of low, almost bare hills from fifty to seventy feet high, composed of boulders imbedded in a matrix of barren red sand. Low hills of sand are also scattered among those of boulders, and beside them the banks of the river are sandy. These stony hills indicate a morainic area in which are scattered sandy kames. The river traverses this morainic area for eight miles, spreading out in the middle of the distance into a long narrow lake, on the banks of which are some horizontal outcrops of coarse white sandstone.

Old shore-lines.

A hill on the south-west shore, which was more particularly examined, is seventy feet high, with a summit of barren sand scattered with boulders. On its side, twelve feet above the lake, is a terrace of boulders, and fifteen feet higher is a steep bank of boulders, both denoting old shore-lines. From this hill a deep bay extends in a south-westerly direction towards the mouth of Waterfound River. At the bottom of the bay are several well rounded, lightly wooded, drumlin-like hills.

Two miles above this hill, and a mile and a quarter below the next rapid, we camped on the south bank, on a low boss of flat-lying sandstone, which extends from the bend in the river back to a narrow lake or old river-channel. Its surface, though generally rough, is scratched and grooved by glacial markings running S. 45° W., the stoss and lee sides of the rock being clearly shown. The lake, back of camp, is about a mile long, and lies in a narrow valley running S. 45° W., the north-west side of which is composed of a ridge of boulders thirty feet high, and between 200 and 300 yards wide. On this ridge the boulders are chiefly of red and gray gneiss, but some are of Huronian conglomerate, white and gray quartzite, crystalline dolomite, etc. West of this boulder ridge, are two other small lakes through which Waterfound River flows. Between the lakes it is fifty feet wide and eighteen inches deep, flowing swiftly over a gravel bed. Up this river there is said to be a canoe-route to Churchill River, crossing the height of land, and passing down Haultain River. A short distance above the mouth of Waterfound River, a stream joins the Stone River from the north, forty feet wide at its mouth, where it flows in a shallow rapid over a bed of boulders.

Ridge of boulders.

Waterfound River.

The next rapid is very swift, with a drop of about ten feet, and up it the canoes were taken by hand. Stone River is now much reduced in size, being only between eighty and one hundred feet wide.

Three-quarters of a mile farther up the stream is another swift rapid, up which the canoes were also taken by hand, although the Indians commonly carry their canoes on the south bank for 1000 yards. The bed of the stream is of boulders, but the horizontal sandstone has formed the banks more or less continuously from the mouth of Waterfound River to here. This was the last outcrop of Athabasca sandstone seen in the ascent of this river. Since leaving Black Lake all the outcrops have been very similar in character, generally horizontal and undisturbed, and none showing any great thickness. Beyond Crooked Lake, which lies just above, the Archæan granites and gneisses again come to the surface. Crooked Lake is a narrow, winding body of water, through which we travelled for seven miles. The water is clear but dark, and seems to be rather shallow. The shores of the lake are low and stony, and are covered with a thick growth of willows that overhang the water. A few sparsely wooded hills about sixty feet high rise in the background.

Last outcrop of Athabasca sandstone.

Crooked Lake.

Stone River empties into the east end of the lake in a heavy cascade, with a fall of about twelve feet, over a rounded ridge of rather coarse, red biotite-granite, heavily jointed and massive, except for an occasional

Laurentian granite.

slight horizontal foliation. Crooked Lake, therefore, lies along the line of junction of the Archæan granites and gneisses and the overlying Athabasca sandstone. A portage 360 yards long leads past this fall across a bend on the south side, at first through swamp, then over boulders, and finally over a granite knoll wooded with small spruce. In the next mile are two rapids with drops of six and eight feet respectively, over large boulders. At the upper one the banks are composed of red granite similar to the last, but finer grained and generally foliated. The canoes were carried past it on a rough portage 370 yards long on the south side over a rounded hill of gneiss, the surface of which is broken and irregular. Above the portage is a small lake with high bold shores of red gneiss. On the evening of 16th August, camp was pitched in a little sandy bay on the south side of this lake, at the foot of some rounded hills of boulders. The latitude as determined was 58° 40′ 47″

Red gneiss.

From this lake we ascended a heavy rapid over boulders to Hatchet Lake. The rapid has a total fall of about eighteen feet. At its foot the descent is very steep; near its head it is divided into two channels by an island, and the men hauled the canoes by hand up the north channel. At the head of the rapid the south bank is formed of red granite, while the north bank consists of boulders on the edge of a very wet spruce swamp.

Hatchet Lake.

Hatchet Lake is a small rectangular body of clear water, with a greatest length of twelve miles, a greatest width of seven miles, and a shore line of thirty-nine miles.

South shore.

Mr. Dowling surveyed the south shore, and found it to be composed chiefly of boulders, with occasional outcrops of reddish gneiss at the points.

North and east shores.

The writer surveyed the north and east shores, which were found to be generally low, with beaches covered with boulders, alternating with occasional stretches of sand in the bottoms of the bays. Behind the beach is a low wooded country, with some rounded hills in the distance. The points on the north shore are underlain by massive red granite, or reddish-gray gneiss. The east shore is composed of a massive medium-grained white biotite-granite rich in plagioclase.

Glacial striæ were observed both on the east and west shores, in both cases running S. 25° W.

The islands in the lake are generally low and underlain by red granite. But near the north-west angle some stand out higher than the others. One of these was more particularly examined, and was found to be an esker or narrow lenticular hill 70 feet high running S. 25° W. parallel to the glacial striation. It is composed almost entirely of loose sand, mingled with a few well-rounded pebbles and small boulders, up to ten inches in diameter. Its west face is scarped where it overlooks the lake. East of the main ridge of the esker is a little valley, beyond which, on the same island, is another lower parallel sand ridge. On top of the esker are some fine tall white spruces, as much as six feet in circumference, forming very conspicuous objects in this country which is generally wooded with small black spruce. Esker.

On our arrival at Stone River, which empties into the south-east corner of the lake, Mr. Dowling had not yet arrived, so we determined to continue the ascent of the stream and wait for him at Wollaston Lake. Stone River.

Wooded hills, probably of boulders, rise on each side of the mouth of the river.

A mile above its mouth the river turns sharply, coming from the south, and winds for three-quarters of a mile through a marsh, to a rapid over boulders, with a fall of three feet, up which we poled without difficulty. From here the river has an even width of from sixty to eighty feet, and flows with a current of about two miles an hour through a marsh or grassy meadow. Back from the river are some low wooded hills of sand or boulders. The next rapid has a drop of about six feet, and was easily ascended with poles. Above this rapid the river gradually widens, and the banks are mostly low, with low hills of boulders back from the river. A small island a mile below the rapid was found to consist of red biotite-granite, with a slight foliation in some places, and farther north a hill about a hundred feet high seemed to be composed of white granite. River sixty to eighty feet wide.

For four miles above this island the country is low and without rock exposures, and the river is wide except at one point, where there is a swift current. At the end of this distance a rounded hill, sixty feet high, stands out conspicuously from the north bank into the middle of the stream. It consists of a reddish-gray biotite-gneiss, foliated N. 65° E. and with a dip varying from vertical to a high angle S. 25° E. It is heavily jointed approximately at right angles to the foliation, so that its south face forms a very precipitous cliff. Two small islands, and a point on the south shore a mile and a quarter above this cliff, are also composed of similar gneiss, while the north bank opposite is a steep cliff of sand and boulders. A short distance above the latter Hill of gneiss.

Rock disappears.

point the rock disappears, and from there upwards to Wollaston Lake the banks are lined with boulders. At the point where the river flows out of a bay at the north-west corner of the lake, it is rather narrow, and has a moderate current. The bed of the stream could not be seen, but the banks were composed entirely of sand and boulders.

Wollaston Lake.

Area.

Wollaston Lake is a large body of beautifully clear transparent water lying in a general north-and-south direction, with a greatest length of about fifty-five miles, and an approximate area of 800 square miles Its contour is exceedingly irregular, its shore-line being indented by deep bays, and its surface dotted with numerous rocky islands. Two tributaries were discovered flowing from the south-west into its western side, while it holds the unique position, for so large a lake, of being drained by two almost equal streams which flow in opposite directions. Stone River, one of these, has just been described from where it flows out of the north-west angle of the lake to its mouth in Lake Athabasca, where its waters join those of the Mackenzie River and are carried northward to the Arctic Ocean. Cochrane, or Ice River, which was first ascended by the late Mr. A. S. Cochrane in 1881, flows from the north-eastern angle of the lake, and after a course of 200 miles empties into Reindeer Lake, from which the water flows by Reindeer and Churchill rivers into Hudson Bay. The name Cochrane River is proposed for this stream instead of Ice River, to avoid confusion with Icy River, which flows into Great Fish River, and as a fitting tribute to the memory of my friend, Mr. Cochrane, who was the first white man to ascend and survey the stream, and to set at rest the question whether Wollaston Lake is drained by two streams, as marked on David Thompson's map, or by only one, as positively asserted by Abbé Petitot.

Drained by two rivers flowing in opposite directions.

Cochrane River.

North-west bay.

The bay of Wollaston Lake, from which Stone River flows, is a mile and a-half long and three-quarters of a mile wide, and on the east side of it we pitched our camp on the evening of the 18th of August, to wait for Mr. Dowling. The latitude was determined as 58° 26′ 44″, and the variation of the compass to be 27° east. The shore is generally lined with boulders, but there are a few little stretches of sand, at one of which we hauled up our canoes. Behind camp a low ridge composed of sand and boulders of granite, well wooded with spruce and Banksian pine, runs southward to a low prominent point that appeared to be a favourite Indian camping ground.

Mr. Dowling arrived on the following morning and shortly afterwards we started southward down the west side of the lake. The beach is a line of boulders, behind which the country is low and wooded with small black spruce. Three miles south of the head of Stone River, is an esker-like ridge of sand and boulders between 200 and 300 feet high, lightly wooded with Banksian pine. Behind a little sandy bay near its south end, a deep mossy bog stretches up a gentle slope to the edge of a terrace of rounded gravel sixty feet above the lake, marking an ancient lake shore. West shore of Wollaston Lake. Esker.

A mile south-east of this sloping bog a long and narrow island lies in the mouth of a rounding bay. It is made up of very steep esker-like hills and ridges seventy feet high, of sand and well rounded boulders, between which are deep kettle-holes, occasionally containing small ponds. The sides of the hills are as steep as the sand will stand, and their bases are fringed by rings of boulders.

Following the shore onwards for four miles, the first rock in place met with was on a small island of red granite. The granite is composed chiefly of orthoclase and quartz, with a little plagioclase and biotite and contains some inclusions of foliated gneiss. The surface is smooth, but, like most of the rock-surfaces in this region, it is not striated. Red granite. Absence of striæ.

For ten miles southward, to the mouth of Collins Creek, no rock was seen in place, but the shore is mostly strewn with boulders, many of which are of Athabasca sandstone and conglomerate. Behind the beach is a rather steep slope, rising from ten to twenty feet, to a sandy plain wooded with Banksian pine, similar to the plain on the west shore of Cree Lake. Many of the sandstone masses are quite angular, and their presence here, and not farther north, taken together with the general sandy character of the surrounding country, is conclusive evidence of the occurrence of Athabasca sandstone in the immediate vicinity. The occurrence of the sandstone here shows that this lake, as well as all the other large lakes through which we have passed, lies along the line of contact of the Archæan and Palæozoic rocks. Athabasca sandstone.

Collins Creek is, at its mouth, a small stream forty-five feet wide, running over a bed of boulders. Its water is of a light-brown colour, and its banks are grown with spruce and willows. It flows into the bottom of a long narrow bay with beaches of sand and boulders. Collins Creek.

We followed the low east shore of Collins Bay outwards for six miles, to a point behind which is a high rounded hill of dark-gray well foliated biotite-gneiss, striking N. 20° E. and dipping S. 70° E. at an angle of 50°. In some places it is very coarse, and full of biotite, and Point of gneiss.

is much broken by irregular veins of coarse red pegmatite. Its surface is smooth, and shows strong glacial grooves, trending S. 10° W.

White granite.

Two miles and a-half farther around the shore, is a long point of massive, coarse white granite, containing inclusions of dark biotite-gneiss, while just behind is a high rounded hill of dark-gray biotite gneiss striking N. 45° E. and with a vertical dip.

From the top of this hill a magnificent view may be had of the lake. Towards the north and east it is dotted with many islands, while towards the south is an extensive stretch of clear blue water. Its shore-line is very irregular, and behind it rise low, gently sloping hills thinly wooded with spruce and pine, often separated by extensive swamps wooded with small spruce and larch.

Hornblende-biotite-gneiss.

Depth of water.

From this place we struck southward, at first past some points of white granite, and then for five miles straight across the open lake to the east point of a large wooded island, composed of greenish-black thinly foliated, fine-grained hornblende-biotite-gneiss, striking N. 45° E. and dipping S. 45° E. at an angle of 75°. Interlaminated with the gneiss are some bands of white quartz. The surface is smoothed, and on the summit are glacial grooves trending S. 15° W. In the last stretch, the water in the lake was found to have an average depth of twenty-eight fathoms, with a greatest depth of thirty-two and a-half fathoms. From this island we crossed for three miles, to a small bare island of massive very coarse white granite, consisting chiefly of quartz and orthoclase, with a small quantity of biotite, and black tourmaline in large crystals. A mile and a-half farther on, is a large island of similar white, but finer grained, granite. Two miles farther is a long bar of boulders, forming the north point of a very large rocky island or peninsula. A mile and a-half farther south, we camped on a boggy spot at the foot of a hill on the south side of a point, in north latitude 58° 7′ 40″. The hill is 250 feet high, and is composed of a coarsely granular red biotite-gneiss foliated N. 65° E.

For nine miles farther south, the shore is very irregular and composed of similar reddish gneiss rising in hills from 100 to 300 feet in height, with a fairly persistent strike, N. 40° to 65° E. The summits and south-west sides of many of these hills are covered with sand and boulders. Wherever glacial striæ were observed they trend S. 30° W.

Low shore.

From here we turned south-westward for eight miles, along the strike of the gneiss, in a channel from a mile to two miles wide, between a large island to the east and the low shore to the west, but whether of a large island or of the mainland was not determined. This shore is thickly strewn with boulders, and low exposures of reddish-gray gneiss were seen at but a few places. Some wooded islands lying off the shore are low and chiefly composed of boulders.

From the end of this channel we struck westward, past some red granite islands piled around with boulders, to a sandy beach where Indians had lately been camped. High sand-hills rise here and there, and banks of sand, being sections of these sand hills, occur at various places along the shore, but their faces are so covered with talus that nothing could be determined from them as to the structure of the hills. Among the pebbles found on the beach was one of white crystalline limestone. Sand-hills.

From this sand-beach we turned eastward for two miles and a-half, to a point, and then southward down the west shore of Nekweaza Bay, which is fourteen miles in depth. The shore is composed of similar red granite and gneiss, and some of the islands lying off it are narrow esker-like ridges of sand. On the evening of August 23rd, camp was pitched on the shore in north latitude 57° 48′ 48″ on a gravel beach ten feet above the lake. Just behind the camp was an old gravel shore-line five feet higher. Towards the south-west was a swamp lying on a bed of boulders, beyond which was a high rounded hill, wooded with spruce and pine. Its centre consists of a reddish gneiss, while almost all the surface is covered with a fine reddish sand or silt, holding a large number of rounded boulders. Nekweaza Bay.

The next morning we travelled down to the southern extremity of Nekweaza Bay, where it ends in a wide marsh. We retraced our course for a short distance, and then turned westward for four miles, into an irregular arm of the bay, near the bottom of which we found a small band of Chippewyan Indians in camp, living on the fish they could catch in their nets, and what partridges and ducks they were able to shoot. We inquired from these Indians about any available canoe-route from this lake through the unexplored country southward to Churchill River. They informed us that a river flowed into this bay a short distance south of their camp, and that many years ago Indians used to travel up this river and cross to a tributary of Churchill River, but that it had not been used for a long time, that many forest fires had doubtless killed much of the timber, that the portages would be blocked up by windfalls, but that they could not give any certain information as they had never travelled over the route. This information was rather dispiriting, but at least it told us of the existence of a river flowing from the south, that had been followed to the source of one of its branches from which a passable tributary of Churchill River was not far distant. Indian camp. Route to Churchill River.

Division of the party.

It was decided to divide the party. The provisions, about ten days' rations per man, were apportioned to each. The writer took one canoe, with the three men employed at Ile à la Crosse, who, after considerable hesitation and an evening's talk over the matter among themselves, agreed to accompany him, and began the ascent of the river, here called Geikie River, in honour of Professor James Geikie, of Edinburgh, who has done so much to foster the study of glacial geology. Mr. Dowling took two canoes and four men, with instructions to follow the south shore of Wollaston Lake, and David Thompson's Canoe River to Reindeer Lake, where supplies could be obtained at the Hudson's Bay Company's post. Thence he would continue the survey southward to the south end of Reindeer Lake, down Reindeer River to its junction with the Churchill, and up that river to Stanley Mission, connecting with the survey of the river previously made by Mr. Fawcett, of the Dominion Lands Branch of the Department of Interior. From Stanley he was to continue southward by Lac la Ronge, and the Montreal River to Prince Albert.

Mr. Dowling's report.

The following is Mr. Dowling's account of the work done by him on this journey :—

Islands at mouth of Nekweaza Bay.

"Nekweaza Bay, running south-westward to the mouth of Geikie River, is broken on its western side by many smaller bays, but its eastern side seems to be more regular, and part of the shore near the main lake is nearly straight, terminating at the north in a low point, off which is a series of long low narrow islands. Down the centre of this bay, a string of islands stretches from near the mouth to the eastern shore at the bottom of the bay. Those which were visited seemed to be made up entirely of drift, and, judging from their shape, many of the others are of like material. They lie S. 25° W., with their longest diameters nearly parallel and approximating to the general direction of the glacial striæ. The striæ observed on the eastern shore run S. 30° W., or more nearly parallel to the side of the valley.

Glacial striæ.

"Several of the low narrow islands off the point and in the bay to the east, are also of drift and have the same general orientation. The larger ones and the main shore are of Archæan gneiss and granite, and have bold shores.

Hills bordering south shore of Wollaston Lake.

"The hills bordering the south shore of the lake are high, but slope gradually from the beach, with the exception of those at the entrance to Compulsion Bay, where they are much steeper, rising to nearly 200 feet. East of the bay higher hills are seen, some probably reaching 400 feet above the lake.

"The rock exposures near Geikie River are of dark-gray gneiss, foliation running S. W. to S. 55° W., but near the mouth Nekweaza Bay this is broken into by a red unfoliated granite and thence eastward the granite seems to have replaced the darker rock, though in places a slight foliation was noticed." Gneiss and granite.

Wollaston Lake to Reindeer Lake.

"The country between these two lakes was traversed on the canoe-route which leaves the south-eastern end of Wollaston Lake, crossing a series of small lakes to the head-waters of a small stream, Canoe River, flowing to Reindeer Lake. The general character of the country is rough and rocky with little soil, and in the valley of the Canoe River showing a considerable deposit of sand. Between the head-waters of this stream and Wollaston Lake, the lakes crossed appear to occupy a low strip of land, bordered on the south by a continuation of the high rocky ridges of the south shore of Wollaston Lake, and on the north by several high hills, forming thus a wide valley opening to the east. The general level of this lake country is but slightly above that of the western lake but forms a plateau sixty feet above Canoe River at the point reached on the route. Character of lake country east of Compulsion Bay.

"The portages on the lake portion of the route are nine in number, and, enumerated in order from the westward, are as follows:— Portages on canoe route from Wollaston Lake to Canoe River.

(1.) Portage 300 yards, from east side of Compulsion Bay to a small lake thirty feet above Wollaston Lake.

(2.) Portage 1200 yards, mostly through swamp, but crossing a ridge of slightly foliated granite. The lakes at either end appear to be at about the same elevation.

(3.) Portage 1550 yards. This crosses a ridge of dark gneiss similar to that on the west side of Wollaston Lake. The country here is well covered with boulders, many appearing on the trail and through the burnt country.

(4.) Portage, in low water made over a narrow strip of swamp, separating a small narrow lake from a larger one to the east, called Middle Lake. This lake lies in a north-and-south direction, divided into two parts by a large island. The extreme length is about five miles and it varies in width from a mile or more at the north end to half a mile to the south. There seems to be lower country to the east, and it is possible that this lake drains to the Canoe River, though its outlet was not seen. The succeeding lakes are all on a lower level, Middle Lake.

and the intervening barriers in a great measure appear to be of boulders and sand.

(5.) Portage, 900 yards. A ridge twenty feet high separates Middle Lake from the next lake to the east, which is nearly twenty feet lower. The barrier is composed of boulders and small stones, and may allow the passage through it of the surplus water from Middle Lake.

(6.) Portage, 200 yards, to the western side of a shallow pond, dotted with large boulders.

(7.) and (8.) Portages cross narrow strips of low country separating three lakes, draining to one another and to the Canoe River.

(9.) Portage, 530 yards, from the last lake of the chain to the Canoe River. The lake is situated on the edge of the valley and is sixty feet above the bed of the stream. A small rivulet trickles down the slope, oozing out through the boulder and gravel-strewn margin of the lake, and joins the stream just above the portage camping place.

Valley of Canoe River.

"The valley of the upper part of Canoe River is cut through a sandy plain which appears to be the surface of a deposit of considerable depth, hiding nearly all the underlying rock except the tops of what appear to be granite ridges. A distance of five or six miles down the stream to the south-east brings us out of this sandy country, and then the river traverses a low swampy flat by many crooked windings till it joins a small lake variously named Swan Lake or Martin Lake. From the hills at the eastern side, the country to the west has the appearance of a rough ridge, smoothed in outline by the sand deposit which seems to be in the form of a belt or terrace running north and south flanking the eastern edge of the high country.

Sand terrace.

"To the east, between Swan Lake and Reindeer Lake, is again a rough rocky country, but at a general level much below that of the head-waters of Canoe River. Through this the stream follows an irregular depression or valley, falling over many ledges of rock or barriers of boulders. Fine reddish gneiss is seen along the eastern side of Swan Lake, terraces of gravel and sand are cut through by the river below the outlet and at the second rapid dark hornblende-gneiss is exposed in small ledges. The lower part of the valley is covered by a thick coating of glacial débris and no exposures of rock were noted.

Gneiss of lower part of Canoe River.

Fall in river.

"The fall in the river, from the highest point reached, is estimated as about forty feet to Swan Lake with an additional eighty feet to Reindeer Lake.

"Middle Lake is estimated as standing at about 200 feet above Reindeer Lake."

Reindeer Lake, west shore.

"By reference to the map it will be seen that this lake, which is very extensive and of large area in its northern part, becomes narrow towards the south, ending in a long arm filled with islands. The total length, from the outlet to the Hudson's Bay Company's post at the north end, is more than 135 miles, while the width of the northern part averages 30 miles. The shores generally are flanked by a very numerous array of islands of all sizes, and a string of islands reaching from Vermilion Point on the west to Porcupine Point on the east, divides the northern part into two large portions in which other islands are seen dotting the more open spaces. The whole of the western shore is of a rough, rocky character. The uneven surface of the Archæan rocks though glaciated and the hills partly rounded, is clearly shown by the number of islands scattered all along the shores. The surface of the country at the north is very poorly wooded and islands and several hills appear as bare rocks. A slender growth of black spruce and small birch is, however, found to the extreme northern limit of the lake. The western shore, southward from near Canoe River, is fairly well wooded, though the soil is thin and is found mainly in the lower parts.

General description.

"The rock near the north-eastern part is chiefly a red granite. On the western shore a reddish granite-gneiss with large porphyritic crystals of felspar is the prevailing rock. The foliation runs about south-west, though local variations from this are found. Bands of a whitish granite, which may be intrusive, are seen on some of the small islands, as well as dark dioritic patches which also appear to be intrusions. On the east side, the same granitic-gneiss was seen, and near Porcupine Point the foliation is more distinct, the large crystals of felspar being arranged more in the form of interrupted bands. Intrusive veins of a light flesh-colourd pegmatite cut the gneiss. The same intrusive granite is seen again on a point at the west side sixteen miles north of Priest's Point. It is in the form of a large boss, and is coarse in texture, with the peculiar arrangement of the quartz which gives the appearance of graphic granite.

Granite-gneiss of northern part of lake.

Intrusive granite.

"The western shore from Vermilion Point was followed southward, so that the eastern shore is still indefinite. The numerous islands are nearly all bosses of rock more or less rounded by glacial action and covered with a slight growth of small spruce, the immediate surface

West shore south of Vermilion Point.

back from the water-mark being generally carpeted with a thick growth of the light yellow reindeer moss. Though these islands are usually high, the main land is generally still higher, and often the main shore is easily traced because bare from forest fires, while all the islands, with a few exceptions, are still green. To the south, and especially in the narrow portion, both the hills forming the mainland on both sides and the islands, appear to rise higher than at the north, giving that part of the lake a very picturesque appearance. The timber also, in the south, is of a more varied nature. There, spruce, poplar and birch are found, but north of the middle of the lake, poplar is rarely seen and the small spruce is the principal tree.

Timber.

"The rocks at Vermilion Point are of spotted red granite-gneiss, which extend northward to the limit of the lake and appear in about the same position, the beds standing at a high angle running S. W. and N. E. At Thompson Island, the largest and highest south of Vermilion Point, they give place to a series of hornblende-mica-gneisses, followed on the point to the south by finer, laminated beds approaching schists. These to the east are found to alternate with granite, and for a considerable distance south, to near Priest's Point, the rock is a banded series of granites and thin beds of mica-schist broken into by the graphic granite mentioned previously. Near Thompson Island the beds run W. S. W. and E. N. E., but again in a short distance are found slightly twisted or wavy, although preserving a general parallel strike to that first noted.

Hornblende-mica-gneiss at Thompson Island.

"From Priest's Point, the lake gradually narrows from a minimum width of four miles, to a narrow inlet less than a mile wide at the outlet, and the course of this part lies very nearly S. W. and N. E., following in a general way the strike of the rocks. A band of dark mica-schists is crossed, reaching from near Priest's Point to twenty miles S. W., and along the course followed through the islands many small dykes of a quartzose fine-grained granite were found, in which iron pyrites is freely developed. The beds of fine-grained gneiss on Camping Island ten miles south from Priest's Point, are also found with many veins of pyrites and on the hill in the centre of the island many of the beds are very much rusted and decomposed. The pyrites is found to contain a small percentage of nickel and traces of cobalt. At the north side of a small creek on the west shore, south-west from Camping Island, the Indians report a soft soapstone or serpentinous rock from which they make pipes, but a visit to the locality did not result in finding this rock, which was then said to be obtained in small pieces from the shore and generally under the water. The rock there, was

Band of dark mica-schist.

Pyrites in gneiss on Camping Island.

however, a light green sericite-schist, and it is possible that unfoliated or less cleavable portions of this might be soft enough for the purpose named. The stratigraphical relations of this band with the surrounding gneisses, could not in the time at the disposal of the party be made out, so that it is problematical whether this may be a small area of highly altered Huronian beds or not. The next rock occurring to the south is a dark garnetiferous gneiss, followed by reddish granitic gneiss to the outlet of the lake." Sericite-schist.

Reindeer River.

"Reindeer River drains Reindeer Lake into Churchill River, and forms one of the largest branches of that river. The lakes to the north are all of clear water, and Reindeer River is remarkable in being beautifully clear and cold, forming thus a contrast to the dark water of the Churchill above the junction of the two streams. The valley through which it runs is an irregular depression following roughly the trend of the gneiss. From the south end of Reindeer Lake, two outlets exist by which the waters flow with slight current to a round lake-expansion to the south. Thence, falling out by the east side around a rocky island, it passes in succession through two lake-expansions with rapids and falls separating them, before it assumes the dimensions of a river and turns to the south. The first fall on leaving the lake is ten feet in height, over ledges of gneiss. The portage past this is across a narrow rocky islet fifty yards wide, and is known locally as the Rock Portage. The second, which is between the next two lakes, is called the White-sand Portage, so named from the cliffs of sand on the north side, opposite the portage. The rock exposed on the portage is a dark gneiss running S. 15° W. or N. 15° E., and standing vertical. The river in this course runs to the eastwards about five miles, and from there to the Churchill bears due south, though the main part lies to the eastward of this line. The dark hornblende-gneiss found at the White-sand Portage, and on the lake to the east, is cut in a few places by a whitish intrusive granite. Valley of Reindeer River. Rock and White-sand portages.

"The river narrows after turning to the south and flows through a low swampy flat confined between high ridges. Before entering the swampy stretch, there is a sharp bend at which the river falls slightly over ledges of dark gneiss, and the many eddies along the face of the steep banks make it dangerous for small boats. The place bears the name of the Devil's Rapids, and expresses the Indian's fear of this as a treacherous place. Devil's Rapids.

"In this swampy tract, the banks are mostly a mossy swamp and the current is not strong, but very regular. Turning slightly to the east, a wide lake-expansion is crossed. High hills surround this, and a narrow passage of a quarter of a mile connects with another called Red-hill Lake. A branch of the river is said to leave the lake above Devil's Rapid, and by a detour to the east to again join the main stream at Red-hill Lake. On Mr. Cochrane's survey, this branch is called the Stump River. To the east of the mouth of this river, a prominent hill with red colouring along the ridge, forms a very marked feature. On a nearer view, this red colouring is found to be due to the débris of a decomposed band occupying the crest of the ridge. The rock has been very highly charged with iron oxides and pyrites. The strike of the beds is S. 10° E., with dip eastward at angles varying from 60° to 80°. Several large seams of red granite cut into the hill and break up the beds somewhat.

Red Hill Lake and Stump River.

"A section of the hill shows a light, coarse gneiss near the bottom, with a dark mica-schist, followed by a bed of light rusty coloured gneiss having a thickness of about five feet. This in some places seems to have been very rich in pyrites and is weathered out to a reddish ochre. The outcrop is just below the crest of the ridge, and from it the ochre falling down, stains the whole face of the hill. Above, on the summit the rock is mostly a dark-red gneiss.

Red Hill.

Ochre.

"The river between Red-hill Lake and Steep Hill Portage, runs directly south, passing through several small lake-like expansions, on which the rocks are found to be generally gneiss, dipping to the north-east, but cut into by large dykes of red granite. Large bosses of this same intrusive material are seen at the middle distance or just north of the mouth of White River. Above the Steep Hill Portage, the river broadens out to a lake about two miles in diameter. Into the north-western corner a branch of the Reindeer River enters from the west. This stream, the White River, drains White Lake, into which two branches fall—one from Whitefish Lake and the other said by the Indians to be a small channel draining from the Churchill River above Stanley Mission. The usual route from Stanley to Reindeer Lake is by this stream and the White River. Another route, said to be feasible for large York boats, is from Reindeer Lake up the Vermilion River, which enters on the western shore, to Vermilion Lake, thence up still farther to a second lake and southward to the Churchill by a stream said to be large and of easy fall to the English River near Stanley.

Intrusive granites.

White River route to Churchill River.

"At the Steep Hill Portage, light clay is seen in greater quantities than farther north. A ridge of clay thirty-five feet high is crossed

Steep Hill Portage.

in making the portage. The lake above drains to the east and falls over a steep ledge, between three islands, at the south-east corner, making about twenty feet fall. The boats have to be portaged here as well as the goods. The sides of the valley are more thickly timbered with poplar, and a few small trees of white spruce were noticed a few miles below the Steep Hill Portage. The river makes a long bend to the east and then south, passing through a wide lake-like expansion with many islands, narrowing at places, in which the current is found quite strong, but generally, from the Steep Hill Rapids to near the mouth of the river at the Deer Rapids, the river is wide with little current. From its eastward bend it turns to S.S.W. and maintains a very uniform course to its mouth, following a valley which is parallel to the strike of the gneiss. The sides of the valley are clothed with small poplar, showing patches of the darker foliage of the spruce. Veins of a reddish pegmatite are occasionally seen cutting the gneiss, and larger masses occur on the east shore above Deer Rapid. The last interruption to the navigation of the stream is at Deer Rapid, about two miles north from Churchill River, where there is a fall of about five feet over a ledge of gneiss. Below this is a wide deep channel, in which the current is almost imperceptible. The junction of these two streams may be said to occur in a narrow moon-shaped lake, occupying a depression in the valley common to both streams. The Reindeer River enters at the north end and the Churchill at the south-west; while the outlet is from the east side by a narrow gap, through which the river pours in a wild rapid. Below this the Indians report the remains of a trading post, which is probably the site of old Fairford House.

Deer Rapids.

"The water of the Churchill is found to be very much darker in colour than that from the north, and evidently contains much more organic matter, as the shores show a greater profusion of aquatic plants and the submerged surfaces of rocks bear an abundant growth of sponges and the smaller forms of algæ. On the Reindeer River and the lakes above, all the submerged rocks appear bare and clear.

Character of water of Reindeer River and Churchill River.

A chemical examination of the waters from Reindeer Lake and Churchill River was made by Dr. F. D. Adams in the Laboratory of the Survey in 1882.* In summing up the general results, Dr. Adams says:—"Of the foregoing waters that from Reindeer Lake is remarkable for the small amount of dissolved solid matter which it contains; in this regard it would take rank with the waters of Bala

*Report of Progress, Geol. Surv. Can., 1880-82, p. 6 H.

Lake, Merionethshire, Wales, and Loch Katrine, Perthshire, Scotland * * *."

Churchill River.

"The first fall on the Churchill River above the mouth of Reindeer River, is a steep descent of fifteen feet over dark greenish schists, forming what is called the Kettle Fall. A portage of 130 yards is made on the north side over a ledge of these schists.

Band of dark schist in centre of valley near Trade Portage.

"Up to Conjuring Creek, the course is obliquely across the strike of the gneisses, and those crossed are of the following varieties.—A dark gneiss, forming a wide band, follows the valley of the Reindeer River and is exposed on the Churchill up to near the Kettle Fall, where we cross dark green hornblende-schists, forming a band nearly a mile wide running to the south. A granitic gneiss occupies most of the lake above Kettle Fall, but at the western extremity a dark band of fine-grained hornblendic gneiss, in many places a black schist, is found to occupy the bottom of a valley, which here reaches the lake coming from the south and south-west, and in which the upper extension of the Churchill River runs. This dark band appears to have been more easily denuded than the granitic rocks apparently flanking it on both sides, so that to near the Trade Portage it occupies the islands in the channel and strips and points along the shores. The Trade Portage rocks are of the lighter granites and gneisses which lie along the eastern border of the dark band. The strike of these gneisses above the Trade Portage, bends more to the west and the dark band is seen at intervals to Key Rapid, the second above, where a long island divides the channel into two parts. The rocks dip here N. N. E. $< 80°$. They are mica and garnet schists and cleave into thin laminæ.

Trade Portage gneisses.

Gneisses of Churchill River above Trade Portage.

"Above, is a long lake-expansion in which are many large islands forming a continuous string with small openings between, to the end of the lake. The north side and parts of the islands are of the dark schists running about west. The upper part of the river now leaves the dark rocks, which are deflected to the north, and on the next lake above are found a series of gneisses and greenish schists running more in a northerly direction, giving place on the west to lighter gneisses, broken by many granite veins and dykes. Forks Lake, into which the outlet of Lac la Ronge empties, is of larger dimensions than those immediately below, and on it the rocks are found trending to the north and north-east. A light-coloured gneiss is found to contain a wide band of crystalline limestone, the first seen in the Laurentian in this district. At the end of the lake several of the small islands are of red granite, in which patches of the gneiss occur as inclusions, and large bosses and veins of the same granite are seen at several places along the south shore to near Stanley Mission.

Crystalline limestone on Forks Lake.

"The rocks are everywhere glaciated and more or less polished. On the granitic rocks the striae are very obscure, but on the finer grained gneisses and schists are better marked. At the Trade Lake, above Trade Portage, the direction is S. 40° W., and half way to Stanley they are about S. 32° W.

Glacial striæ on Churchill River.

"The gneisses of the lower part of Churchill River are seen to follow roughly the course of the valley, without any great local disturbance, merely a general bending to follow the long curve. But nearing Stanley Mission the change in strike is seen to carry the prominent dark band by a rather sharper curve to the north, and the succeeding beds on the west become broken into by a light granite, past which the gneisses are found to be running to the east of north.

Change in strike of gneisses near Stanley Mission.

"From Stanley Mission to Lac la Ronge the course is to the west of south, and the gneissic bands exposed on the bay into which the canoe-route leads are apparently the same as at the Mission, while the same band is followed through the chain of islands which extend to the mouth of the Big Stone River. The general direction in which this is found to run is about W.S.W.

Band of spotted gneiss.

"These gneisses are porphyritic in several places, being spotted with large phenocrysts of plagioclase, surrounded by a darker—almost black—matrix. Under the microscope a decided cataclastic structure is apparent. Farther south, the squeezing has developed a ropy or beaded structure—the coarser crystalline granitic material being arranged in a series of lenticular and oval patches between the layers of finer gneissic and schistose rock that is much darker in colour. The contrast in colour brings out the structure very plainly as will be seen by the accompanying plate. The photograph was taken at the south end of a long point or island on the west shore of Lac la Ronge, about five miles north of the mouth of Big Stone River.

Beaded gneiss.

"The succeeding beds to the westward were seen only on the canoe-route near Stanley. They appear to be of a fine-grained greenish gneiss, approaching a schist, forming with the spotted gneiss of the lake, a narrow band of less than a mile wide, followed to the west by reddish coarse-grained gneiss.

"A covering of drift conceals the underlying rock of the vicinity of the south-west corner of Lac la Ronge and extends southward, being apparently covered in turn by a thick deposit of stratified sand, forming a plateau extending north from Montreal Mountain to within eight or ten miles of the above lake. In this area the only indication of the nature of the rocks below is to be derived from the boulders,

Drift deposits south of Lac la Ronge.

and is of course very uncertain. At the trading post between Egg Lake and Big Stone Lake, several fragments of a light-yellow dolomite or limestone were noticed, and would seem to indicate the presence of rocks of this kind in the vicinity or to the northward. The Indians reported exposures of a similar rock on the south shore of Lac la Ronge, so that the extension of the limestones of Lake Winnipegosis or of Pine Island Lake may be expected as far north as Lac la Ronge.

Montreal Lake.

"Montreal Lake is a shallow basin about thirty miles long and from five to ten miles wide, lying to the north of Montreal Mountain and on the sandy plateau above mentioned. The outlet is by a small stream flowing northwards. This cuts gradually through the terrace, and near the northern edge shows a section of sixty feet of stratified sand. To the north of the sandy terrace, the stream turns to the east and passing through several small lakes in the drift-covered region, reaches the south-west corner of Lac la Ronge.

Terrace of stratified sand.

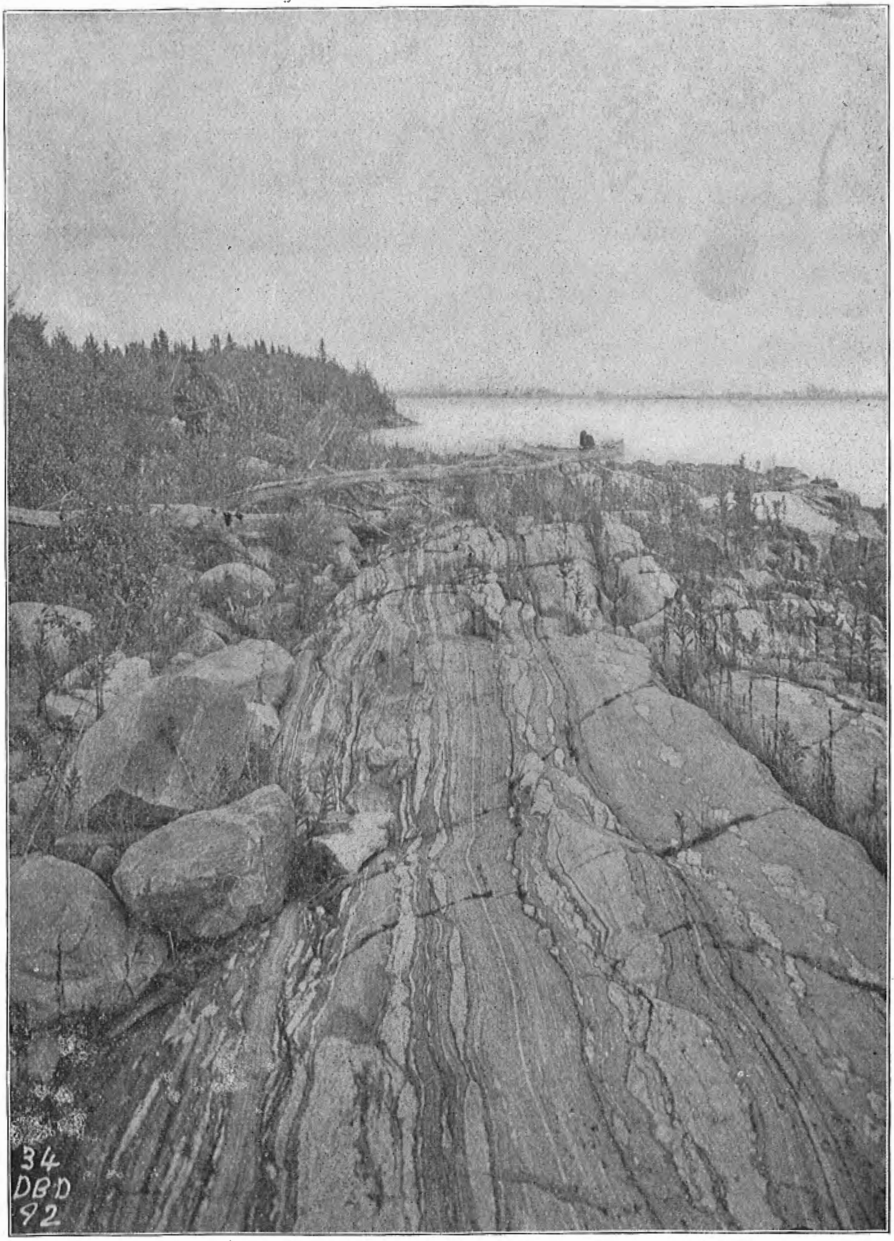
"The timber in the rocky country bordered by the southern shore of Lac la Ronge is not large or abundant. Southward there is some improvement, and large individual spruce trees occur occasionally. The 'lob sticks' at Big Stone, Hudson Bay Company's post, are fine examples of these. On the Montreal River, small Banksian pine cover the eastern slope of the sandy plateau. No large timber, spruce or pine, is seen till near the lake, where at the southern end some groves of large spruce occur. On the watershed south of Montreal and Deer Lakes the largest timber is seen. Here the formation of the country is evidently morainic, but southward the country slopes gently toward the Saskatchewan River."

Timber of country near Montreal Lake.

Geikie River.

Geikie River opens with a bell-shaped mouth into the bottom of Nekweaza Bay of Wollaston Lake. The water is clear, but of a slightly brownish tinge. At the first narrows, in which there is no perceptible current, are high hills of dark-gray well-foliated biotite-gneiss, striking N. 60° E., and with vertical dip. Above this is another stretch of quiet water studded with high elongated or dome-shaped rocky islands, while similar hills also rise on the shore. One arm of this lakelet runs off S. 60° W. on the strike of the gneiss, but the smoke that filled the air, caused by forest fire started by the Indians, prevented us from seeing how far. On the eastern shore one high point was found to consist of coarse red granite. The eastern arm of the lakelet was followed through a strait into another lake-like expansion, the shores

Narrows.



D. B. DOWLING.—Photo., Sept. 27, 1892.

BEADED GNEISS

South-western shore of Lac la Ronge.

of which are at first high rocky ridges of gneiss, and then become lower and thickly strewn with boulders. The underlying rock here does not come to the edge of the water, though it may occasionally be seen in the distance, and is then apparently micaceous gneiss, the same as that recorded above.

Plain of white sand.

On the evening of August 25th camp was pitched on the west bank in latitude 57° 38′ 30″, on lightly rolling white sand, wooded with small Banksian pines.

River deep and without current.

Three-quarters of a mile above this camp, the dark-gray gneiss crops out at a rounded point on the east bank, striking N. 70° E. and dipping S. 20° E., at an angle of 55°. It is cut by, and interlaminated with bands of red pegmatite. For three miles and a-half further, to the foot of a rapid, the river is deep and a hundred yards wide at its narrowest parts, with a scarcely perceptible current. In some places high sand-hills rise on the west bank, and occasionally low outcrops of gneiss were also seen. The rapid here reached has a fall of about three feet over a ledge of gneiss. An island lies in the middle of the current, on the east side of which the canoe was tracked up with a line. The river here carries about as much water as Stone River, below the mouth of Waterfound River.

Long Rapid.

Two miles further up stream, there is a heavy long rapid, in which the channel is wide and full of boulders. The cargo was landed on a sandy slope on the west bank at the foot of this rapid, in latitude 57° 35′ 45″, and two of the men continued up the stream with the empty canoe. The cargo was carried for 1800 yards across a portage, first up a gently rising sandy plain, sprinkled with boulders, then into a valley and across a deep bog, 115 yards wide, then over low sandy hills and down forty feet into a valley, to the reedy shore of an arm of the river. There is no sign of the underlying rock on the portage. The total rise as shown by the aneroid, was forty-five feet.

Portage.

Straight valley.

This closed arm of the river was followed south-westward in a straight valley, between steep sandy banks fifty feet high, for a mile and a-half, until the river was again reached, flowing in a continuation of the same valley, out of the side of which it cuts between two rounded sand-hills, to rush down the rapids below. Above this arm it flows between sand and gravel banks to the mouth of Poor-fish River, a stream, navigable for canoes, flowing from the southwest.

Poor-fish River.

Above Poor-fish River, Geikie River widens to a small lake, the shores of which are generally wooded with spruce, through which rise some high hills of sand and boulders. Near the south end of the lake is a small island of coarse, red massive biotite-granite, cut by quartz veins, and scored by glacial markings, trending S. 30° W.

Rapid.

Two miles and a-half further up the currentless river, between wooded hills, there is a heavy rapid over a bed of boulders, with a total fall of about thirty-five feet. The men hauled the canoe up this rapid, but an easy portage 600 yards long can be made over a sandy plain on the east bank.

Three-quarters of a mile above the rapid, up the river, now wide and with swampy banks, camp was pitched beside a little knoll of gray, slightly reddish, very compact biotite-gneiss striking N. 60° E., and dipping S. 30°, E. 35°.

Rapid.

For the next two miles the river is generally rapid, running over a bed of boulders, and has a total fall of about thirty-five feet. Low outcrops of gneiss were occasionally seen. Above these rapids, for fourteen miles, the river is straight and wide, like a long narrow lake, with current at a couple of places near the middle of the distance. The shore is composed of sand-hills and wooded sandy banks, with occasional banks of peat. A few hills of gneiss also approach the river. One of these, six miles from the north end of this straight reach, is a high rounded hill of an indistinctly foliated dark-gray biotite-gneiss. The summit is well smoothed and shows many distinct parallel glacial grooves trending west. As they differ so greatly in direction from all the other glacial markings found on the river, they are supposed to have been formed by a local glacier, after the retreat of the Keewatin glacier.

Hill of gneiss.

Above the quiet water of the lake the canoe was hauled up two rapids, a quarter of a mile apart, between hills of boulders, then paddled for half a mile along a wide shallow piece of river to the foot of White Spruce Rapid, a swift narrow rapid with a fall of about eighteen feet. The canoe was landed on the east bank and carried on a portage 1100 yards long beside the river, over a stony hill, and along a stony hillside through small black spruce woods. The rapid is a very picturesque one, the water tumbling over a series of rocky barriers of gneiss, and then over and between large rounded boulders. In places the west bank is low and sandy, and wooded with some fine large white spruce, the first observed on the river. Under the trees pembina berries, raspberries, &c, were growing in profusion. Camp was pitched at the head of the portage on a slope covered with reindeer moss, and a short distance back from the marshy border of the river.

White Spruce Rapid.

The next morning we continued for three miles up the straight quiet river, between sand ridges, to a fall over a ledge of massive rather fine-grained red granite, past which the canoes were carried on the west bank for 180 yards over a stony hill, through small Banksian pines. Sand ridges.

For the next three miles, the river is for the most part shallow and rapid, flowing between hills and ridges composed of fine reddish sand or silt, mixed with rounded waterworn cobbles and boulders. The sandy material here, as well as that along the banks all the way to the mouth of the river, is much finer and more silty than that seen on Stone and Cree rivers, and supports a much stronger growth of vegetation.

At this point the country changes. The hills are no longer composed of sand, but consist of gneiss or boulders imbedded in silt and white sand. These boulders are almost entirely of granite or gneiss, and but one small one of Athabasca sandstone was found. Glacial striæ run S. 20° W. Change in character of country.

A moose was here shot and the following night was spent drying the meat, so that we might be able to carry it more readily with us. In the morning the dried meat was put in one flour sack. Moose.

Above camp we tracked and poled up two heavy rapids over boulders, in which the river falls respectively thirty and twelve feet. The river flows in a sloping valley 30 to 40 feet deep cut in a somewhat irregular plain of sand and travelled cobbles and boulders, above which rise occasional rounded hills, probably of gneiss. Above the second rapid a narrow lake four miles long was entered. A gray biotite-gneiss outcrops at points here and there on its shores, striking generally parallel to the course of the river, and cut by many granite veins. At one point on the west side, there is a low exposure of massive red and green granite, composed chiefly of orthoclase and fibrous hornblende, but containing a large quantity of titaniferous iron ore. Above the narrow lake is a fall, with a descent of eight feet, where the river flows between vertical walls of rock, that on the west side a well-foliated biotite-gneiss with vertical dip, and striking along the stream, that on the east side a fine-grained red granite. The canoe was carried for 350 yards on the east side, over the smooth surface of the granite, to a little grassy bay above the fall. Heavy rapids Narrow lake. Falls.

Above the fall are two rapids, with descents respectively of about five and two feet, to the north end of what is known as Big Sandy

River straight.

Lake. Thus far the river trends remarkably straight in a southerly direction, its course being determined by the strike of the gneiss. The surrounding country is much more heavily covered with drift than most of the Archæan areas further north and east. When exposed the rocks are not polished, and glacial markings are not common.

Rocks unpolished.

Big Sandy Lake.

Big Sandy Lake is fifteen miles long, from a quarter to half a mile wide, and like the river, lies in a north-easterly and south-westerly direction. Generally speaking, it lies along the line of contact of the massive red granite, holding a large quantity of titaniferous iron ore, to the east, and the gray biotite-gneiss to the west. For three days we were detained in camp on its western shore by a heavy cold storm of wind and rain. Camp was pitched in open pine woods on a sandy terrace ten feet above the lake. Behind us rose a gentle sandy slope, scattered with a few boulders, to a rounded hill, a hundred feet high, of granite and gneiss in very irregular contact and in about equal amount. On the fourth day, September 2nd, the remainder of the lake was surveyed in the drizzling rain. On both sides were ridges of rock, or sand and boulders. The country gradually became more barren, until the small, thinly scattered pines appeared to form but an open stubble over the surface.

River above the lake.

The river that was found flowing into the south-west end of the lake, does not bring in more than a third of the water that leaves the lake. It is about fifty feet wide and is spread out thinly over coarse rounded gravel. It comes from the east across the strike of the gneiss for a short distance, and then turns again from the south-west. On both sides are high barren hills covered with boulders. Many of the hills have a core of gneiss. One, which was ascended, was found to be 180 feet high. Its summit is of gray biotite-gneiss striking N. 55° E., and with vertical dip, cut by bands of red granite. Its sides are scattered with boulders. Other hills are composed entirely, as far as could be seen, of water-worn sand and gravel, with a few scattered boulders. No definite regular arrangement of this detrital material could be detected, but it was probably deposited at or near the face of the Keewatin glacier as it gradually retreated towards the north.

Moraine.

Camp was pitched a mile and three-quarters above the lake in north latitude 57° 1′ 15″, in the bottom of a valley fifty feet deep. In front of the tents flowed the shallow rapid stream, now only thirty feet wide.

Deep valley.

For half a mile above this camp the river flows in a sloping valley a hundred feet deep, when it turns from the south-west and flows through a plain of sand and gravel, above which rise occasional rounded knobs of gray gneiss. Again it turns from the south-west in a very narrow valley, to the north-west of which is a narrow kame composed of sand and gravel. Beyond the south-west end of the kame, on the west bank, is a high cliff of well-foliated compact reddish-gray biotite-gneiss striking N. 60° E., and dipping N. 30° W., at an angle of 70°. A quarter of a mile above this hill a small lake was entered. This lake lies five miles in a direct line from the Big Sandy Lake, and, as has been seen, the whole of the intermediate country is buried under stones, gravel and coarse sand borne from the face of the Keewatin glacier. Kame.

Into the western angle of the lakelet the river issues, and above it, for three miles and a half, it passes through a moderately level sandy country, the boulders and coarser material becoming less frequent up the stream. At the end of the above distance we entered another lake, passing to the east of a narrow sandy esker-like ridge that projects as a long point into the water. This lake, like the others, lies in a south-westerly direction, but its shores are broken and irregular. The course followed through it, from one end to the other, was eleven miles, as measured by a boat-log, and its greatest width is about three-quarters of a mile. Its shores are high, with thickly wooded slopes extending down to the water. The islands are for the most part ridges of sand and gravel, but both they and the surrounding hills, some of which rise to heights of 300 feet or more, are underlain by gneiss. In one place glacial grooves were observed, trending S. 35° W. Camp was pitched on the east shore, on the edge of a swamp, behind a sandy beach, in north latitude 56° 52′ 45″. Behind us was a low hill composed at the top of a well-foliated gray gneiss, striking S. 25° W. and dipping S. 65 E. at an angle of 45°. Its surface is generally strewn with boulders. Esker or kame. Lake. High shores.

The river, where it flows into the south-west angle of the lake, is 35 feet wide and a foot deep, with low sandy hills flanking it on each side. The little stream then winds in a very crooked channel, with strong current, through an extensive marsh. At a point a mile from the lake, a hill rises on the east bank to a height of a hundred feet above the marsh. Near the base it is sandy, while at the top it consists of a well foliated biotite-gneiss, striking south and dipping east at an angle of 60°. Its rounded surface is rather roughly weathered, but shows distinct glacial grooves, running S. 35° W. To the west is a wide sandy valley, wooded with Banksian pines, stretching out north-westward into low land as far as the eye can see. In other directions he whole surrounding country is sandy, with a few isolated hills. Low sandy hills.

Beaver-dam.

South-west of the marsh the stream spreads out into little elongated ponds, often not more than a hundred yards in width. At one place it was blocked by a beaver-dam, over which we were obliged to carry the canoe.

Forks.

Camp was again pitched in latitude 56° 46′, on a sandy plain wooded with Banksian pine at the junction of two forks of the little river, both of which were blocked by beaver-dams. The surrounding country is undulating and sandy, but to the west is a high hill, the north side of the summit of which is composed of gneiss, while the south side extends into a long ridge of rounded boulders.

West branch.

We struggled up the west branch of the little river, which here varies from six to twenty feet in width and flows through wooded sandy country, to another small oval lake three miles long and three-quarters of a mile in greatest width. Both its east and west shores are formed of ridges, apparently of gneiss, from 100 to 300 feet high, and its islands are also rounded bosses of the same rock. Many of the higher points are smoothed and polished, showing glacial striæ trending S. 55° W. At one point the rock is a light-gray almost massive biotite-gneiss, the surface of which is beautifully polished and shows two sets of glacial striæ, often separated by sharp angles, the older one trending S. 33° W., and the later S. 20° W. In some places the shore is composed of a wall of boulders. The water in the lake is beautifully clear.

Gray biotite-gneiss.

Sand plain.

The stream flowing into the south end of the lake is from six to twelve feet wide, and winds in the bottom of a shallow valley through a plain of sand and gravel. After a course of a mile it comes from another small lake three-quarters of a mile long with wooded rocky shores. Half a mile farther up the creek from this lake, is another small shallow lake surrounded by high spruce-covered hills, and almost divided by a narrow wooded island, apparently composed of sand and boulders. A little rapid streamlet was ascended for half a mile from this lake to another shallow straggling lake, on the south shore of which camp was pitched on the evening of September 5th, on a sandy plain with a thick growth of small Banksian pine, in north latitude 56° 37′ 35″. Around us the country was low, but to the south rose a high unbroken ridge of spruce-covered hills, barring further progress in that direction.

Source of Geikie River.

We had now reached the source of Geikie River, or at least of the branch of it that we had lately been ascending, and it was necessary to find some practicable route by which the canoe could be taken across the height of land to the head of some stream flowing southward towards Churchill River. The first thing to be done was to examine the shore foot by foot, in order to discover whether Indians hunting in this vicinity had ever entered or left this lake by any other route than the one by which we had entered it. At the east end of the lake we crossed a narrow wooded sandy neck of land beside a brook, and entered another little lake a quarter of a mile in diameter, on the east side of which, after long and careful search, we were delighted to find traces of an old portage route, though it was now blocked and barred by underbrush and much fallen timber. The path was 650 yards long, and when chopped out was a very good one, over hard sandy ground through a thick growth of small spruce and Banksian pine. The east end of this portage opens on a narrow, irregular lake, from the opposite side of which a little brook flows across a stretch of low land into another small lake, beside which are high rocky hills. There was no sign of Indians having ever travelled down this brook, so we turned southward to the south end of the lake. The rocky points on its shore are rounded, and consist of red biotite-gneiss, striking S. 30° W., and dipping S. 60° E. at an angle of 50°, but blackened by a thin coating of *tripe de roches*. Finding no signs of a portage, we again turned northward and searched the shores for two miles, to the north end of the lake; where a brook three feet wide was found flowing into it. On each side were high narrow elongated hills or eskers of sand and boulders, trending S. 45° W. Carrying our canoe past this brook for eighty yards, we entered another small lake lying in the same direction as the last.

Old portage-route.

Red biotite-gneiss.

Passing up this lake, to the west of which rise high wooded hills, for half a mile, we found a portage on the east bank at the foot of a steep slope of sand and cobbles. The portage is 325 yards long, the first 225 yards being up a slope of sand and rounded cobbles, over a ridge of gneiss forty-five feet above the lake, and the last 100 yards across a sand-plain to the end of a lake lying transversely to the last. This lake is narrow and three-quarters of a mile long, with low wooded shores. From its east end a brook flows eastward, on whose north bank we carried the canoe for eighty yards to another and rather larger lake, across which we travelled for a mile and a-half to its outlet in a brook six feet wide, near which we camped for the night in north latitude 56° 38′ 18″. The variation of the compass was found to be 26° east.

Height-of-land Portage.

The work of the next few days showed us that the low sandy country which we had just crossed lies on the height of land between the waters flowing to Wollaston Lake and those flowing to Churchill

Low sandy country.

River. As we have seen, the country to the north of this watershed is thickly covered with detrital material, brought by the great Keewatin glacier and its glacial streams and lodged near its front as it retired to the north.

Foster Lake and River.

Brook flowing southward.

From camp we descended a little brook, that tumbled over boulders in a wooded valley, for a quarter of a mile, to a fall over a ridge of green and red hornblende-gneiss containing a considerable quantity of titaniferous iron ore in small grains. The canoe was carried for 190 yards on the south-east bank to the foot of the rapid.

Small lake.

The brook enters the south-western extremity of a larger lake of very yellow muddy water, with rather low shores fringed with boulders, but with occasional points composed of gneiss striking in the direction of the long axis of the lake. One smoothly polished surface showed glacial striæ, trending S. 48° W. The lake is five miles and a-half long, and its south-east shore was followed to its north-eastern end, where a short rapid stream was found flowing eastward into another lake, which was not recognised at the time, but which we afterwards learned to be an arm of Foster Lake, so called in honour of Hon. G. E. Foster, Finance Minister of Canada.

Foster Lake.

Three-quarters of a mile south-east of the mouth of the brook, is a high island of gray hornblende-gneiss, striking S. 20° W., and with a high dip to E. S. E. From the top of this island the lake is seen to extend a long distance north-eastward with a high esker-like ridge on its north-west shore, and on the south-east shore some cliffs of sand. Generally speaking, however, the surrounding country is rather low, undulating and thickly wooded.

At the time it seemed to us that this might be a lake lying on the Vermilion River which flows into the south-west side of Reindeer Lake.

Recent tracks of Indians.

Again turning southward, for we were anxious to find a passable canoe-route in that direction, we paddled for two miles to the mouth of a little brook two feet wide flowing into the bottom of the lake. Here we had the good fortune to find a portage newly cut out by Indians apparently travelling southward to Ile à la Crosse, and we at once decided, if possible, to follow them.

The portage was 250 yards long, over a flat composed of broken fragments of gneiss. It leads to the north shore of another lake four miles long with thickly wooded rocky hills on both sides, though the beach is often composed of boulders.

Behind a small island at the south end of this lake, the fresh Indian trail was again found on a portage 225 yards long. The first half of this portage was up a sandy slope wooded with small Banksian pine to the top of a hill of gray, not very evenly foliated gneiss, striking S. 30° W., while the second half was down a very gentle slope to the swampy shore of a small lake thirty-five feet above the last. Camp was pitched on this portage, in latitude 56° 36′ 30″.

Small lakes and portages.

The next lake was only a quarter of a mile wide, beyond which was a portage eighty yards long, over a flat composed of broken fragments of gneiss, to another lake three-quarters of a mile long, discharged by a little brook eighteen inches wide; but the Indians had not passed here, so we searched back around the eastern shore till we came to the portage. It was 950 yards long, and led south of a high rocky hill over rolling country of sand and boulders to a small lake from which is a portage 200 yards long, over a sandy ridge, to a sloping sandy beach at the bottom of a bay of what was afterwards found to be the lake known to the Indians as Little Whitefish Lake.

Little Whitefish Lake.

The wind had now risen very high and it began to rain, so that our progress was much impeded. The lake is a very pretty body of clear, cold water. Its contour is very irregular, and it is divided into two roughly equal parts by a strait 725 feet wide. Its shores are rugged and rocky, rising into high thinly wooded hills and ridges, separated by deep valleys. The rock is an evenly foliated reddish-gray granular biotite-gneiss, with a general strike S. 25° W., and a high dip, cut by many large and small veins of red pegmatite. There is but little sand or till, and the rock is almost everywhere well glaciated, showing glacial markings trending S. 30° W. The lake is discharged by a stream fifty feet wide, with stiff current, flowing between low rugged points of gneiss. A third of a mile lower this stream flows over two little rapids into another irregular lake similar to, but smaller than, Little Whitefish Lake. On a low rocky point on its shore we camped, in pouring rain, on the evening of the eighth of September.

Circling to the right round the rocky shores of this lake, we travelled seven miles in search of its outlet, which we at length found less than a mile from where we entered it. The rapid at the head of the river was run with the half-loaded canoe, and a short distance below it another winding lake was entered. At its entrance is a point of coarse dark-gray hornblende-granite-gneiss, cut by many joints and breaking down in vertical cliffs.

We passed for three miles and a quarter under the rocky banks and islands of this crooked lake, and down the river for a mile and three-quarters over two little rapids, to its mouth in a lake which was subsequently found to be Foster Lake, and which the Indians at Ile à la Crosse afterwards told us, was the same lake we had left two days before. We paddled for three-quarters of a mile, to a high point of heavily laminated gneiss striking S. 45° W., and with almost vertical dip. From this point we passed out into the large lake, studded with islands, when Heddery, one of our Chippewyan Indians, suddenly recognized a point where he had taken dinner in the previous spring. He at once recalled to mind the geography of the surrounding country, and as he had many times descended the river flowing from this lake to Churchill River, all uncertainty as to our course was at an end. We were on the regular hunting grounds of the Ile à la Crosse Indians, and the remainder of our course to that trading post was known to both our Chippewyans.

Foster Lake.

We immediately turned into a bay, rather more than half a mile deep and reached a river of considerable size at a heavy rapid. This rapid has a descent of ten feet, the upper part in a gorge between rocks only ten feet apart, and the lower part wide and over a bed of large boulders. The canoe was carried for 270 yards on the north bank to a grassy flat at the bottom of the rapid. A hundred yards below, the river opens into the side of a long narrow lake, stretching north-east and south-west, belonging to the group of lakes here called Foster Lakes. We turned southward for a mile and a-quarter and camped on its west shore, behind a little sandy beach at the foot of a steep cliff of gneiss, striking south-west and dipping north-west, at an angle of 60°. The country passed through during the day rises in high rocky hills, sand-plains and hills of boulders being conspicuously absent.

Heavy rapid.

High rocky hills.

The country now slopes southward, and the detrital material derived from the drainage of the Keewatin glacier appears, for the most part, to have been carried away by the rapid streams, instead of lodging near the foot of the glacier, as it had done north of the watershed.

Foster Lakes are said to consist of three long irregular bodies of water, connected by short stretches of rapid river, and like Wollaston Lake, to discharge by two outlets in opposite directions, the Vermilion River flowing north-eastward to Reindeer Lake, and Foster River flowing southward to Churchill River. But the lateness of the season, and the almost exhausted state of our provisions, prevented us from exploring the lake in any other direction than towards the head of Foster

Foster Lakes.

River. This arm of the lake, from the mouth of the river just descended to the head of Foster River, is fifteen miles long and about half a mile wide, but narrowing at one place to 150 feet wide. The shores are composed of high ridges of rather dark fine-grained biotite-gneiss, striking south-westward, their sides descending in wooded slopes to a beach of boulders. At the Sandy Narrows, four miles north-east from the head of the river, there is a stiff current between high thickly wooded hills. Just at the foot of the current, on the west shore, is a long narrow esker-like ridge of sand and boulders, running S. 30° W., wooded with a pleasant grove of aspens, giving promise of more fertile country further south, where, as the Indians said with glee, we would burn only poplar. To the south-west of the sandy ridge is a hill 175 feet high, composed of dark highly garnetiferous biotite-gneiss, interlaminated with many bands of very coarse white pegmatite. For the rest of the way to the head of the river the shores consist of similar garnetiferous gneiss.

Esker.

Foster River.

From the lake, Foster River continues to flow in a deep valley along the strike of the gneiss, and for eighteen miles, measured in a straight line, it is one almost continuous series of heavy rapids over a bed of well-rounded boulders. Most of these rapids were descended with poles. The river seldom impinges against the rocky banks, but where seen the rock is a dark gray biotite-gneiss or schist. Towards the end of the distance mentioned, the rapids are separated by wide shallow stretches of quieter water, and hills of sand and boulders begin to make their appearance. At the end of the eighteen miles is a heavy crooked rapid with a descent of ten feet, past which the canoe was carried on the west bank for 280 yards, on a sandy slope at the foot of a hill of sand and boulders, and then over a flat of large boulders.

Hill of reddish gneiss.

Half a mile further south, the river touches the foot of a hill of rather coarse-grained reddish biotite-granite-gneiss, striking S. 60° W. and dipping N. 30° W. at an angle of 40°. It is interlaminated here and there with occasional distinct dark bands of gneiss or mica-schist, with a large proportion of biotite.

Valley expands.

On entering this country of red gneiss, the valley spreads out into sloping basin-shaped depressions. At first, for five miles and a-half, the river takes a very straight course between wooded hills, having a moderate current, except at three heavy rapids where rocky barriers cross the stream. At these rapids portages were made on the east bank, respectively 275, 200 and 210 yards in length. Afterwards the river winds for three miles and a-half, measured as the crow flies, in a very crooked channel with reedy banks, through a low marsh, occupying the bottom of a basin surrounded by rocky hills.

Below this marsh it drops in a very beautiful fall, where a barrier of reddish gneiss crosses its course. The canoe was carried for 160 yards on the east bank, over rock and through swamp, to the foot of the fall. About 300 yards below the foot of this portage the canoe was again put ashore on the west bank and carried for 750 yards over gently undulating sandy ground and over a bench of sand and rounded cobbles, to the foot of a long rapid in which are two abrupt falls over bands of similar gneiss.

Little Whitefish River.

For half a mile farther, the river continues to flow in the same southerly direction, until it is joined by Little Whitefish River, a stream of considerable size flowing from the west.

Change in course of stream.

Thus far Foster River had been a rapid torrential stream, flowing in a very direct course southward in a well-defined channel and not expanding into lakes. Here it turns sharply eastward and at a distance of a third of a mile, reaches the head of another rapid, past which the canoe was carried for 275 yards, on the south bank, over a little hill, the centre of which is of reddish gneiss, while the sides are of sand and rounded cobbles. A short distance below this hill a rounded boss of dark-gray gneiss shows distinct glacial grooves, trending S. 32° W. Three-quarters of a mile lower down the stream the water rushes over ledges of reddish gneiss, with a descent of eight feet, down which the empty canoe was run. The load was carried for 250 yards on the south bank along a sloping rounded hillside over broken fragments of slippery rock.

Sand plain.

The country now changes considerably, the rocky hills almost entirely disappear, and the river flows in a narrow crooked valley through a sand and gravel plain or terrace that rises forty feet above it. This plain gradually descends until, in latitude 55° 58′ 45″ it was found to be but three feet above the water. The river, 150 feet wide, here runs with an easy current in a channel overhung with willows.

One of the men was observed writing in syllabic characters on one of the trees, and on being asked what he had written he answered, "Namukakwé mechim" (no food at all). For the remainder of our journey to Ile à la Crosse we depended on ducks shot by the way.

Bold rocky shores.

Below this place, the sandy plain descends to the level of the river, which flows through a low marshy tract, until passing through a bed of reeds, it enters a lake with bold rocky shores. Three-quarters of a mile above the lake, the river impinges against the foot of a high ridge, running S. 15° W., of a medium-grained red granite, in places slightly foliated, and interlaminated with occasional bands of medium-grained dark-gray mica-diorite-gneiss. In the lee of the rocky hill boulders are scattered, imbedded in a fine white sandy clay or rock-flour. The lake is three miles and a-half long, the shore to the south-east being almost bare red granite, while the rocky hills to the north-west are generally covered with forest. Below the lake the river rushes down two rapids hardly a quarter of a mile apart, both over reddish gneiss. Past the first, the canoe was carried for 300 yards on the north bank, over stony land covered with scrub; and past the second it was carried for 500 yards on the south side over a ridge of gneiss, with low country on both sides.

Sandy Creek.

A mile and a quarter below the latter portage, past a narrow winding lake, Sandy Creek, a stream between twenty and thirty feet wide, flows in from the north; and three-quarters of a mile farther, below three short rocky rapids, is a portage eighty yards long on the south bank. On this portage, among woods of small white birch and stinking willow (*Viburnum lentago*) camp was pitched on the evening of the 12th of September in latitude 56° 3′ 35″.

River turns southward.

Below this camp the river continues to flow between rocky banks north-eastward for a mile and a-half, and then turns sharply south-ward to a heavy rapid where the water flows over red and dark-gray gneiss, striking S. 40° W. Here the canoe was carried for 380 yards on the west bank, along the foot of a hill of gneiss, over a soil of fine light-gray silt, made up chiefly of small angular grains of clear quartz. This fine sand lies in all the little depressions in the rock surface. Three-quarters of a mile lower is another short swift rapid, with a descent of five feet over reddish gneiss, past which the canoes were carried for 140 yards on the east bank, over gneiss and the soft gray silt.

High gneissic hills.

The river continues to flow southward with a decreasing current for three miles, until it empties into a narrow lake, three miles long, on each side of which are high gneissic hills, thickly wooded with small poplar and spruce.

Below the last lake, the river is again well-defined for two miles. In the middle of the distance it passes through a deep narrow valley, with thickly wooded slopes on each side, to a rapid over boulders with a descent of about fifteen feet. This rapid is passed by a portage on the west side 600 yards long, through thick woods over a narrow morainic hill, composed of boulders imbedded in the light gray silt. On the bank, at the foot of the portage, is a little gravel terrace. No rock in place is exposed in the vicinity.

Jumping-into-the-water Lake.

The river then opens into the northern arm of Jumping-into-the-water Lake. This lake is nine miles in length, gradually narrowing towards both ends, and bellying out towards the east, in the middle. Its northern end has rather low easily sloping shores, with some sandy beaches, while its southern shores are very rugged, steep barren rocky hills rising from the edge of the water. A point on a wooded island near its centre was found to be composed of highly garnetiferous biotite-gneiss striking S. 45° W., and dipping S. 45° E., at an angle of 73°. The rounded surface of this gneiss is much decomposed, but shows strong glacial grooves trending S. 40° W. Camp was pitched on the evening of September 13th near the south end of the lake, among small poplars, at the foot of a rocky hill of reddish-gray gneiss rather unevenly foliated S 35° W.

High wall of gneiss.

The river flows from the south end of the lake on the west side of a high abrupt wall of gneiss, and shortly afterwards tumbles down a heavy rapid over broken masses of gneiss to quiet water again. The canoe was carried for 300 yards on the east bank, through woods of small poplar and pine, over a soil composed of gray clay or silt, overlying a dark-gray rather irregularly foliated biotite-gneiss.

Last rapid on the river.

The next and last obstruction on this river is three miles lower down, where the water flows in a heavy double rapid with a descent of about twenty-five feet, chiefly over a bed of boulders. The canoe was carried past it for 300 yards on the west bank on a good track over a low hill of soft gray clay or silt. The surrounding country consists chiefly of high barren rocky hills.

Granite highly charged with pyrite.

Two miles lower, the river flows through a narrow rocky gap into the bottom of a deep bay of one of the lake-like expansions of Churchill River. On the west side of this gap is a steep rocky slope, underlain by a rather coarse plagioclase-granite often highly charged with pyrite. The pyrite has commonly been dissolved from the face of the rock, leaving a red or yellow porous mass and giving the whole face of the cliff a very rough spongy appearance. At a low point just outside the gap, a dark-green hornblende-schist lies in very irregular contact with the gneiss, and at an adjoining exposure the schist is irregularly cut by many veins of light red pegmatite. The surface of the rock here is scored by glacial grooves trending S. 35° W.

Foster River had now been descended throughout its whole course from Foster Lakes, a distance of ninety miles, and with a total descent of 400 feet. The journey through the unknown country south of Wollaston Lake had been accomplished, and it remained to return up Churchill River to Ile à la Crosse as quickly as consistent with the necessity of shooting ducks enough to furnish us with food by the way.

Churchill River.

The Churchill River had already been surveyed by Mr. T. Fawcett, D.L.S., and our survey was continued from the mouth of Foster River to a recognisable point on an island in Churchill River, after which our attention was devoted to sketching in additional topography along the line of Mr. Fawcett's survey, and examining the country at the portages, camps, and at any other points where we were obliged to land. End of survey.

After leaving Foster River, the high hills disappear, and the shores become lower and more gently undulating, rising in thickly wooded slopes from the rocky banks.

At the Lower Needle Falls, the water drops about four feet over a band of thinly and evenly foliated greenish-gray fine-grained biotite-gneiss striking S. 25° W. and dipping N. 65° W. at an angle of 80°, interlaminated with some swelling and contracting bands of red granite. The surface of this rock has been weathered into sharp rough points and edges, and on their account, the voyageurs, who were obliged to carry their heavy loads over it with feet bare, or at best protected by soft moccasins, gave it the name of Needle Portage. Lower Needle Falls.

The Middle Needle Falls are over the same thinly foliated gneiss containing a large number of quartz inclusions and associated with a rather fine-grained light reddish-gray quartzite. It is everywhere very much jointed and broken. Middle Needle Falls. At the Upper Needle Falls, the rock is a thinly foliated gneiss, irregularly interlaminated with bands of granite. Upper Needle Falls. Needle Lake is a considerable body of water extending a long distance south of the line of travel, while deep bays indent its northern shore. A few hills rise here and there, one extending east and another south of the lake, the latter having the appearance of a ridge of sand. The country is more or less generally wooded with small poplar and spruce. The shores towards the east are composed of dark biotite-gneiss, generally dipping at a low angle toward the west, and further westward this rock is replaced by a coarse red granite rising in barren rounded hills. At the west end of the lake the rock is a whitish, red-weathering, granular granite composed of quartz and microcline, in places showing a slight gneissic foliation. The surface is well rounded and smoothed, showing glacial markings trending S. 25° W.

Souris River. Souris or Mouse River, flows into Churchill River in a wide marsh, circling round the north-east end of a high range of hills of red gneiss, striking S. 30° W. Glacial grooves were observed in two places trending respectively S. 43° W. and S. 50° W.

A mile and a-half above the mouth of the river is an old fur-trading outpost, occupied only in winter.

Opposite the mouth of Trout Creek are three small parallel drumlin-like islands composed entirely of sand and boulders.

Souris Lake. Souris Lake is a long stretch of open water, the shores of which are for the most part well wooded with poplar. Occasionally low points of red gneiss may be seen here and there, but the beach is generally of sand and boulders, and most of the low hills that lie back from the shore seem to be of the same composition. Where we turned again into the river the lake continued southward beyond the limit of vision.

Snake Rapid. Snake Rapid, a mile and a-half long, over a bed of boulders, connects Souris and Snake lakes. On its north side is a sandy terrace fifteen feet high, which gradually rises until it seems to merge in a low hill of sand and boulders. On its south side is a low hill, the summit of which is a moderately level plain, covered with Archæan boulders chiefly of local origin. On the portage-track beside this rapid, an Indian living a short distance higher up the river had two large steel bear traps concealed and set, and some one of the party would have almost certainly been seriously injured but for a letter written in Chippewyan syllabic characters and hung on a pole warning everyone to "look out for the bear traps on the portage." Unless our men had been able to read Chippewyan, this letter would have been of little service in warning us of the danger.

Snake Lake. Snake Lake was crossed against a heavy west wind. No rock was seen, the surrounding country being composed of wooded hills of boulders, the highest being the ridge to the south-east of the lake.

A short distance above Snake Lake, the rock again makes its appearance, as a coarse red garnetiferous hornblende-gneiss, striking S. 30° to 35° W., and more or less nearly vertical. Below the mouth of Haultain River, it flows with a strong current through a wide marsh between long ridges of gneiss. Haultain River, where it flows into the north side of Churchill River, over a shallow bar of sand, is about 300 feet wide. Haultain River.

Lac de Geneau or Knee Lake is a large stretch of fairly open water, bent around a long narrow point extending towards the south-west. This point, and, in fact, most of the shore, consists of low hills covered with a forest of poplar, through which bare rounded points and knobs of gneiss project here and there. Between these points the beach is commonly strewn with boulders. Knee Lake.

The Lower Knee Rapid is a long shallow stretch of water flowing at first over a ledge of moderately coarse red gneiss, and then over a bed of boulders. The north bank is a cliff thirty feet or more in height, of light-gray sandy till, holding a large number of boulders and rising to an even sandy plain or terrace. The Middle and Upper Knee Rapids are around a long point of red gneiss, which becomes grayer and contains more plagioclase on its west side. Knee Rapids.

The shores of Lake Primeau are generally low and composed of reddish gneiss, rising to some rather high hills towards the north. Primeau Lake.

On the east side of Pelican Lake is a low point of reddish-grey gneiss wooded with poplar and willow. The surface is somewhat weathered, but it shows clear glacial grooves running S. 20° W., in which are many typical cross fractures opening southward. Here we heard shooting at the mouth of the river, about four miles distant, and crossing the lake, we came to a large band of Chippewyans on their way from Ile à la Crosse to their hunting grounds in the north on Haultain and Foster rivers. From them provisions were obtained sufficient for the remainder of our journey. Pelican Lake.

Pelican Rapids is a cascade with a descent of about eight feet over a red medium-grained biotite-gneiss, generally almost massive, but in places slightly foliated N. 50° W. The north bank below the fall is a terrace of sand and boulders twenty feet high. Pelican Rapids.

For several miles above Pelican Rapid, the river flows from the north-west with a moderate current, between low sandy banks overhung with willows, beyond which the country is wooded with poplar.

At the lowest Deer Rapid, on the south bank, is a rounded hill of coarse red gneiss striking S. 15° W., and dipping S. 75° E. at an angle of 60°. The surface is smooth, and in many places quite brightly polished, and up the stoss side and on the summit, fine and coarse Deer Rapid.

striæ can be clearly seen running S. 22° W. On a polished surface in a slight hollow on the summit, older striæ run south, but it is not probable that there is much difference in the ages of the two sets. Above this rapid, for half a mile, to the next rapid, the river flows from the south in a trough of this coarse red granitoid gneiss, the sloping rock on each side being beautifully smoothed and grooved all down its side, by the action of the ice-sheet, which moved directly along the axis of the trough.

Last exposure of Archæan rocks on Churchill River.

A short distance above this rapid, a hill of red granite rises on the south bank, being the last outcrop of Archæan rocks seen in the ascent of the Churchill River. A little higher up stream, the mouth of Mudjatic River was passed, and we were again in country that we had passed through nearly three months before.

Our circle of explorations through the country to the north had been completed, and we hurried on and reached Ile à la Crosse on the evening of the 20th September, just as a heavy equinoxial storm set in.

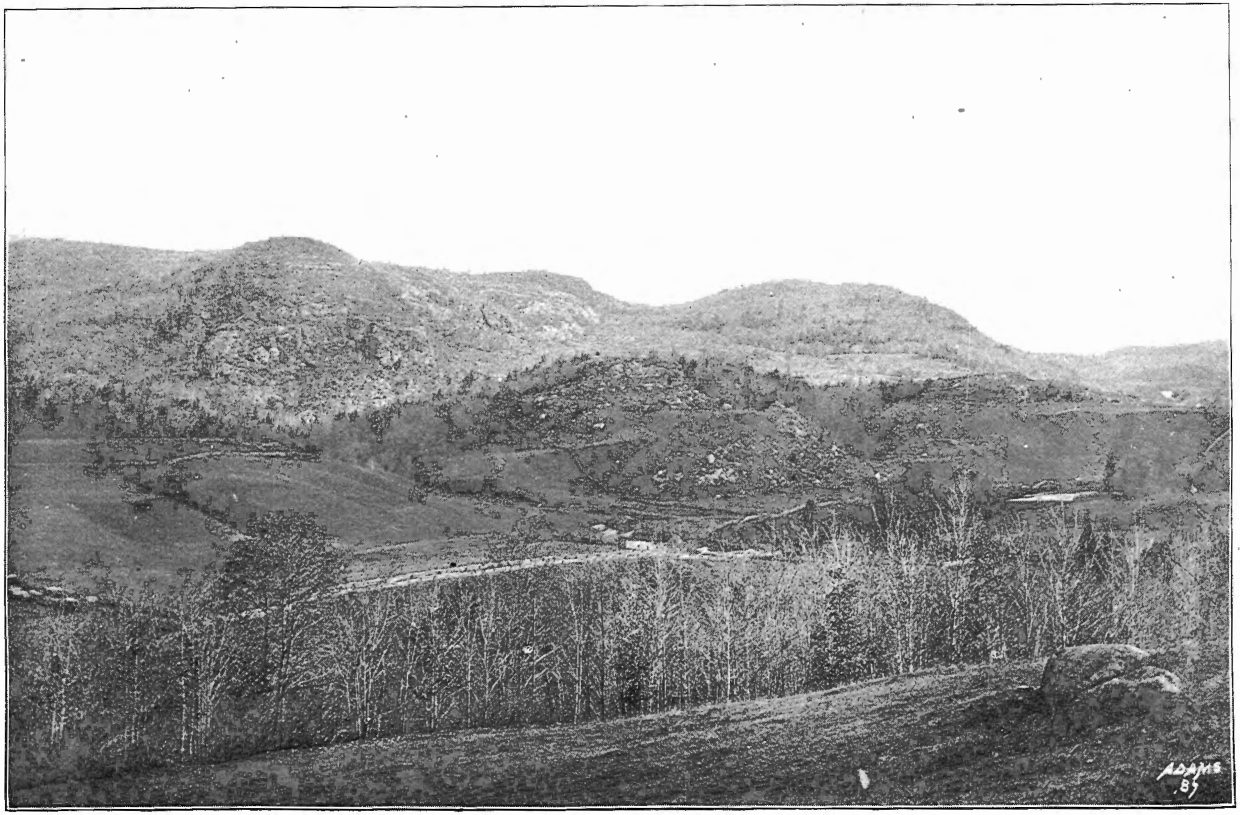


PLATE I.—CONTACT OF THE ANORTHOSITE AND GRENVILLE SERIES, AS SEEN FROM PIEDMONT, AUGMENTATION OF MILLE ISLES.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

GEOLOGY OF A PORTION OF THE LAURENTIAN AREA

LYING TO THE

NORTH OF THE ISLAND OF MONTREAL

BY

FRANK D. ADAMS, Ph.D., F.G.S., F.R.S.C.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1896

To George M. Dawson, C.M.G., LL.D., F.R.S.,

Director of the Geological Survey of Canada.

Sir,—I beg herewith to submit to you a Report upon the Geology and Economic Resources of that portion of the Laurentian region lying to the north of the Island of Montreal, together with a geological map of the same.

In the spring of 1885 I was instructed by Dr. A. R. C. Selwyn, then Director of the Survey, to undertake a detailed geological examination of this district, with a view to ascertaining the true character and relations of the great masses of anorthosite which occur in it and which had been supposed by Sir William Logan to constitute an upper member of the Laurentian system. These rocks, which are also very extensively developed in several other parts of the Laurentian, had attracted much attention on account of the large deposits of iron ore which they contain, but their true relation it was believed could best be ascertained in this district, which is for the most part comparatively easy of access, while forming as it does an eastward continuation of the Grenville district, previously mapped by Sir William Logan, it also promised to afford important additions to our knowledge of the Laurentian system as a whole. These expectations have, it is hoped, been in a measure realized.

The field work was carried out during portions of the summers of 1885, 1887, 1888 and 1889, and was completed in 1891 after the severance of my connection with the Geological Survey, to accept the Logan Professorship of Geology in McGill University.

The south-western corner of the area I have not studied, as no anorthosites occur there, and that portion of the sheet was carefully examined by Logan, being embraced in his map of the Grenville district, which appears in the Atlas accompanying the "Geology of Canada," and published in 1865. It has also quite recently been re-examined by Dr. Ells, to whom I am indebted for information concerning the distribution of the crystalline limestones in this portion of the area.

The north-west and south-west sheets of the "Eastern Townships" map, issued by the Geological Survey, and the Sectional Map of the Province of Quebec, published in 1894 by the Crown Lands Department of the province, have been taken as a basis for the topography of the accompanying map. It has, however, been corrected and supplemented by the more recent government surveys, as well as by extensive surveys of my own. The issue of a separate map to accompany the present report, is necessitated by the fact that the area described is unfortunately situated at the meeting of four sheets of the geological map of the Province of Quebec, now in course of preparation, two of which sheets cannot be completed for publication for some years yet.

The petrographical work in connection with the Report has been carried out in part at the University of Heidelberg and in part in the petrographical laboratory of McGill University.

Previous to the commencement of my survey, a certain amount of work had been done in this district, by various members of the Geological Survey, at different times. Short visits to certain parts of it had been made by Sir William Logan, Dr. Sterry Hunt and Mr. John Lowe, a number of localities being referred to by them in the early reports of the Survey. In the summer of 1880, Mr. R. G. McConnell mapped an area of considerable size lying to the southern portion of the counties of Berthier, Maskinongé and St. Maurice, a small portion of which is included in the present map. Mr. H. G. Vennor and Mr. Lewis R. Ord also examined portions of the district in 1879-80. A short statement concerning the work of these three gentlemen is contained in the Summary Report of the Operations of the Geological Corps, by Dr. A. R. C. Selwyn, 1879-80, pp. 3-5.

My warmest thanks are due to Prof. Rosenbusch of Heidelberg for aid and advice on many points connected with the petrography of this district; also to Prof. Carlyle, formerly of McGill University, now Provincial Mineralogist for British Columbia, who ably assisted me during the seasons of 1885 and 1887, as well as to Mr. Walter C. Adams, B.A.Sc., Mr. Nevil Norton Evans, M.A.Sc., and Dr. B. J. Harrington, for chemical analyses of rocks, and to Mr. G. H. Garden, C.E., and several other gentlemen who have assisted me in various ways.

I have the honour to be, sir,

Your obedient servant,

FRANK D. ADAMS.

MONTREAL, 25th June, 1896.

TABLE OF CONTENTS.

NOTE.—*The bearings given in this report are all referred to the true meridian.*

REPORT

ON THE

GEOLOGY OF A PORTION OF THE LAURENTIAN AREA

LYING TO THE

NORTH OF THE ISLAND OF MONTREAL.

Physical Features.

The continent of North America, as is well known, has been gradually built up by the accumulation of sediments, about certain very ancient land areas which now form the skeleton of the continent and are termed its Protaxes. Of these by far the largest and most important is the great Northern Protaxis, which forms the hilly and mountainous country bounding the plains of central Canada on the north, its southerly limit extending from Lake Superior in a north-easterly direction to the coast of Labrador, while in a north-westerly direction from that lake it runs nearly to the shores of the Arctic Sea.

Northern Protaxis.

This great core or nucleus of the American continent, lying almost entirely within the Dominion of Canada and embracing as exposed an area of some 2,001,250 square miles,* constitutes what the distinguished Austrian geologist Suess, has termed "The Canadian Shield" or "Boss," of the earth's crust, as well as the more mountainous stretch of country along the Labrador coast, and is composed exclusively of very ancient crystalline rocks.

The district covered by the present Report forms a portion of this Protaxis, being situated at its southern edge, which here runs nearly parallel to the course of the River St. Lawrence and is about twenty miles north of the Island of Montreal, as shown in the accompanying map, which comprises an area of 3258 square miles, situated in the counties of Argenteuil, Terrebonne, Montcalm, Joliette, L'Assomption, Berthier and Maskinongé, in the province of Quebec.

*This does not include the outlying and separated Archæan areas, occurring in Newfoundland, and in the States of New York and Michigan, and is based on the supposition that the limits assigned to the nucleus in the imperfectly explored regions of the far north by Dr. G. M. Dawson are correct. *See* G. M. Dawson, Notes to accompany a Geological Map of the Northern Portion of the Dominion of Canada, Annual Report, Geol. Surv. Can., vol. II. (N.S.), 1886.

Aspect of its relief.

In the aspect of its relief, the district embraced by the accompanying map presents a well marked division into a great plain which stretches across its southern portion, occupying the valley of the St. Lawrence, and which is underlain by Palæozoic strata of Cambro-Silurian age, and a hilly or mountainous district composed of Archæan rocks to the north.

From the St. Lawrence the plain gradually rises to the north-west, attaining in the present area at its northern limit, a height of about 300 feet above the St. Lawrence at Montreal. It is usually covered with a heavy mantle of drift, so that over large areas no exposures can be found, and is well watered, fertile and thickly settled by an industrious and thriving agricultural population.

Rising abruptly from this plain, the Archæan appears as a line of hills, stretching across the country and forming a very well marked topographic feature. These hills are distinctly visible from "Mount Royal," on the slopes of which lies the city of Montreal in the extreme south-east corner of the sheet, as one looks to the north on a clear day.

The appearance which they present when seen from the plain at a distance of a few miles is shown in the accompanying sketch, taken from near the southern corner of the township of Brandon (Plate II).

These hills really constitute the edge or southerly limit of a great uneven plateau, which, however, like the plain, rises gradually to the north-west.

Elevation of plateau.

Roughly speaking it may be said that, if a line be drawn across the plateau, parallel to the northern edge of the plains, and about half way between the plain and the north-west corner of the sheet, the district to the south of this line would have an average elevation of about 1000 feet, while to the north of it the country frequently attains an elevation of 1500 feet, or to the extreme north-west, of 1900 feet. Isolated hills rise still higher, as, for instance, Trembling Mountain (Plate II.), which is probably the highest point in the district, and which attains a height of 2380 feet above sea level. Logan in 1858 measured trigonometrically the height of Trembling Mountain above Trembling Lake and found it to be 1713 feet. A barometic determination by Dr. Ells and myself gave the height as 1720 feet. Logan's estimate of the total height of this mountain as "about 2061 feet above Lake St. Peter," is, however, too low, as the railway at Chute aux Iroquois is 726 feet above Montreal and Trembling Lake is 90 feet below Chute aux Iroquois.

Trembling Mountain.

The hills about Ste. Agricole also, on a moderate computation, must attain a height of 2100 feet, the central portion of the township of

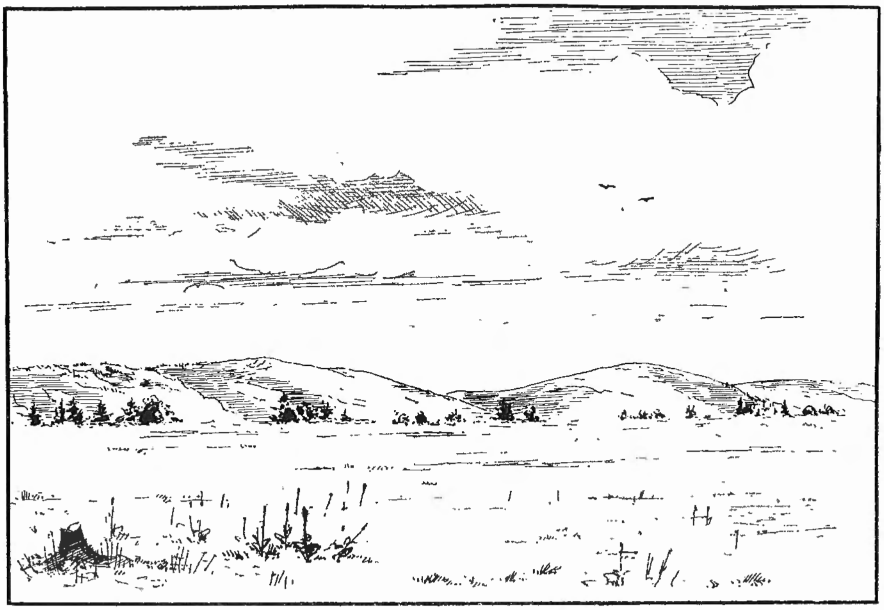


FIG. 1.—LAURENTIAN HILLS, FORMING THE EDGE OF THE NORTHERN PROTAXIS, NEAR SOUTHERN CORNER OF THE TOWNSHIP OF BRANDON.

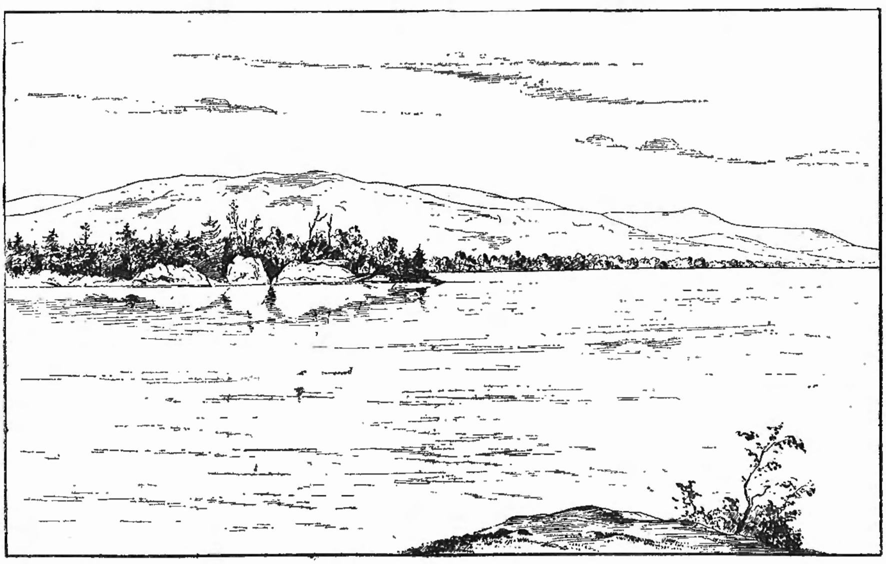


FIG. 2.—TREMBLING MOUNTAIN, AS SEEN FROM SOUTH-WEST SIDE OF TREMBLING LAKE.

PLATE II.

Archambault, in which this place is situated, being occupied by the "Montagne Noire," which is so rugged that in laying out the township, it was left entirely unsurveyed.

This Archæan plateau has a remarkable mammillated or undulating surface, the depressions being generally filled in with drift, forming extensive flats which are studded with numerous lakes, great and small, filled with clear water and forming one of the most characteristic features of the country. Rounded, ice-worn bosses or hills, protrude through the drift in every direction. These seldom rise to a height of more than three or four hundred feet above the average level of the country, and present, especially where the district has been traversed by forest fires, great faces or whole summits of bare rock. The lakes are drained by several rivers tributary to the St. Lawrence, that run through drifted valleys of which the sides are usually beautifully terraced.

Character of country.

The landscape in this Laurentian country is of a very pronounced type, which, while lacking on one hand the grandeur and sublimity of the great mountain regions of the world, and on the other, the tranquil beauty of well cultivated lowlands, has a certain rugged beauty of its own, and when clothed with the autumn foliage, a remarkable brilliance. Although the slopes of the hills are often cultivated, it is principally the depressions and river-valleys that afford land capable of settlement and suitable for agricultural purposes. The settlements therefore are, and must of necessity always be, more scattered than those on the plain, and the land although producing excellent crops in many places, is generally sandy and less fertile than that of the plains. The country, however, now supports a hardy and contented population of farmers, which, except in the south-west corner of the district is almost exclusively of French extraction, and settlements are, year by year, extending further back into the hitherto unreclaimed forests of the north.

Heights of important points.

The following is a list of the heights of some of the more important points in the area. These, with the exception of that of Trembling Mountain, before referred to, have been determined by instrumental levelling, carried out in connection with the construction of the Canadian Pacific, the Montreal and Western, and the Great Northern railways. The datum line adopted is that of the Canadian Pacific Railway, which is 19 feet above the old lock-sill at the entrance of the Lachine Canal in Montreal Harbour. This datum line is 30·61 feet above Steckel's mean level of the Gulf of St. Lawrence. In the following table this correction has been applied, 31 feet being added in each case to the height of the point as given by the railways.

Altitude of various Points on the lines of the Canadian Pacific, the Montreal and Western, and the Great Northern Railways above Steckel's mean level of the Ocean in the Gulf of St. Lawrence:—

Grenville	221	feet.
Lachute	241	"
Ste. Thérèse	126	"
St. Jérôme	314	"
Shawbridge	605	"
Montfort Junction	531	"
Piedmont	555	"
Ste. Adèle	641	"
Ste. Marguerite	911	"
Deep Rock Cut (M. & W. R. R.)	1031	"
Lac la Fourche	1014	"
Ste. Agathe	1243	"
Summit near St. Faustin	1406	"
St. Faustin	1261	"
St. Jovite	711	"
Lake Sam (surface)	750	"
Chute aux Iroquois (rail level)	757	"
Three Sisters' Rapids (low water)	728	"
Trembling Mountain	2380	"
Ste. Sophie	274	"
New Glasgow	367	"
Bank of River Ouareau, 300 feet above the bridge—McLaren's Mills, Grande Ligne	266	"

ARCHÆAN GEOLOGY.

GENERAL STATEMENT.

General statement.

That portion of the area occupied by the Archæan, is underlain for the most part by a series of gneisses, presenting great variations in both structure and composition, and with which are associated crystalline limestones, quartzites, &c. These belong to the *Grenville Series* of Sir William Logan,* and are of Laurentian age. In certain parts of the area, however, there are great stretches of orthoclase-gneiss much more uniform in character and without limestones and quartzites. These are referable, in some cases at least, to the *Fundamental Gneiss* of Logan, which was by him believed to underlie the Grenville series and to form the basal member of the Laurentian system.

* Geology of Canada, 1863, p. 839.

Breaking through these gneisses and in some cases interbanded or interstratified with them, are several anorthosite masses, by far the largest of these being that which for purposes of convenience may be termed the Morin anorthosite, and which comprises an area of 990 square miles. Two important intrusions of acid rocks, one of granite and the other of syenite also occur in the district.

In the present report the anorthosites are shown to be intrusions, and are separated from the Laurentian proper. The name Laurentian is therefore made to embrace the Fundamental Gneiss, which, although, so far as can be ascertained at present, essentially igneous in origin, may possibly contain some sedimentary material, and the Grenville Series, which is composed of altered sediments associated with much injected igneous matter.

The Laurentian Gneisses and their Associated Rocks.

STRATIGRAPHICAL RELATIONS.

Grenville Series.

The rocks composing the Laurentian in this portion of the Protaxis, usually possess a more or less distinct arrangement in the form of bands, layers or beds which alternate with one another. That a purely objective attitude may be preserved the term band rather than bed will be employed, the latter term being usually associated with the idea of a sedimentary origin which in the present case should not thus be taken for granted.

Banding of the rocks.

This banding is frequently replaced by a foliation caused by the parallel arrangement of the individual grains of the several constituents of the rock, without any distinct arrangement of these latter in bands. In any district where banding and foliation occur together they usually coincide in direction, and are often found in the same rock.

In the eastern portion of the area, in the townships of Joliette, Brandon, Peterborough and Chapleau, as well as in the country to the north of these townships, these Laurentian rocks lie flat or nearly so. Further west, as shown in the sections accompanying the map, a series of low undulations appear, while in the western portion of the area they are thrown into a series of sharp folds with nearly vertical dips, the strike varying in different places from north-east to north-west.

Flat-lying gneisses.

The eastern area of flat-lying gneisses, with occasional intercalated bands of crystalline limestone and quartzite, extends far beyond the limits of the map to the north-east, occupying in this direction a very large district traversed by the River Mattawin, the Rivière du Loup and other smaller streams, which cut their way down these nearly horizontal rocks, and along whose banks, from time to time, as well as in the cliffs bordering many of the little lakes drained by these streams, good sections, often representing a vertical thickness of from two to three hundred feet, are obtained. On the more level surface of the country on the other hand, the rocks exposed are of course comparatively uniform in character. Over this tract of country, embracing an area of at least 750 square miles, the gneisses often lie quite flat, while low dips seldom exceeding 30° everywhere prevail. In several localities the direction of dip varies rapidly from place to place, low undulations in the flat gneisses being observed, running now in one direction and now in another. The whole area gives the impression of a comparatively thin crust, which has rested upon or has been sustained by an underlying molten or fluid mass.

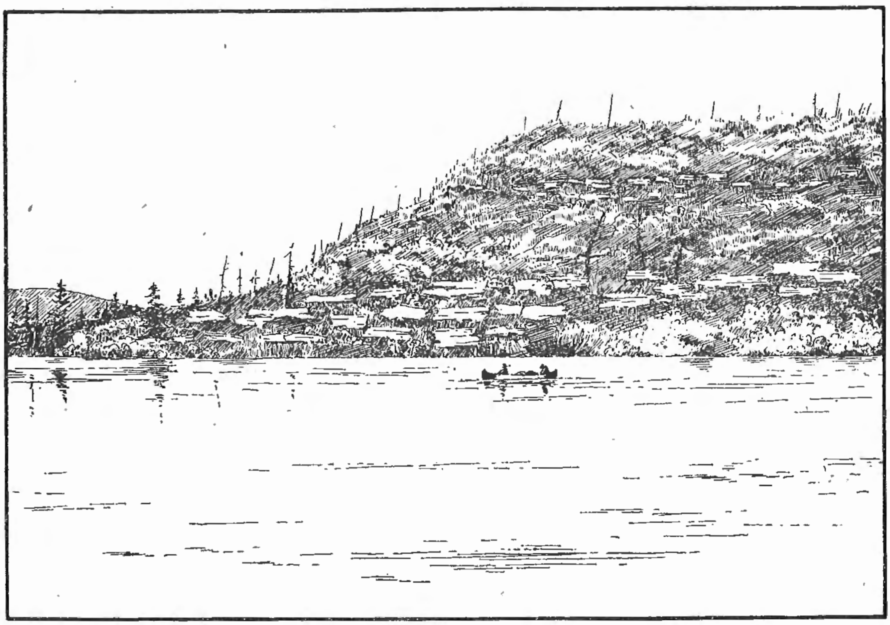


Figure 1.—Horizontal Gneiss, near Cedar Rapids, River Mattawin, Que.

Granite batholite.

That this in all probability was really the case, is shown by the appearance from under the gneisses, in the southern part of this district, of a great area of granite, a portion of which is seen in the north-east corner of the map. This would seem to represent a very extensive batholitic mass of granite underlying the district in question at no very great depth beneath the surface, and here partially exposed by erosion.

Plate III.—CLIFF OF WHITE GARNETIFEROUS QUARTZITE, INTERSTRATIFIED WITH GARNETIFEROUS AND RUSTY-WEATHERING GNEISS—2 MILES N.W. OF ST. JEAN DE MATHA.

Figure I. represents a sketch, showing a cliff of these nearly horizontal gneisses just below the Cedar Rapids, on the River Mattawin, about 20 miles beyond the northern limit of the accompanying map.

Plate III. is a photograph of another cliff, consisting in this case of white garnetiferous quartzite, interbanded with garnetiferous sillimanite gneisses, within the limits of the map, about 2 miles north-west of St. Jean de Matha.

In the area embraced by the map, limestones have not been found in the Laurentian to the east of Ste. Emilie or Ste. Beatrix, but in the extension of this district to the north beyond the limits of the map, bands of crystalline limestone have been found at a number of widely separated points in the flat-lying gneisses along the River Mattawin and about the head-waters of the Rivière du Loup. At one locality three miles north-west of the Lacroix Rapids, on the Mattawin River, reddish and grayish gneisses with interstratified quartzites occur in horizontal layers, with bands of white crystalline limestone, in some places quite pure and elsewhere holding grains of serpentine and scales of mica. At one place, in a cliff by the side of a lake, several limestone bands were observed, one above the other in the same exposure. Three of these had thicknesses of three, four and eight feet, respectively. At another point half a mile distant, two bands of limestone were seen in a similar exposure, the upper being six feet thick, while the lower was exposed for a thickness of twenty feet, the lower limit not being seen. These bands could be traced horizontally in the face of the cliff for a distance of half a mile.

Crystalline limestones.

Between Ste. Emilie, Ste. Beatrix and Radstock on the east and the Morin anorthosite on the west, the Laurentian is thrown into a series of folds, which toward the south are overturned, and in this district crystalline limestone is exposed at a number of points. Most of the exposures, however, seem to be parts of a single band repeatedly brought up by the folding, and coinciding in strike with the surrounding gneiss. (See the sections accompanying the map). Some large bands of anorthosite also occur in this district. Toward its southern limit along the edge of the Palæozoic, in the townships of Rawdon and Kildare, the gneiss strikes nearly north-and-south, but going north along the eastern limit of the Morin anorthosite, the strike gradually turns more and more to the west; the gneiss wrapping itself around the anorthosite mass, until at Lac des Iles it strikes N. 75° W.

Strike of gneiss conforms to anorthosite boundary.

In the great block of gneiss which extends into the anorthosite from the north, and in which lie the valleys of Lake Archambault, Lake Ouareau and a number of smaller sheets of water, a similar coincidence between the strike of the gneiss and the direction of the anorthosite boundery is observed. North-east of Lake Croche and on the north-east arm of Lake Ouareau the strike averages about N. 20° E., while on the west side of Lake Ouareau north of St. Donat and about Lake Lafronay, which is situated about the middle of the township of Lussier, it averages about N. 55° W. This strike to the east of north is confined to the immediate westerly margin of the anorthosite, as on the north-west of Lake Croche it has already veered around to the west again.

Determines course of streams.

The influence of the strike of the gneiss on the shape and position of the lakes and on the course of the streams is also very marked in this district, being especially well seen as determining the course of the River L'Assomption and the shape of Lac des Iles, Lake Croche, Lake Lafronay and Lake Pembina. Also in the forking of Lake Ouareau, corresponding to a change of strike, in the course of the River Ouareau between Lake Archambault and Lake Ouareau and in the position of Lake Archambault itself.

In the north-west corner of the map the strike of the gneiss continues to follow the outline of the Morin anorthosite mass, being N. 20° E. on the Devil's River, just north of the anorthosite contact, and N. 5° W. in exposures about two miles from the forks of the river, further south in the township of Grandison.

Further south in the township of Wolfe, the gneiss is more masive, so that it is difficult to ascertain the strike, but at Lac Gauthier, on the line between Grandison and Wolfe, it is N. 20° E., still following the line of contact. Over the greater portion of the Augmentation of Mille Isles, further south, there is a general north-easterly strike, which, however, in the vicinity of the Lakefield anorthosite mass, veers around to the north-west, following the course of the mass in question.

Between St. Jérôme and New Glasgow the strike, which is at first north-easterly, swings around to the north as the latter place is approached, while to the east of New Glasgow, a wedge of gneiss striking to the north runs up into the Morin anorthosite for a distance of fifteen miles, splitting it in two just before it disappears beneath the Palæozoic strata of the plains.

Foliation induced by pressure.

In certain parts of the Morin anorthosite mass, as will be explained, a foliation has also been induced by pressure in the anorthosite itself, which can be shown to have been originally a coarse-grained massive rock. This foliation also runs parallel to the limits of the mass, except along its southern boundary about St. Sauveur, where the anorthosite cuts across the gneisses and limestones of the Grenville series, the strike of the foliation being continuous across the boundary from the gneiss into the anorthosite.

It thus becomes evident that, with the one exception just mentioned, the foliation of the gneiss runs around the anorthosite mass, following the windings of the boundary, and that it is not entirely an original structure, in consequence of which the anorthosite mass took its present outline, but it is in part at least secondary, having been caused by the great pressure to which both rocks have been subjected subsequent to the intrusion of the anorthosite mass, which pressure has induced a certain amount of motion in both rocks. This motion has been accompanied by a certain stretching, dragging, or flowing of the gneissic series along the edge of the anorthosite, as seen especially well in the abrupt change in strike of the gneisses along the immediate margin of the anorthosite mass about Lake Croche and to the north-east of Lake Ouareau.

Stretching of the gneissic series.

That a stretching of the gneissic series has taken place, is also clearly proved in many places where the ordinary quartzose orthoclase-gneiss alternates with bands of dark pyroxene-granulite or amphibolite. In such cases the dark bands are often seen to have been pulled apart, the disconnected pieces being arranged in lines following the strike of the rock, and can be plainly seen by the fact that the ends of adjacent pieces match one another, to have originally formed parts of the same band. The accompanying sketch taken from an exposure on the Cypress River, a short distance beyond the northerly limit of the map, shows this excellently. Here there are large exposures of fine-grained reddish quartz-orthoclase-gneiss, with bands of a dark pyroxene-amphibolite, the whole series being much stretched owing to a great curve or sweep in the strike of the gneisses of this district, whereby they are bent back upon themselves. By this stretching the amphibolite bands have been torn apart as seen in Figure 2, while the quartz-orthoclase-gneiss possessing a certain degree of plasticity, not only stretches, but fills up the spaces between the disconnected fragments of the amphibolite bands.

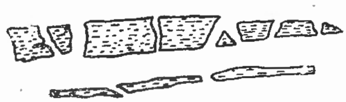


Figure 2.—Bands of Pyroxene-Amphibolite in Quartz-Orthoclase-Gneiss, torn apart by the stretching of the series. Cypress River. Scale, 1 inch to two feet.

The same phenomenon has been observed in hundreds of cases, not only in the area at present under consideration, but elsewhere in widely separated parts of the Laurentian. If the pressure is so intense that any member of the series is torn apart, it is always the basic rock which shows itself to be the less plastic, while the highly quartzose rocks accommodate themselves to the strain by plastic movements. Sometimes, however, these basic rocks themselves suffer a very considerable amount of stretching before they break. This stretching can be observed occasionally in the nearly flat gneisses of the eastern part of the district embraced by the map, the fragments here moving apart in a horizontal direction as from a horizontal disrupting force, such as might be exercised if the gneisses had been stretched over the underlying granite batholite, either by a downward pressure due to a great weight of overlying rock, since removed, or by an upward force exerted by the rise of the granite magma.

Tearing apart of basic bands.

In the folded portion of the district further to the south-west, this tearing apart of the basic bands becomes more marked and very striking and seems to be the invariable rule whenever rocks of this character are associated with quartzose gneisses and the whole series is bent or twisted.

The same phenomenon is very well seen in the case of the thin bands of gneiss, so frequently found interstratified with the limestone bands. Here the limestone under the influence of pressure is the more plastic of the two rocks, and the gneiss, also plastic to a lesser extent, is bent into curiously complicated forms, but when the movements become too great is torn apart into curved and crumpled fragments, which, standing out from the weathered surface, give the rock a very remarkable and characteristic appearance.

Faults.

It may appear somewhat remarkable, in view of the folding to which these rocks have been subjected, that faults are not more numerous. They seem, however, to be rare, although in such areas of contorted crystalline rocks, their existence is not easily determined. Only two were noted, although the existence of others was conjectured. The first of these is at the dam on the River Ouareau, where it flows out of Lake Ouareau. Here, two masses of red orthoclase-gneiss, with interstratified quartzite bands, come together, one set striking N. 10° W. and the other N. 40° E., both having a high south dip. This it will be noted is a portion of the area where the compression of the gneiss must have been especially severe, the ordinary north-westerly strike of the country-rock being changed to a north-easterly strike along the margin of the anorthosite mass. The second fault which was noted is on the road between New Glasgow and St. Calixte de Kilkenny, about six miles in a straight line from the former place, and at the contact between the gneiss and the anorthosite, where a fault probably occupies the bed of the River Achigan, one conspicuous band of gabbro running up to the river and there disappearing.

The fact that these rocks have been folded rather than faulted, does not seem so remarkable when it is remembered that the movements to which they were subjected were brought about when the rocks were deeply buried and hence heavily loaded. Heim has shown folding rather than faulting to be the result of such conditions in the Alps. The fact that the rocks, when subjected to these movements, were in a highly heated condition, as will be shown in treating of the anorthosites, probably contributed to the same result. Conditions of faulting.

The alternation of the various varieties of orthoclase-gneiss with one another is especially well displayed in the township of Brandon where also there are very numerous and heavy bands of pyroxene-granulite, as well as several bands of anorthosite (p. 126 J) conforming to the general strike. The township, therefore, merits a short, special description.

The first ten ranges are for the most part cleared and settled, while the last two ranges are still largely under forest, the country rising to the north and being there more rugged. Unfortunately much of the south-eastern part is heavily drifted so that over considerable areas no exposures can be seen. A striking feature of the eastern part of the township is the beautiful stretch of water known as Lake Maskinongé, with its extensive valley of flat drift extending northward through the 8th and 9th ranges and indicating a much greater extension of the lake in this direction in post-glacial times. Lac Corbeau and Lac Noir have also, as seen in the presence of similar drifted valleys, been much larger sheets of water in former times. The township is traversed by numerous roads which afford means of access to almost every part of it, and owing to the way in which it is laid out, the ranges running north-east and south-west, while the rocks strike north-west, the roads running between the ranges afford a series of lines of section directly across the strike.

In geological structure the township may be divided into two parts, one consisting of the north-west two-thirds and the other of the south-east portion comprising the remaining one-third. The north-west portion is occupied by a flat syncline, the rocks striking north-west, those of the eastern half of the township dipping at low angles, averaging about 25°, to the south-west, while those in the western half dip to the north-east at angles of about 15° (see accompanying section, Fig. 3.) In the two upper ranges, the strata over considerable areas are quite flat, and no dip exceeding 15° was anywhere observed. In addition to the regular north-east and south-west dips above mentioned, Township of Brandon.

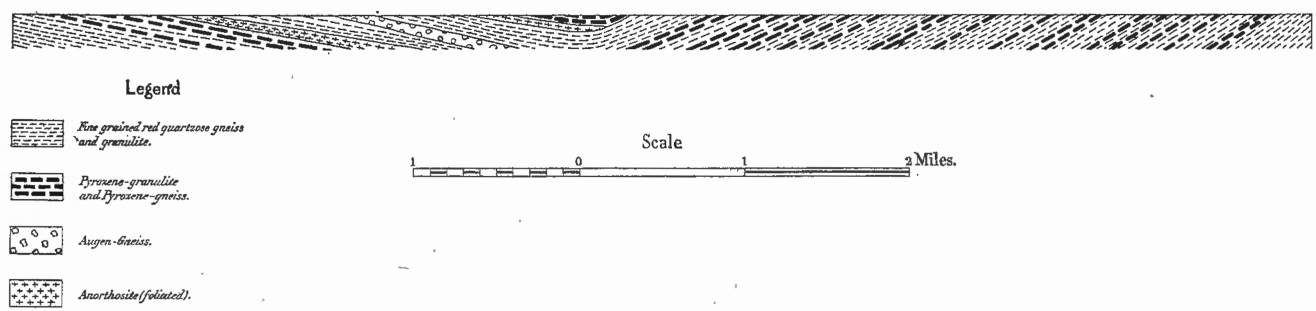


Figure 3.—Section across Township of Brandon on line between Ranges VIII. and IX

slight undulations of the strata in the direction of the strike are often seen, so that in isolated exposures dips to the north west or south-east can occasionally be observed.

The rocks occupying this syncline consist of gneisses in great variety, fine grained granulites and leaf-gneisses, augen-gneisses, garnetiferous gneisses of various kinds, with occasional silliminate-gneisses. Also heavy bands of pyroxene-granulite and pyroxene-amphibolite, with bands of quartzite and three bands of anorthosite. A section across the township along the line between ranges VIII and IX. a distance of eight miles, is seen in Figure 3, and detailed petrographical descriptions of the several rocks are given on pages 38 J, 76 J. These various rocks have the form of distinct bands which are usually sharply defined. No limestone occurs in this township. The rocks, as for instance granulite and pyroxene-granulite, often alternate in bands much too thin to be separately mapped, and the individual masses, even if of large size, frequently pinch out or alter their character in the direction of the strike, and the drifted character of the basin of Lake Maskinongé renders it impossible to ascertain whether the several groups of rocks recognized in the western half of the section reappear in regular order to the east of the synclinal axis. The anorthosites, however, were nowhere observed on this side, which indicates that they are not interstratified layers but rather squeezed out intrusive masses and the exposures which are seen on the eastern half of the section indicate that the rocks here present fewer varieties. It is probable, however, that the fact that certain well-defined bands which appear in the western half of the section do not reappear to the east of the synclinal axis is due to the series being essentially a rolled out complex of igneous masses. Rocks occupying syncline.

The exact thickness of the "strata" represented in this north-west portion of the township is not known, but, as has been mentioned, the country gradually rises to the north, and it was ascertained by direct measurement (aneroid), that starting from the edge of the drift-filled basin of Lake Maskinongé, at lot 6 on the concession line between ranges IX. and X., and going north to a point about the middle of lot 1 of range XII., the ascent is made over 540 feet of nearly horizontal strata; if the average dip of these be taken at 15° this alone would represent a thickness of 522 feet.

The evidence here, as in other parts of the area where the gneisses are approximately horizontal, goes to show that although the bands are not flexed and contorted they have been subject to great vertical compression. The various rocks are quite as highly crystalline as in the more contorted districts, the anorthosites show evidence of very great crushing since they were injected, and the gneisses themselves under the microscope show very marked cataclastic structure.

Granite mass

The south-east portion of the township is quite different in structure At the extreme south-east corner is a small area occupied by a portion of the great granite mass which occurs along the eastern side of the sheet. It is coarse in grain and sometimes possesses an indistinct foliation.

Limiting this granite on the west is a band of fine-grained granite about a mile and a half wide. It is quartzose and reddish in colour, almost free from mica or other iron-magnesia silicates, and nearly uniform in grain and composition.

In many places one can observe little local irregularities in grain such as are often seen in granite apophyses, and it frequently holds large orthoclase phenocrysts like the coarse granite to the east. In many places an indistinct foliation can be seen, and it often holds little strings and sometimes apparent fragments of white quartzite and of a dark basic rock, usually coinciding in direction with the indistinct foliation above mentioned, which is about N. 5° W. and parallel to the limit of the coarse-grained granite. This fine-grained granite is apparently a contact phase of the coarse granite, the transition, however, being very rapid, since on lot 1 of range III. the two can be seen within a few yards of one another. An actual contact or passage between them was nowhere observed. The western limit of this fine-grained granite, on the line between ranges I. and II., is about the east half of lot 8. To the west of this the fine-grained granite is succeeded in the following lot by a well-banded grayish gneiss, striking N. 10° W. and dipping to the east at an angle of 65°. In this area are many dykes, veins or bands of granite, often very coarsely grained as is so generally the case in pegmatite apophyses, sometimes running parallel to the banding of the gneiss and elsewhere across it and anastomosing with one another. This gneiss is exposed at frequent intervals along the road for a distance of rather over three miles from the fine-grained granite, but is usually reddish in colour and holds bands of quartzose and hornblendic gneiss, frequently broken up into fragments, which, although in many cases evidently having formed parts of the same band, now lie in the reddish gneiss separated from one another. This reddish gneiss in many places resembles the fine-grained granite and is almost free from iron-magnesia minerals. The strike of the gneiss varies very much in different places, and even in the same exposure. It, however, always dips in an easterly direction or towards the granite, and always at very high angles of from 65° to vertical. From the last exposure of the gneiss on lot 17 to the western limit of the township, there are no other exposures, the country being heavily drifted.

In the south-east corner of the township, therefore, we have the edge of a great mass of granite flanked by a band of much finer grained granite, and beyond this a series of highly tilted gneisses, which have been much disturbed, and penetrated by granite veins or dykes apparently apophyses from the main mass, the series being entirely different both in character and attitude from the well-banded gneisses of the flat syncline occupying the north-western portion of the township. Between these two areas the township is under heavy drift, so that the actual relation of the two sets of gneisses to one another is obscured. It would seem, however, that they must be separated by some stratigraphical break, either a fault or an unconformity. It may be noted that if a line be drawn from the most westerly exposure of these south-eastern gneisses, on lot 17, to the northern point of Lake Maskinongé, it will divide the two series from one another, and such a line would also run nearly parallel to the limits of the granite mass.

The north-western gneisses belong to the Grenville series; whether the south-eastern gneisses should be referred to the "fundamental gneiss" or not is uncertain.

Crystalline limestones.

Among the most important constituents of the Grenville series, not so much on account of their volume as owing to their economic value and the genetic considerations attached to them, as well as to the aid which they afford in working out the stratigraphical relations of the series, are the crystalline limestones. The existence of bands of crystalline limestone in the flat-lying gneisses, beyond the north-eastern limit of the map, has already been referred to, but within the area embraced by the map, although not observed in the nearly horizontal gneisses of the north-eastern district, crystalline limestone is repeatedly exposed elsewhere, as will be seen by consulting the map, being brought up by the folding of the gneisses in the more contorted parts of the area.

In south-we portion of area.

The south-western portion of the area embraced by the map, as has already been mentioned, was included in a "Map Showing the Distribution of the Laurentian Rocks in Parts of the Counties of Ottawa, Terrebonne, Argenteuil and Two Mountains," by Sir William Logan, published in the Atlas accompanying the "Geology of Canada," which appeared in 1865. In the map accompanying the present Report, the distribution of the limestones in Montcalm, Morin, the Augmentation of Mille Isles, and in the district to the south-west has been taken from this map. In the area worked out by Logan, which, however, lay principally beyond the western limits of the present map, he believed that the existence of either three or four distinct limestone bands of considerable size, at widely separated horizons, could be established with tolerable certainty. Dr. Ells, however, who has recently re-examined this district, and whose report will appear shortly, doubts the correctness of these views, and believes that the limestones are concentrated towards the summit of the series. The character and distribution of the limestones in this portion of the area being described in the reports of Logan and Ells, need not here be further referred to.

In the north-west corner of the area, the Laurentian is represented by reddish and gray gneisses, often rich in quartz and well foliated, which on the Devil's River are occasionally garnetiferous and associated with quartzites. This district is a good deal drift-covered, and no crystalline limestone was observed in place, but a large angular block of this rock found by the side of the Devil's River, about the northern limit of the map, indicates that bands of this rock do occur here associated with the gneiss.

Crystalline limestone of Trembling Lake.

A heavy band of limestone runs through Trembling Lake, which lies immediately west of Trembling Mountain, being exposed on the islands in the lake as well as at its outlet. Crystalline limestone is also exposed at several points in the vicinity of St. Jovite, in the township of De Salaberry, but the heavy drift which mantles this portion of the country renders it impossible to ascertain the extent and distribution of the rock.

In that portion of the district to the east of the Morin anorthosite, it was also believed at first that some five or six different bands of limestone existed, but the result of a detailed study goes to show that the three principal bands at least are probably repetitions of one and the same horizon, being related to one another as shown in the sections accompanying the map.

The course of the several lines of outcrop of these eastern limestones may be briefly indicated.

Crystalline limestone near St. Jérôme.

There is first a small and comparatively unimportant occurrence on the west side of the North River, near St. Jérôme. Exposures of the limestone are seen crossing the road, and blocks of it may be found at intervals in the fields to the south of the road. Logan states that it can be traced for about a mile and a half, running in a direction

N. 12° E. Although the surrounding country was carefully examined, no actual exposures of this limestone could be found, except those above-mentioned. In the direction of its strike to the south, it would cross the North River and be covered up by the Cambro-Silurian rocks within the next half mile. It does not appear on the banks of the river, however, neither could any continuation of it be found to the north.

A more important occurrence of limestone, although still comparatively thin and impure, is found a short distance to the west of the village of New Glasgow, being exposed in the bed of the River Jordan and near the Cambro-Silurian contact. From this point it can be traced in a direction a little east of north, skirting along the edge of the great anorthosite arm, as far as range III. of Kilkenny, a distance of about six miles, where it is lost sight of. Near New Glasgow.

An isolated exposure of a pure white crystalline limestone occurs on lot 10, range VII., of Kilkenny, where it forms a low ridge about a hundred yards wide. This, however, is probably distinct from the New Glasgow band, which, if it holds its course as above described, would be cut off by the anorthosite a short distance to the north of the point where it is last exposed. It certainly is cut off by the anorthosite eventually, for the latter on the north passes across the strike of the gneissic series. What may be a continuation of this same limestone band, however, appears on the other side of the anorthosite mass, at Lake Ouareau. The most northerly point at which the limestone is here exposed, is a slight elevation rising above the drift on the Couture Road, on lot 20, range II., of Lussier. Following the prevailing strike, it appears again to the south-east, in Lake Ouareau, forming a series of little islands, which lie along the west shore of the lake. On one of these, which is composed exclusively of white crystalline limestone, with many little inclusions of gneiss produced by the tearing apart of narrow bands in the manner already described, the strike is about N. 75° W., and the limestone is exposed for a width of 275 yards across the strike. This is not the whole width of the band as the exposure is bounded by the waters of the lake on either side. The band then appears on the east shore of the lake, near its southern extremity, where it has a width of about 200 yards. The southern portion of the lake is, in fact, excavated in a band of limestone, interstratified with white quartzite and certain gneisses which are almost invariably found associated with the limestones, which band, being very near the border of the anorthosite mass is, at many places all about the lake, invaded by and mixed up with anorthosite, which is At Lake Ouareau.

often intruded parallel to the foliation of the gneiss, and often has a more or less distinct foliation accompanied by excellent cataclastic structure (section 370). The fact that it was possible to point out the existence of limestone in this remote district was of considerable importance to the settlers there, who had been obliged previously to haul all their lime from St. Jérôme, a distance of forty miles over rough roads.

The strike, wherever this can be observed, indicates a sharp bending of the strata back upon themselves at the southern portion of the lake, corresponding to the outline of the lake. The foliation is probably largely a secondary one, induced by pressure, as shown by the fact that it is shared by the intruded anorthosite. The limestone with its associated gneisses is limited on three sides by the anorthosite, and here again is evidently cut off by it.

Crystalline limestone in Cathcart.

A second limestone band occurring to the east of the Morin anorthosite, is seen in the bed of the Black River, on the line between ranges VIII. and IX. of the township of Rawdon; then in large exposures on ranges IX., X. and XI. of the same township, crossing into ranges III. and IV. of the Augmentation of Kildare, on the western corner of that township. Going still further north, it is seen on lot 11 of range IV. of Cathcart, crossing range VII. of Cathcart and running under a little lake on range VIII., appears again near St. Come, and is then exposed on lots 27 and 28 of the last range of the township of Cathcart. To the north of this point the country is unsettled, and covered with a dense growth of forest, so that the continuous tracing out of a small band of limestone is impossible. Continuing on the same strike, however, limestone was observed on the front of lot 28 of range II. of Cartier, on the line between II. and III. of Cartier, also about lot 28, and then at two points on two little lakes lying a short distance to the east of Lac des Ilets on the stream issuing from that lake. Limestone was also observed protruding through the drift by the shore of the River L'Assomption, about four miles from Lake L'Assomption. It is here exposed for a width of fifteen feet across the strike, but the limit of the band is seen only on one side, the water concealing its contact with the gneisses on the other. The petrographical character of this limestone is described on page 66 J. This occurrence, however, is not on the same strike and may not belong to the band above described.

It was impossible to follow this band with certainty in its southerly extension. This is owing to the fact that the southern part of the township of Rawdon is heavily drift-covered, comparatively little rock being exposed. Mr. Carlyle carefully examined the River Ouareau, from Rawdon to the Cambro-Silurian contact, and was unable to find any limestone. Above the village, the river runs through drift, until the exposure of anorthosite at the upper bridge is reached. Small exposures of the limestone were, however, found protruding through the drift, on range IV. of Rawdon, about lot 13, which may possibly mark a continuation of the band in this direction, but if so, the limestone band is greatly diminished in size to the south.

This band, which may be called the Rawdon band, is most extensively exposed on range IX. of Rawdon, and in the vicinity of St. Come. At the former locality, several years ago, it was extensively burned for lime, and at the latter place it is now being burned at two different points. Rawdon band.

A noteworthy fact in connection with this limestone band, is that it occupies the summit of an anticline, the dip being from it on either side.

A third band is seen in considerable exposures about a mile and a half west of St. Alphonse, on range I. of Cathcart, where it is burned for lime, and to the south on the adjoining range of the Augmentation of Kildare. It is then seen near the road, about lot 38 of range VI. of Cathcart, and then at a number of places lying in a direction west of north from the last exposure and running through ranges VII., VIII. and IX. of the same township, it passes into the forest covered township of Tracy.

The fourth band is thin and impure. A few exposures about a mile to the south-west of St. Ambroise de Kildare may probably be referred to it, but it is well exposed first, on range VII. of Kildare, near the cheese factory, then about the rear of this township, then in the village of Ste. Beatrix, and again about a mile further north, at the bend of the River L'Assomption. Then in the Seigniory of the D'Aillebout, about three miles south of Ste. Emilie, and again on the Mattawin road, about the line between ranges III. and IV. of Joliette.

A fifth band, still further to the east, is exposed on lot 2, of range VII. of Kildare, and is then covered with drift until it reappears about three miles further north, in D'Argenteuil, at a point one mile east of the town-line of Kildare. Crystalline limestone in Kildare.

These several bands, together with those described in the south-eastern portion of the area by Sir William Logan, embrace all the limestones which occur in it, with the exception of four small isolated occurrences. The first of these has been already mentioned, and is Other occurrences.

situated on lot 10 of range VII. of Kilkenny. The second was found on lot 22 of range IX. of Rawdon. It is about twenty feet wide, and is associated with a band of nearly pure, coarsely-granular, pyroxene rock, which is described on page 85 J. Its mode of occurrence is that of a lenticular mass. The third is on lot 20 of range V. of Rawdon. The fourth occurrence is found near the line between lots 8 and 9 of range VI. of Cathcart. This has been opened as a marble quarry, and partakes rather of the nature of a vein deposit. It is described on page 152 J, in the section treating of the Economic Geology of the district.

Continuity of the limestone

The question as to whether the Laurentian limestones form continuous bands or are merely a series of disconnected lenticular masses has been frequently discussed. Their softness and the ease with which they are eroded makes these limestones appear less continuous than they really are, for glacial and pre-glacial decay and erosion acted far more vigorously on the limestone bands and the strata immediately associated with them than on the harder gneiss of the series, and as a result the former almost invariably occupy depressions, and very frequently river-valleys or lake beds. In such places, of course, the drift is thickest and most persistent. When, therefore, the strata underlying such a drifted area are contorted and only protrude at intervals through the gneiss, or even when they are not contorted but exposed only at considerable intervals, it becomes a matter of great difficulty to decide whether the occurrences of limestone form a continuous band of limestone or a series of disconnected patches. It becomes, however, necessary in this connection to define what is meant by the term "limestone band." Pure crystalline limestone or marble, ten, twenty to sometimes 100 or more feet in thickness, is often found, but in the majority of cases the bands consist of the limestone interstratified with many thin bands of gneiss. This was true of all the limestone bands described by Sir William Logan in the "Geology of Canada," the gneiss often constituting half or more than half of the whole thickness. When by squeezing or stretching these gneiss bands have been torn apart or pulled out into fragments, the gneiss and limestone become irregularly mingled together; subordinate masses of limestone may disappear along the strike and gneiss may come in, to be succeeded again by limestones. The limestone also being very plastic under pressure, the relative amounts of the two rocks may vary in different parts of the band.

The band as a whole may thus be continuous for a long distance, while its individual component masses may and do thin out, disappear, and become succeeded by others. It is thus by no means uncommon to find a limestone band which, at one part of its course, is represented by a thick development of nearly pure limestone, further on represented by a number of thin layers of limestone interstratified with bands of gneiss. A limestone band thus becomes a certain horizon more or less thick in which limestone is abundant, while it is absent from the rocks on either side.

Accepting the term "limestone band" in this sense, investigations in this area go to show that when the country is favourable for study, limestone bands are found to be continuous for long distances following the strike of the associated rocks, and that they are at least as continuous as the bands of any other kind of rock making up the series. But, as before mentioned, their very nature causes them to be more easily hidden or drift-covered, than the bands of the harder associated rocks, and they are thus sometimes apparently less continuous than these.

Movements along limestone bands.

There is reason to believe that the limestone bands sometimes act as lines of least resistance along which motion is especially pronounced under the differential strains incident to folding. An excellent example of this, on a small scale, was seen in an exposure about one mile south-east of a point two miles below the Ox-bow Rapids, on the River Mattawin, in the region of flat-lying gneisses beyond the northern limit of the map. Here the gneiss is usually medium in grain and is to all appearance as well bedded as any sedimentary series. Several little bands of crystalline limestone, from a few inches to two feet in thickness, together with a few small bands of quartzite, are interstratified with the gneiss. An excellent section is presented in the cliff by the side of a little brook, and the effects of a thrust in a direction parallel to the bedding, consequent on the stretching to which the rocks in this district have been subjected, is well displayed. The upper beds can be plainly seen to have moved for a few feet over the lower beds, along the plane of a thin limestone band, which, with its interstratified gneiss layers, is quite undisturbed in the northern end of the section, while further south it has been broken off, folded on itself, and puckered up in a most complicated manner by the horizontal motion.

Thickest body of limestone.

The thickest body of limestone exposed in the area is probably that on the islands of Lake Ouareau, which, as above mentioned, has a width 275 yards across the strike, with neither wall seen. The largest occurrence of pure limestone, unmixed with gneiss, uncontorted and dipping regularly, so that its true thickness can be ascertained, is a portion of the Rawdon band, on lots 27 and 28 of range X. of Rawdon, in the valley of a branch of the River Rouge. Hills of gneiss rise on either side of the river at this point, those to the west also holding some limestone, and between them is a nearly level interval through which the river runs. This strip or interval is 225 yards wide, and is in all probability entirely occupied by the limestone band, which, in that case, would here be about double its ordinary thickness, as it is bent back on itself, occupying, as it does, the summit of an anticline (see Section No. 1, on the map). Over the greater part of the flat valley-bottom, however, the underlying rock is concealed by drift, but on the east of the river coarsely crystalline limestone, for the most part nearly pure but in some places rich in serpentine, lying in regular beds or bands striking N. 20° W and dipping to the east at an angle of about 60°, is exposed for a width of 155 feet across the strike. This would give as a minimum an actual thickness of limestone unmixed with gneiss of 134 feet, while the thickness is probably much greater.

The petrographical character of this limestone is described on page 65 J.

Fundamental Gneiss.

Fundamental gneiss.

Trembling Mountain (Plate II.), which was taken by Sir William Logan as the typical development of the Fundamental Gneiss, is composed of a fine-grained, pale red, orthoclase-gneiss, with a foliation which is generally distinct and with occasional bands differing slightly in character or coarseness of grain. It contains a very few thin bands of a nearly black pyroxene-amphibolite. The petrographical character of these rocks will be considered in detail on pages 42 J, 77 J, where it will be shown that the gneiss is really a crushed or granulated granite. The mountain is flanked on the south-west by the limestones and their associated sedimentary gneisses, of the Grenville series, occupying the greater part of the bed of Trembling Lake, and described on page 49 J.

In the south-western portion of the map, to the west of the great Morin anorthosite, considerable masses of more or less indistinctly foliated gneiss, without banding and often passing into augen-gneiss, are seen. These are also in great part crushed igneous rocks, and may be intrusive, but on account of the folding and squeezing to which the district has been subjected, it is difficult to separate them from the limestone-bearing series.

Along the southern portion of the township of Brandon also, as has been mentioned, there occurs a somewhat similar set of gneisses quite distinct in character and attitude from those in the northern portion of the same township (p. 20 J.)

Whether all these gneisses really form a portion of a floor on which the Grenville series was deposited, since brought up by folding and erosion, and thus entitled to the appellation "fundamental gneiss," or whether they are intrusive masses, foliated by the pressure to which the whole region has been submitted, cannot be determined.

Acid Intrusions.

Two large and important intrusions of acid plutonic rock break through the gneisses, one in the south-western and the other in the north-eastern corner of the area. The former, which was examined many years ago by Sir William Logan, is referred to by him as follows:—"This mass of intrusive syenite occupies an area of about thirty-six square miles in the townships of Grenville, Chatham and Wentworth. In its lithological character the rock is very uniform, being composed for the most part of orthoclase, either of some tinge of flesh-red or a dull white with black hornblende and a rather sparing quantity of grayish vitreous quartz. The red tinge prevails more on the west side, the white on the east. In the spur which runs into Wentworth, mica is occasionally found accompanying the hornblende. The rock is rather coarse-grained in the main body, but dykes of it are sometimes observed cutting the limestone and gneiss, in which the grain is finer. These have not been traced as yet to any great distance from the nucleus."* Intrusive syenite.

The granite occurring in the north-east corner of the map occupies a much larger area, but the mass lies for the most part outside the limits of the sheet. It is very coarse in grain, red in colour, and usually contains but little quartz and iron-magnesia constituents. The orthoclase usually occurs in very large individuals giving a porphyritic appearance to the rock, while in certain parts of the area, and especially towards the outer limits of the mass, the rock takes the form of a well defined augen-gneiss. This variety is well seen about St. Didace, where a microscopical examination shows that some of the augen are plagioclase and that the iron-magnesia constituent is biotite (section 357). The felspar augen, both in the massive and gneissic varieties, usually have an approximation to a good crystalline form.

The relation of this granite to the gneissic series in the township of Brandon, has already been described (p. 20 J). Mr. R. G. McConnell, who mapped a portion of it in 1880, refers to it as cutting off the gneissic series at one point where the direct contact could be seen.† Granite of St. Didace.

---

* Geology of Canada, 1863, p. 39.

† Report of Progress, Geol. Surv. Can., 1879-80, p. 5.

In the district south-east of St. Didace, the granite also appears to break through the gneiss. An examination of that district shows that at the junction there is a zone of rocks which have been much crushed and twisted and which show no distinct strike, while the strike of the gneiss beyond this zone follows the line of contact, the gneiss, however, having been apparently submitted to great pressure, as if shoved against the granite and forced or dragged along its edge. The granite beyond the eastern limit of the sheet is cut by a small area of anorthosite, so that if the anorthosite intrusions within the map are of the same age, the granite was intruded before them.

On the upturned edges of these deeply eroded Archæan rocks, with their anorthosite and granite intrusions, the Potsdam sandstone and succeeding Cambro-Silurian rocks repose in flat undisturbed beds. At some points along the edge of the Protaxis, as at St. Canute, to the west of St. Jérôme, and on the River L'Assomption, the Potsdam sandstone is observed resting on the gneiss, while elsewhere the strata in closest proximity to the gneiss consists of a magnesian limestone, probably Calciferous in age, as to the south of St. Jérôme, or of a highly fossiliferous limestone of Trenton age, as between New Glasgow and Ste. Julienne.

Palæozoic outlier.

An outlier of those Palæozoic rocks, almost circular in form and about two miles in diameter, occurs about nine miles north of the edge of the Protaxis, on ranges III. and IV. of the township of Abercrombie, showing that the Palæozoic covering once extended at least as far north as this.

These strata cover up the gneisses, anorthosites and granites alike, and are evidently of much more recent age, being separated from the Laurentian and its associates by a long interval occupied in the upheaval and erosion of the Laurentian area.

How long before Upper Cambrian time this folding and erosion took place cannot be determined from a study of this area, but further west along the edge of the Protaxis in the Lake Superior district, we find that the Keweenawan and Animikie series also repose in flat undisturbed beds on the eroded remnants of a series of crystalline rocks which have the petrographical character of the fundamental gneiss. This makes it at least very probable that in this eastern area also, the erosion took place in pre-Cambrian times.

Pre-Cambrian erosion.

It is a very remarkable fact that the roche moutonnée character possessed by the eroded Laurentian rocks and which is usually attributed to the glaciation undergone by them in the Pleistocene, was really impressed upon them in the first instance in these pre-Cambrian times, for all along the edge of the nucleus from Lake Superior to the Saguenay, the Palæozoic strata, often in little patches, can be seen to overlie and cover up a mammillated and roche moutonnée surface showing no traces of decay and similar to that exposed over the uncovered part of the area. The conclusion therefore seems inevitable that not only were these Laurentian rocks sharply folded and subjected to enormous erosion, but that they had given to them in pre-Cambrian times their peculiar hummocky contours so suggestive of ice action.* The pre-Palæozoic surface of the fundamental gneiss of Scotland, as Sir Archibald Geikie has shown, also presents the same hummocky character.†

Petrography.

The Laurentian of this area consists of orthoclase-gneiss in almost endless variety, alternating or interstratified with pyroxene-gneisses, amphibolites, crystalline limestones, quartzites, garnet rocks, etc., which also present a great variety of forms and are connected by many transitional members. Thus bands of quartzite, while usually forming well defined stratigraphical units, frequently hold more or less orthoclase, and thus pass into quartzose gneisses, or crystalline limestones in certain places become very impure owing to the presence of various silicates, and might thus be classed as calcareous gneisses, and so on. Orthoclase gneiss.

The orthoclase-gneisses preponderate largely and might, if the crystalline schists were classified in the same detail as intrusive masses, be separated into a number of petrographical species, each with its distinctive name, representing the mineralogical equivalents, not only of the granites and syenites, but also of all the various transitional forms standing between these and the gabbros and diorites, which latter find their equivalents in the true plagioclase-gneisses and amphibolites. The one essential character of the gneisses is the possession of a certain banding or foliation, which on one hand may and often is as well pronounced as the lamination in any sedimentary rock or, on the other hand, may be so indistinct that its existence can only be detected by the examination of large weathered surfaces.

It is not, however, advisable in all cases to attempt to separate, classify and map these numerous varieties of gneiss, owing to the fact that they occur in smaller masses and are much more intimately associated with one another than is the case with their intrusive equivalents. Mineralogical varieties.

* A. C. Lawson,—Notes on the pre-Palæozoic surface of the Archæan Terranes of Canada—Bull. Geol. Soc. Am., vol. I., 1890.

† A Fragment of Primeval Europe—Nature, Aug. 26, 1888.

The classification of these gneisses is further complicated by the fact that each mineralogical variety may present great and important diversities of structure in different places.

Rocks of the Laurentian.

From a mineralogical standpoint, the rocks of the Laurentian in this region might be arranged in the following classes :—

Gneisses—

Quartz-Orthoclase-Gneiss (Granulite in part) Quartz-Orthoclase-Biotite-Gneiss. Quartz-Orthoclase-Hornblende-Gneiss.	Granite-Gneiss, or when poor in quartz or free from that constituent Syenite-Gneiss.
Orthoclase-Plagioclase-Hornblende-Gneiss.—Syenitic-Diorite-Gneiss.	
Orthoclase-Plagioclase-Pyroxene-Gneiss.—Syenitic-Gabbro-Gneiss Plagioclase-Pyroxene-Hornblende-Gneiss.—Gabbro-Diorite-Gneiss Plagioclase-Pyroxene-Gneiss.—Gabbro Gneiss.	Pyroxene granulite in part.
Plagioclase-Hornblende-Gneiss.—Diorite-Gneiss (Amphibolite in part).	
Garnet-Sillimanite-Gneiss. Orthoclase-Scapolite-Pyroxene-Gneiss, &c.	No mineralogical equivalent in the igneous series.

Quartzite.

Garnet Rock.

Pyroxene Rock.

Crystalline Limestone.

The gneisses, especially in the basic varieties, are often rich in garnets, pink or red in colour, and frequently of large size. Such garnetiferous gneisses are an important element in many parts of the series, and especially in the vicinity of the limestone bands. Many of the plagioclase-pyroxene-gneisses are of course closely related to the foliated anorthosites. Muscovite is seldom or never found, while in the pyroxene-gneisses, rhombic as well as monoclinic pyroxenes frequently occur. In addition to the certain constituents of the gneisses, as given in the above table, accessary constituents are frequently present, although these are neither abundant nor numerous. Of these acccessary constituents the most important are, magnetite, ilmenite, pyrite, apatite, zircon, rutile, graphite, tourmaline, orthite, monazite and spinel. In some parts of the district the gneiss over large areas is very uniform and regular in structure and composition. This is especially true in those areas which may be referred to the lower or fundamental gneiss. Elsewhere, there is a great variation in composition and character in different bands within comparatively limited areas. This is particularly marked in the vicinity of the limestone bands, where the gneisses are usually garnetiferous and more frequently contain sillimanite, graphite, rutile, pyrite and other accessary minerals.

A peculiar, very rusty-weathering gneiss usually, rather fine-grained and often nearly white on the fresh fracture, seldom occurs except in association with the limestone bands, and it is the exception to find crystalline limestone unaccompanied by this gneiss. It occurs not only in many parts of the area at present under discussion, but in every other part of Canada and the United States where the Grenville series with its characteristic limestones is found. It is especially well developed in central Ontario* and about Port Henry in the State of New York. Rusty weathering gneiss.

The quartzite, often garnetiferous, also occurs, chiefly in association with the limestones.

A noticeable feature in those Laurentian gneisses which have quartz and orthoclase as the chief constituents, is the small proportion of iron-magnesia minerals which they contain. It is rare to find such a gneiss rich in these constituents, and very frequently they are entirely absent. On the whole, hornblende is more common than biotite.

The colour of the ordinary gneiss on a fresh fracture is reddish or grayish. The more basic varieties are dark-gray or even brown in colour, while in the acid gneisses, reddish and light-gray tints prevail. The gneisses weather white, gray, reddish, or brown, according to their composition. They are occasionally very coarse-grained, especially in the case of the augen gneisses, which sometimes hold masses of felspar, an inch or more in diameter. They are generally however medium in grain, often fine-grained, but seldom so fine that the chief constituents cannot be distinguished by the unaided eye, especially when the weathered surface is examined.

As has been stated above, the distinctive characteristic of all these gneisses is the possession of a more or less decided foliation or banded structure. By foliation is understood a laminated structure, produced in a rock by the parallel arrangement of certain or all of its constituent minerals. Thus a granite would become foliated if all the little biotite individuals were caused to assume a parallel position, and the foliation would become still more pronounced if the other constituents were also arranged in parallel strings. By banding is understood the alternation in the form of bands, of gneisses differing more or less in composition or structure, which gneisses may or may not be foliated as well. The origin of this foliated or banded structure in the case of the Archæan is one of the most difficult problems presented in the study of these ancient rocks. It was formerly supposed to represent the Foliation and banding.

*F. D. Adams,—Report on the Geology of a portion of Central Ontario, Annual Report, Geol. Surv. Can., Vol. VI. (N.S.), 1892-93.

remains of an original bedding, due to sedimentation, but now almost obliterated, the gneiss thus being comparable to certain indistinctly foliated rocks found in contact zones about great eruptive masses of granite. In recent years, however, the study by many able investigators* of the effects produced in rocks when deeply buried in the earth's crust and subjected to great pressure during the process of mountain making, have clearly shown that perfectly foliated rocks may be and are produced from massive igneous rocks, by such processes, so that the existence of a foliated structure in a rock can no longer be regarded as evidence of sedimentary origin. Any rock when subjected to deformation under the influence of pressure, will tend to assume a foliated character. If these movements have been very pronounced, the foliation will be correspondingly distinct; while, if the pressure has acted on a complicated series of rocks of diverse character, as for instance igneous and sedimentary rocks penetrated by later intrusions, or on a great body of igneous rock which has undergone magmatic differentiation, a petrographical series composed of alternating bands of very different varieties of gneissic rocks may result.

Its origin.

The great irregularities in composition which of recent years have been shown to exist in many large eruptive masses, make the intimate association of different varieties of gneiss, and their passage into one another, much more intelligible than formerly, since such associations and gradual transitions would certainly be presented in any gneissic series formed by the squeezing or stretching of differentiated masses of this kind. Thus, in several districts of ancient crystalline rocks which in recent years have been made the subject of very careful study, as for instance the granulite region of Saxony and the southern portion of the Grand Duchy of Baden, a great weight of evidence has been accumulated which goes to show that certain rocks which have been classed as Archæan gneisses or schists are altered sedimentary rocks, while other gneisses in the same districts can be shown to be squeezed or crushed rocks of igneous origin.

Altered sediments.

Crushed igneous rocks.

The separation and recognition of these two classes of rocks will probably become more easy and certain as investigation advances, but it remains to be ascertained whether it will be possible eventually to bring all gneisses under one or other of these two heads.

---

* A. Heim.—Geologie der Hochalpen zwischen Reuss und Rhein.-Beiträge zur Geol. Karte der Schweiz. vol. XXV. Bern, 1891.

C. Schmidt.—Beiträge zur Kenntniss der auftretenden Gesteine. *Ib.*

B. Milch.—Beiträge zur Kenntniss des Verrucano. Erster Theil. Leipzig, 1892, and many others.

The criteria for the determination of gneisses which consist of metamorphosed sediments are not as yet thoroughly worked out, but the following are three lines of evidence by which it would seem that such rocks may be recognized :— Criteria for discrimination.

1. Their Chemical Composition.—Modern investigation goes to show more and more clearly that in their composition igneous rocks do not present and exhaust all possible combinations of silica with the common bases present in them. Certain combinations of silica and bases are found in igneous rocks; others are not. Igneous rocks, furthermore, do not commonly occur indiscriminately associated with one another, but are found in certain family groups, constituting what are known as "petrographical provinces." If, therefore, certain gneisses forming thick, well defined bands in any district of crystalline rocks, have a composition which is not that of any igneous rock but which is identical with that of the ordinary sediment laid down in the present seas, this is a strong argument in favour of the sedimentary origin of the gneiss in question. In the case of granitic rocks undergoing atmospheric disintegration, the chemical processes at work consist chiefly of the partial removal of the alkalies with a certain amount of the silica and a portion of the lime, the rock at the same time taking up a certain amount of water. If the rock becomes thoroughly decomposed, as in the case of the decomposed granites from which china-clay, a material almost free from alkali, is obtained (but in the great majority of cases the decomposition is not so complete), the partial decomposition serves to disintegrate the rock, which, falling to a loose, earthy mass, may then be washed away, and eventually deposited as sediment. If the chemical action has been but slight, an arkose may in this way be produced which will differ but little from the original granite. If, on the other hand, the decomposition, although not complete, is well advanced, a fine mixture of sand and clay will result, which will be distinctly different in composition from the original granite. By chemical composition.

This mixture, speaking generally, will be richer in alumina and poorer in alkalis than the granite, and will contain proportionately more magnesia and less lime than the original rock; and, although granites differing in composition necessarily yield products having corresponding differences, yet when these chemical changes have gone beyond a certain point, a decomposition product results which possesses a composition distinctly different from that of any igneous rock, and the most intense baking or re-crystallization cannot again produce a granite from it. If, therefore, gneisses were produced by the metamorphism of such granitic decomposition products, it might not be possible, from their composition, to recognize them as altered sediments in all or perhaps even in the majority of cases, but in certain instances it would be possible.

Then again, the composition of certain other rocks, such as quartzites and crystalline limestones, mark them as of aqueous origin. Such rocks, if their mode of occurrence precludes the possibility of their being of the nature of vein deposits or residual products, must be altered sediments, as sedimentation is the only other process with which we are acquainted by which such rocks are produced.

Again, the presence of free carbon in the form of graphite or any graphitic mineral, disseminated through a gneiss or schist, points to a sedimentary origin, as such substances do not occur in igneous rocks.

If several of these indications of a sedimentary origin are combined in the same series of rocks, as, for instance, if bands of limestone are found interstratified with bands of quartzite and with a gneiss having the composition of a shale, some or all of the bands holding graphite, the evidence of a sedimentary origin becomes proportionately stronger.

By resemblance to contact rocks.

2. The Resemblance of such Gneisses to the Metamorphosed Rocks of Contact Zones.—Undoubted sedimentary rocks, such as shales or slates, are in many cases invaded by great bodies of molten granite, which bring about certain alterations in these sedimentary rocks, which alterations consist essentially of a re-crystallization of the sediment. This re-crystallization becomes progressively more complete as the contact with the granite is approached, until immediately along the contact a so-called hornstone is produced. This hornstone, as the name implies, is usually fine in grain, but in other cases, as in the Granulite region of Saxony, the most altered portion of the shale is represented by a coarsely crystalline rock resembling a gneiss, through which there runs an immense number of little strings and streaks of the granite. These products of intense metamorphism, although consisting essentially of quartz, biotite, muscovite, felspar and other minerals found in granite rocks, have these minerals arranged in quite a different manner, giving rise, especially in the case of the finer grained varieties, to what is known as a hornstone structure; while certain other minerals not found in granitic rocks but characteristic of these contact zones also occur in them. If, therefore, in any gneissic series, certain rocks are found which present the spotted and other structures of the less altered portions of contact zones, or the hornstone structure of the more altered portions, with or without a swarm of little strings or streaks of granitic material passing through them, the evidence again points to their being altered sediments. Such rocks have been found extensively developed in certain Archæan districts, where these have been carefully examined, as, for instance, in the Black Forest.*

By survival of original structure.

3. The Survival in such Gneisses of Structures peculiar to Sedimentary Rocks.—Undoubtedly sedimentary products, as, for instance, rounded, water-worn pebbles, or angular clastic quartz grains, when recognized in any crystalline rock, also determine it to have been of sedimentary origin. In this way, certain rocks in Norway and Saxony formerly classed as Archæan crystalline schists have been recognized as altered conglomerates. Clastic quartz grains are in some cases rendered possible of recognition by the fact that in the processes of alteration secondary silica is deposited about them, and in this way the form of the original grain marked by its coating of iron oxide or other adhering impurity, is preserved and can be recognized, notwithstanding the complete alteration and crystallization of the rock. This process is especially well seen in the case of sandstones changing into quartzites, but can also be recognized in the metamorphism of certain arkoses into felspathic quartzites, which in composition would be identical with the more acid gneisses of the Archæan.

Applying these tests in the district at present under consideration, it has been found possible to place in one class certain rocks which all lines of evidence indicate as of sedimentary origin. To these belong the crystalline limestones, the quartzites, and certain associated gneisses usually containing sillimanite, garnet, and graphite.

Rocks of doubtful origin.

Another class can be recognized as consisting of rocks of igneous origin which have been squeezed or crushed. To this class, in addition to the anorthosites which are treated by themselves under another heading, are a whole series of quartzose orthoclase-gneisses, usually poor in iron-magnesia constituents, and possessing a variety of structures.

A third class consists of rocks whose origin is as yet doubtful. This is due in part to the fact that, it has been impossible to subject them to an exhaustive examination, including chemical analysis. Possibly, however, their origin could not in many cases be ascertained even if such an examination were made. This class includes a considerable proportion of the ordinary orthoclase-gneisses of the district, as well as most of the pyroxene-gneisses and amphibolites.

* Geologische Specialkarte des Grossherzogthums Baden—Erlaüterungen zu Blatt Gengenbach von A. Sauer—Heidelberg, 1894, page 8.

In the following pages these three classes of rocks will be considered separately, beginning with the gneisses of igneous origin.

Instead of endeavouring to describe every member of the large suite of specimens which has been studied microscopically in the course of this investigation, which would entail the presentation and repetition of an immense mass of petrographical detail, a number of typical occurrences from each class will be selected for description, as it is believed in this way a knowledge of the petrography of the district may be more clearly conveyed.

Class 1.—Gneisses of Igneous Origin.

In these gneisses, orthoclase felspar preponderates largely, which is itself evidence against a sedimentary origin. Quartz is almost always present, though frequently in small amount. Its presence and proportion can be best ascertained in the field, by an examination of the weathered surface of the rock, on which the contrast of the quartz and orthoclase is much more marked than on a fresh fracture. These two minerals frequently make up almost the entire rock (quartz-orthoclase-gneisses), but they are usually associated with small quantities of biotite and hornblende, occurring either separately or together. Graphite, which is abundant in rocks of class 2, is never found in these gneisses. Three structural varieties are especially worthy of mention: (*a*) Augen-gneiss; (*b*) Ordinary granulated gneiss; (*c*) Leaf-gneiss.

These are connected by transitional forms.

Augen-Gneiss (Quartz-Orthoclase-Hornblende-Gneiss)—Township of Brandon, Lots 16 and 17, Range IX. (Section 555).

Augen-gneiss. The rock is of a reddish colour and quite uniform in character over large exposures. In hand specimens, it shows a distinct foliation caused by the presence of slightly undulating but nearly parallel narrow black lines of hornblende, alternating with thicker streaks and layers of reddish orthoclase.

These minerals occur for the most part in the form of fine grains, but in this finely granular mass cores or remnants of large individuals of hornblende and orthoclase respectively are abundant, from the granulation of which the finer grained portion of the rock has been produced. These cores have not a good crystalline form, but are rounded, lenticular, or tear-shaped, with trails of the granulated material running off from them in the direction of the foliation on either side, the foliation curving around them. The orthoclase cores are often large, sometimes over an inch in diameter, frequently presenting curved or twisted faces, and can be seen to be in the very act of breaking up into smaller fragments. The hornblende remnants are identical in shape with those of the orthoclase, but are smaller in size.

Under the microscope the rock is seen to be composed essentially of orthoclase, quartz and hornblende. As accessary minerals, biotite, diallage, apatite, zircon and iron ore are present in very small amount. Orthoclase preponderates largely, partly as large augen and partly as granulated material. The augen show an uneven extinction, although this is not always very pronounced, and between crossed nicols show a finely mottled or spotted structure due to a fine microperthitic intergrowth. They have an irregular oblong, often more or less rounded shape, and lie with their longer axis in the direction of the foliation of the rock, or more or less inclined to it. When considerably magnified they can be seen to possess a finely serrated edge as if jagged from the breaking away of little fragments. The augen can, in fact, be observed in the very act of breaking down into the finely granular material which surrounds them by a process of peripheral granulation, as described in the case of the anorthosites. The groundmass, so to speak, in which these orthoclase augen are embedded, consists principally of small grains of the same mineral. These generally show the same mottled appearance as the augen, and differ but little from one another in size. The larger ones often exhibit an uneven extinction and can frequently be seen to be in the act of breaking up into smaller grains. All these smaller orthoclase grains are very irregular in shape. In one of the sections a very few small grains of plagioclase were present. The quartz occurs chiefly in more or less elongated grains. These are often greatly elongated, forming the "leaves" of quartz so abundant in the "leaf-gneiss." These are distributed through the granulated orthoclase lying in the direction of, and in fact in part causing, the foliation of the rock. These grains have an almost uniform extinction, and are not broken or granulated, even if they are many times as long as they are wide. On very careful examination, however, they can usually be seen to exhibit a slightly uneven extinction suggestive, as will be shown in describing the "leaf gneisses" of a smearing of the mineral out in one plane. They sometimes fork at the extremities or at the sides. These quartz individuals can often be observed sweeping around the partially granulated augen of orthoclase in long curved grains or lines of grains. Granulated structure.

The hornblende, which is green in colour and is present in comparatively small amount, occurs as strings of very irregular-shaped grains, resulting from the granulation of large individuals the cores or remnants of which remain as small augen. A grain or two of biotite is occasionally associated with the hornblende. In one slide a single grain of diallage was present, but in all the slides there are a few grains of a yellowish aggregate, which is apparently a decomposition product of diallage. Even if this be the true explanation of their origin, the diallage would be very subordinate to the hornblende in amount. There is no evidence that the latter has been derived from the former. A few small irregular-shaped individuals of apatite, and small zircon prisms, as well as a small amount of magnetite occurring in elongated grains or long narrow strings like the quartz, complete the list of constituents.

Mode of occurrence.

This augen-gneiss occurs as a very irregular-shaped mass, in the township of Brandon, intercalated in the gneissic series, with the strike of which its foliation coincides. (Fig. 3.) It forms large roche moutonnée exposures, very uniform in character, and is succeeded to the east by a large development of nearly black pyroxene-granulite. Augen-gneiss, identical in character, was found in about a dozen different localities in the same township, in long narrow masses running parallel to the strike of the series. Augen-gneiss, closely related in character, occurs abundantly in many other parts of the area. It is found, for instance, in large exposures at a number of places along the southern edge of the area, between New Glasgow and St. Jérôme, and between the latter place and St. Canute, also to the north of this district towards Shawbridge and St. Sauveur, as well as in the extreme north-west corner of the area, on the Devil's River, the River Macaza, and about the lakes lying to the north of Trembling Lake.

Origin.

With regard to the origin of this augen-gneiss, there can be no doubt but that it is produced by the squeezing of a coarse-grained, in some places perhaps porphyritic, granite. In the case of the Brandon rock, this granite was a basic hornblende variety, probably with large porphyritically developed orthoclase crystals, similar in structure to the great granite mass on the east side of the township of Brandon, well seen about St. Didace, a mass which at many parts of its periphery is developed as an augen-gneiss, closely resembling the one in question. In other cases the original granite has been more acid in character and of the nature of a pegmatite, as in the township of Wolfe, where the line between ranges VIII. and IX. is crossed by the line between lots 34 and 35. Here, the extremely contorted gneiss is cut by a number of pegmatite veins, having a distinct augen-gneiss structure. (Section 567.) In many other parts of the Laurentian, both in this district and in Central Ontario, pegmatite dykes have been observed cutting across the gneissic strata, in which dykes an augen-gneiss structure has been developed, which are in fact augen-gneisses in certain places, or throughout their whole mass. The foliation of this augen-gneiss, moreover, coincides with that of the surrounding gneisses, but is quite independent of the direction of the dyke.

A good example selected from many similar ones is seen on lot 17 of range VI. of Brandon, and is shown in the accompanying figure:— Pegmatite crushed to augen-gneiss.

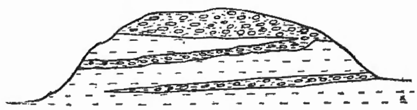


Figure 4.—Pegmatite dykes converted by pressure into Augen-Gneiss, the foliation of which coincides with the foliation and banding of the gneisses through which they cut. This exposure is 8 feet in width. (Range VI., Lot 17, Township of Brandon.)

At this locality there is a series of large roche moutonnée exposures made up of an alternation of fine-grained, reddish, orthoclase-gneiss, coarse augen-gneiss, dark pyroxene-granulite, and vitreous quarztite, the whole dipping to the east at a low angle. Although the several rocks seem at the first glance to succeed one another in pretty regular bands, careful examination shows that in certain places the augen-gneiss cuts across the other bands, as shown in the figure, the foliation in the transverse arm running parallel to the regular foliation and banding of the whole exposure, but not coinciding with the direction of the arm itself. In the thinner apophyses the granulation is more advanced and the augen less abundant than in the heavier bands from which it proceeds.

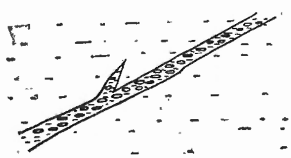


Figure 5.—Dyke of Pegmatite crushed to Augen-Gneiss, the foliation of which coincides with that of the Anorthosite through which it cuts. (Range VIII., Lot 19, Township of Brandon.)

Figure 5 shows a similar case where a pegmatite dyke crushed to an augen-gneiss cuts obliquely across the foliation of the anorthosite in the township of Brandon.

It is thus evident that in these cases, and probably in the cases of all the augen-gneisses, we have to do with granitic intrusions into earlier rocks, which intrusions certainly date from a time before the development of the foliation of the gneisses, or at least before the foliating forces had ceased to act.

Granulated Gneiss (Quartz-Orthoclase-Hornblende-Gneiss)—Trembling Mountain, Township of Joly (Sections 528, 530, 533, 534).

This mountain, which, as is well known, is the highest point in the whole Laurentian range of this part of Canada, rises 2380 feet above sea-level and 1720 feet above the waters of Trembling Lake, which lie along its foot. (Plate II.) It is sculptured out of a great mass of gneiss, uniform in character from base to summit, and has an especial interest in that it was cited by Sir William Logan as the typical occurrence of the Fundamental Gneiss, which he believed to lie at the base of the whole Laurentian system.

Trembling Mountain gneiss.

This gneiss is rather fine in grain, and has a distinct though not very striking foliation, marked by the presence of a series of thin, interrupted black lines, seen on surfaces broken at right angles to the foliation. On large weathered surfaces a slight variation in size of grain can occasionally be seen in thin bands parallel to the foliation, and at long intervals, thin bands of a black pyroxenic amphibolite are met with. The gneiss has a pale reddish colour when fresh, and weathers brownish-gray.

Under the microscope it is seen to be composed essentially of orthoclase, quartz and hornblende, the first-mentioned mineral preponderating largely. As accessary constituents, magnetite, probably containing a certain amount of titanium as in one case it was observed associated with a substance resembling leucoxene, and in some slides a few grains of plagioclase and biotite, are found. A few little zircons and a few irregular grains of a mineral probably apatite are always present, and in one of the specimens a not inconsiderable quantity of a rhombic pyroxene was associated with the hornblende in little irregular grains, without however affording any evidence of having been derived from this latter mineral.

Structure.

The structure of the rock is remarkable. (Plate IV., Fig. 1.) No more typical example of a cataclastic or "mörtel" structure could be found. Large, very irregular-shaped, often more or less rounded individuals of orthoclase, presenting a fibrous appearance, due to a very fine, microperthitic intergrowth and showing excellent strain-shadows, lie

FIG. 1.

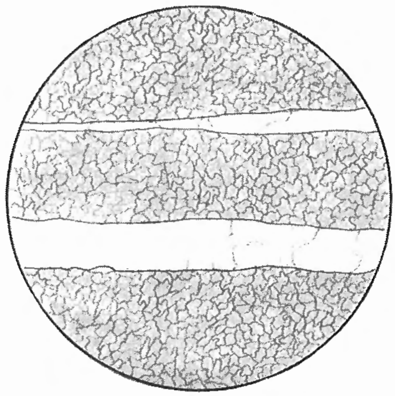


FIG. 2.

FIG. 3.

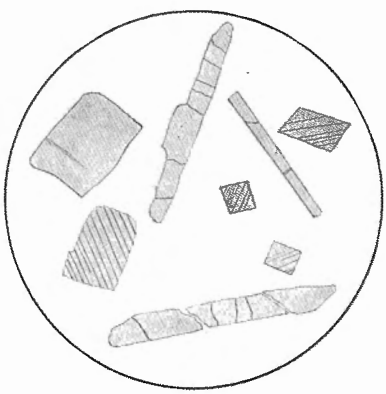


FIG. 4.

PLATE IV.

FIG. 1.—"FUNDAMENTAL GNEISS," TREMBLING MOUNTAIN—Hornblende, Orthoclase and Quartz. × 10.

FIG. 2.—LEAF GNEISS, 3½ MILES NORTH-EAST OF ST. JÉRÔME—Orthoclase and Quartz. × 10.

FIG. 3.—GARNETIFEROUS SILLIMANITE-GNEISS, 1 MILE WEST OF ST. JEAN DE MATHA—Garnet, Sillimanite, Quartz, Orthoclase and Pyrite. × 10.

FIG. 4.—SILLIMANITE CRYSTALS IN GNEISS FROM WEST SHORE OF TREMBLING LAKE.

imbedded in a very finely granulated mass, making up the greater part of the rock, composed also of orthoclase, and which can be plainly seen to have been derived from the breaking down of the larger orthoclases, the process being actually observed in all its stages in the sections. The process consists partly in peripheral granulation and partly in the subdivision of the larger individuals into smaller ones, by the development of lines of this broken material across them in the direction of greatest stress.

The quartz, the larger individuals of which frequently contain little rows of the minute dark inclusions often seen in the quartz of granite, though present in smaller amount, presents the same phenomena. This is also true of the hornblende, the large individuals of which are for the most part broken into fragments which are arranged in rudely parallel lines, forming the interrupted black lines above mentioned as marking the foliation of the rock. The origin of the gneissic structure in the case of this rock admits of no question. It is not an original structure, nor a survival of bedding indicating a sedimentary origin, but it has been produced by movements in the rock brought about by crushing, the original rock having been a hornblende-granite.

In order to ascertain whether the chemical composition of this rock would bear out the conclusions derived from its study in the field and under the microscope, an analysis of it was made for me by Mr. Walter C. Adams, B.A.Sc. The results of this analysis are given below under I., while under II. the results of the analysis of a granite from the Carlingford District, in Ireland, by Haughton, are presented for purposes of comparison:— Chemical composition.

	I. GNEISS. Trembling Mt.	II. GRANITE. Carlingford.
Silica	69·24	70·48
Alumina	14·85	14·24
Ferric oxide	2·62	3·72
Manganous oxide	·45	
Lime	2·10	1·48
Magnesia	·97	·40
Soda	4·30	3·66
Potassa	4·33	4·26
Loss on ignition	·70	1·59
	99·56	99·83
Total alkalies	8·63	7·92

The composition is that of a typical granite, and is entirely different from that of the gneisses of Class II., of which the analyses are discussed on pages 59 J to 61 J. The points of distinction, and those which mark it as of igneous origin, are high silica combined with low alumina, and high percentage of alkalies. The lime also, as is usually the case in granites, is in excess of the magnesia.

For a description of the bands or stratiform masses of pyroxene-amphibolite which are intercalated in this gneiss, see page 77 J.

Leaf-Gneiss—(Quartz-Orthoclase-Gneiss)—3½ miles North-east of St. Jérôme (Sections 334, 665).

Leaf-gneiss.

As a typical locality for this important and interesting variety of gneiss, certain large exposures protruding through the drift near the southern edge of the protaxis, and about 3½ miles from St. Jérôme, by the side of the Great Northern Railway between this place and New Glasgow, may be taken.

The rock is pink in colour, fine in grain, excellently foliated, and practically free from all iron-magnesia constituents. In the hand specimen it appears to consist of very thin alternate layers of quartz and orthoclase. The quartz, however, can scarcely be said to occur in layers, but rather in long narrow leaves, presenting the appearance of layers, when the specimen is broken at right angles to the foliation in one direction, but appearing as much shorter layers or dashes when the rock is broken in the other direction, at right angles to the foliation. When, on the other hand, the rock is broken in a direction parallel to the foliation, the quartz presents the appearance of having been smeared over the felspar surface, in long, narrow streaks, very much as butter might be thinly spread on bread.

Structure.

Under the microscope, in a section cut at right angles to the foliation the rock (Plate IV., Fig. 2) is seen to be composed of a uniform mosaic of felspar grains, through which the quartz runs in narrow, sharply defined bands. These quartz bands in polarized light resolve themselves into a series of individuals, each having a long rectangular section, and placed end to end, the bands being remarkably uniform in width and sharply defined against the felspar mosaic on either side. The quartz individuals are sometimes as much as ten times as long as they are wide, and yet have an almost absolutely even extinction. The orthoclase which constitutes the greater part of the rock, forms, as has been mentioned, a mosaic of much smaller grains, showing, as a general rule, between crossed nicols the wavy lines, due to fine microperthitic intergrowths, so often seen in gneisses. These grains fit into one another along very serrated boundaries; they do not show any very pronounced strain-shadows, neither are there any augen or remnants of larger grains to be seen. Smaller and larger grains are present, but there is no distinct evidence of the larger breaking up into the smaller. A grain or two of plagioclase is seen in each slide, as well as one or two very small decomposed remnants of what may have originally been minute mica scales.

Complete granulation.

The structure suggests a completely granulated rock, in which the granulation has, perhaps, been effected in part, at least, by re-crystallization.

Distribution of the gneiss.

Gneisses presenting this leaf structure with its accompanying microscopic characters are abundant and occur in many widely separated parts of the area embraced in this report. They are for instance, very extensively developed in the last range of the township of Cartier, being excellently exposured on the shores and islands of the typical little Laurentian lakes which lie between the two branches of the River L'Assomption, one of which runs out of Lac des Ilets, and the other out of Lake L'Assomption. Several of these lakes are rock-basins which have been excavated out of this gneiss. The gneiss from this locality (section 348), closely resembles that above described, although the quartz leaves are not so sharp and regular, and plagioclase, in clear, brightly polarizing grains, is more abundant. There are also a number of little scales of biotite scattered through the rock as well as a few very small isotropic red garnets. As before, the appearance under the microscope is suggestive of granulation with at least partial re-crystallization, although no absolute proof of this can be obtained. At many places in the township of Brandon also leaf-gneiss occurs interbanded with pyroxene-granulite, quartzite, &c., consisting as before of quartz and orthoclase, iron-magnesia constituents being absent or represented by a few grains of iron ore. One of these localities is lot 13 of range VI. (section 685), by the side of the road which crosses this lot, where the gneiss is interbanded with pyroxene-granulite and often cut by irregular-shaped masses of augen-gneiss, running now with and now across the direction of foliation as above described.

On lots 18 of range V. and 15 of range IX. (section 576), of the same township, this same variety of gneiss is also well exposed, the latter locality being at the westerly contact of the most eastwardly of the anorthosite masses which occur in this township. In the very fine-grained felspar groundmass of these rocks, however, occasional larger grains of orthoclase can be seen which are much twisted, show a very uneven extinction, and can in some cases be seen to be undergoing a process of peripheral granulation, giving rise to smaller grains like those of the groundmass. In the rock from the latter locality also, sections show distinctly that a movement in the direction of the foliation has taken place in the felspar mosaic, during or subsequent to its formation.

Transitional Forms.

Between augen-gneiss and leaf-gneiss all possible intermediate varieties are found in various parts of the area. Such intermediate forms present leaves or thin layers of quartz alternating with layers of finely granular orthoclase, in which the augen or remnants of large orthoclase individuals are more or less abundant. When these augen are large and abundant the rock approaches an augen-gneiss on one hand; when the granulating process has so far advanced that they have become greatly reduced in number and size, or have almost disappeared, the rock passes gradually over into a leaf-gneiss on the other. Gneisses are often found which would be classed as leaf-gneiss but which on careful examination show a few minute twisted remnants of orthoclase augen, here and there, indicating the true character of the rock.

Transitional forms.

The great granite mass occupying the eastern side of the township of Brandon, along its northern limits assumes first the form of an augen-gneiss, and then passes over into such a leaf-gneiss (section 660), which, however, is poor in quartz, the transition being excellently seen on the shores of Lake Sacacomie, which lies just beyond the eastern limits of the map. Many similar cases of pegmatites passing into augen-gneiss and then into leaf-gneiss have been observed, and even when the transition cannot be seen, transitional forms are so common as to render the conclusion inevitable that many at least if not all the typical leaf-gneisses have been derived from the crushing or foliation of coarse granite rocks, having passed through the intermediate stage of augen-gneiss. In a similar manner those forms of leaf-gneiss in which the quartz individuals are smaller, occurring in the form of little dashes or scales rather than leaves, have probably been formed from finer grained rocks of similar character, passing through an intermediate stage such as that described in the Trembling Mountain gneiss, which, after all, is a species of microscopic augen-gneiss. In the movements which have taken place in these rocks, resulting in the development of a foliated structure, the processes at work are, it is believed, chiefly mechanical.

The structure of mechanical origin.

In certain districts which have been made the subjects of careful study elsewhere, structures resembling closely those above described have been thought to have been produced by the breaking down and re-crystallization of the original constituents. This does not seem to be true in these Laurentian gneisses—for in the case of the felspar and hornblende the granulated material is exactly the same to all appearances as the larger augen. Even when the latter consist of microperthite the granulated material has also the same character, which would hardly be expected if a re-crystallization had taken place. Sericite and the various other minerals so often produced during the re-crystallization of rocks under the influence of pressure are also absent.

The effect of the pressure on the quartz is especially remarkable, for, as has been stated, the individuals of this mineral are not granulated or broken up into smaller grains, but take upon themselves the form of thin leaves or laths, often eight or ten times as long as they are wide, and in the case of the augen-gneiss often following curved courses.

These leaves do not show, as a general rule, the intense strain-shadows often observed in the felspar augen, but almost always show evidences of strain at intervals along the length of the leaf, dividing the latter in this way into certain ill-defined areas with slightly different orientation. The leaves also, as has been stated, can be observed to bend around large orthoclase remnants and sometimes to fork at their extremities. A very long lath of quartz will also in some instances break across, giving several elongated fragments arranged in a line.

Like that of quartz-porphyry at Thal.

That these phenomena are the result of a purely mechanical rolling out of quartz individuals cannot be positively asserted, but they are to all appearance so produced. There is no evidence of any breaking with a restoration of continuity by the deposition of secondary quartz. The process therefore appears to be quite different from that described by Lehmann in the Saxon granulites* but is identical with that seen in the squeezed dykes of quartz-porphyry at Thal, near Eisenach, in Thuringia,† and elsewhere. These dykes, which cut through a series of mica-schists, have had a well marked foliation induced in them parallel to that of the country-rock but often transverse to their own length. The phenocrysts consist of orthoclase, plagioclase and quartz, which are arranged in the groundmass with their longer axes in the direction of the foliation. The felspars and especially the plagioclases have broken into fragments under the pressure to

* Entstehung der altkrystallinen Schiefer Gesteine, S. 250.

† Futterer.—Die Ganggranite von Grossachsen u. d. Quartzphorphyré von Thal im Thuringen. (Inaug Diss. Heidelberg, 1890.)

which the rock has been subjected, which fragments are arranged in lines in the direction of the foliation resembling in that respect the Belemnite fragments in the Bündner Schiefer of the Alps. The spaces between the broken fragments are filled not with the groundmass squeezed into the cavity but with grains of quartz and sometimes felspar, coarser in grain than the groundmass, and which although probably secondary is not derived from the broken phenocrysts, since it can be seen that the several portions of these if brought together would fit closely into one another.

The quartz phenocrysts, on the other hand, are drawn out into cigar-like forms, often eight times as long as they are wide. These are not broken or granulated but are sharply defined against the groundmass and sometimes have a curved form. Occasionally little elongated strings resembling the groundmass are seen within the quartz phenocrysts, which were in all probability inclusions of the groundmass in the original phenocrysts that became rolled out with the phenocrysts themselves. All these elongated quartz phenocrysts present remarkable extinction phenomena. Each individual extinguishes nearly simultaneously over its whole surface, but when carefully examined is seen to divide up into a number of little fields extinguishing in succession, not however sharply separated but merging into one another so that the shadow sweeps over the field with a peculiar twinkling effect.

Plastic deformation of quartz.

This appearance is identical with that seen in the quartz of many gneisses. There is no evidence of breaking and re-cementing, as there is no interruption in optical continuity in the individual as there must be if this had taken place. The phenomenon is probably the same as that exhibited in the plastic deformation of ice crystals recently studied by Mügge.* It is thus evident that under certain conditions when felspar is crushed or granulated, quartz undergoes a rolling out or elongation without breaking, molecular movements taking place in some peculiar way, which result in an entire change in form while the individual still retains an approximately uniform extinction. In this way, in the Laurentian system, granitic rocks became gneisses. It is extremely rare in these rocks to find quartz grains which have been broken or granulated, and although as investigation proceeds it may be found that the granulation of the felspar and bisilicates is in part a chemical process, the evidence at present available tends to the belief that, as in the case of the anorthosites, to be referred to later on, the process is chiefly mechanical. In other rocks of this system, how-

* Ueber die Plasticität der Eiskrystalle. Neues Jahrbuch für Mineralogie &c. 5, II. 3, p. 212.

ever, as well as in other districts of crystalline schists, re-crystallization and chemical re-arrangement have undoubtedly played a chief part.

Class II.—Gneisses, Limestones, Quartzites, &c., of Sedimentary Origin.

Another class of gneisses, quite different in composition and structure from those above described, occurs abundantly in many widely separated parts of the area at present under discussion, as well as in all other parts of Canada where the Grenville series is found. Intimately associated with these gneisses are other rocks whose composition also makes it impossible to class them with rocks of igneous origin: these are the crystalline limestones and quartzites which form such a prominent petrographical feature of the Grenville series. Rocks of sedimentary origin.

The criteria by which gneisses having a sedimentary origin may in many cases be recognized have already been indicated, and the very fact that the rocks just mentioned and included in the present class are almost invariably closely associated with one another, is in itself additional evidence of their common sedimentary origin.

The gneisses of this class, while under the microscope still seen to contain a certain amount of quartz and orthoclase, are made up very largely of garnet and sillimanite, which are their most important constituents. These and other differences in their composition are accompanied by differences in structure as well. One set of these rocks is characterized by a rapid disintegration when exposed to the weather, giving rise to a sand-like product very rusty in colour and which is very characteristic. A second set are very similar in composition, but do not weather in the same rusty manner. Gneisses.

As typical of these rusty-weathering gneisses, the following occurrence may be taken :—

Garnetiferous Sillimanite-Gneiss—About one mile west of the Church of St. Jean de Matha, Seigniory of De Ramsay. (Sections 648, 649).

This gneiss occurs in thick bands, interstratified with and overlain by the white garnetiferous quartzite described on page 62 J, the whole lying very nearly horizontal. The gneiss weathers exceedingly rusty, but on the fresh surface is seen to be fine in grain and dark-gray in colour, small garnets and graphite scales being readily recognized in it. It is more uniform in character than is usual in gneisses, the strike St. Jean de Matha.

being marked by bands somewhat richer or poorer in garnet, or by other slight differences in composition.

Under the microscope the rock is seen to consist of garnet, sillimanite and quartz in large amount, with some orthoclase and iron pyrite, and a little biotite, rutile and graphite. (Plate IV., Fig. 3.)

The garnet individuals, which are usually large, are more or less rounded in form, but frequently elongated in the direction of the foliation, and, as is usually the case in these Laurentian gneisses, are perfectly isotropic. They frequently hold inclusions of quartz, sillimanite and rutile, and present the appearance of having grown in the rock and inclosed these other older constituents.

Sillimanite.

The sillimanite occurs in colourless elongated prisms from ·05 to ·25 millimetres in diameter, the longest individuals being somewhat over 1·1 millimetres in length, and often slightly curved, apparently by pressure. It has a rather high index of refraction, as well as a rather high double refraction. The longitudinal sections show the cleavage parallel to the macropinacoid as a series of fine lines parallel to the longer axis, except when cut parallel to this face. They also show the transverse cracks usually seen in long and slender prisms. When tested by means of the quartz wedge it is found that $c = \mathfrak{c}$. Terminal faces cannot be recognized. In transverse sections the prisms are seen to have the nearly square cross section of the prism $\infty P\frac{3}{2}$. The cleavage crosses these sections diagonally, and in the direction of this cleavage lies the plane of the optic axes, the axial angle being small. These properties serve to identify the mineral and to distinguish it from wollastonite or andalusite, which in certain respects it resembles. (Plate IV., Fig. 4.)

The quartz, which is uniaxial and positive, contains, as is very frequently the case in these gneisses, many minute straight hair-like inclusions, which are dark in colour. In the great majority of cases, it shows a more or less pronounced uneven extinction, and the grains are often long and narrow, the longer axes lying in the direction of the foliation.

Pyrite and graphite.

The orthoclase possesses the usual characters, and between crossed nicols sometimes has the faintly fibrous appearance often seen in the orthoclase of gneisses, the larger grains showing strain-shadows as in the case of the quartz. The biotite occurs in very small amount, and in small individuals of a deep brown colour, here and there slightly twisted. The rutile appears as a few irregular-shaped, nearly opaque, little grains. The pyrite, the presence of which gives rise to the rusty weathering of the rock, and which occurs in considerable amount, is in the form of little irregular-shaped strings and masses scattered through the rock. It frequently occupies little cracks running through the various other minerals or surrounding them. It sometimes occurs well crystallized, but is often very fine-grained and in little masses having a concentric banded structure like that seen in agate, the mineral having evidently been deposited in little cavities subsequent to the crystallization of the rock and being frequently related to the graphite in such a way as to suggest that the pyrite had been deposited owing to a reducing action on the part of the carbon. The graphite, which in the hand specimens seems to be somewhat abundant, is seen in the thin sections to occur in the form of small elongated individuals, black and quite opaque.

A study of the thin sections also shows the rock to be quite different from the quartz-orthoclase-gneisses already described, not only in mineralogical composition but also in structure. The elongated individuals of sillimanite, quartz, etc., lying in one direction, mark the foliation of the rock, though this is not very pronounced.

No evidence of granulation, however, is to be seen, the pressure which granulated the gneisses of the last class, having, to all appearances, crystallized these *in situ*, the constituents being, in the nomenclature of Milch, "eleutheromorphic."* The uneven extinction of the sillimanite, quartz, and orthoclase would, however, seem to indicate that the rock had been subjected to some pressure since their development; but on the other hand, the garnet, which was developed later being quite isotropic, would seem to have been produced during the final compression of the rock.

No evidence of granulation.

Another locality at which a gneiss almost identical in character occurs is in the front of lot 4 of range X. of the township of Brandon. (Section 680). Where the road crosses this lot there are large exposures of gneiss consisting of an alternation of small bands of augen-gneiss and leaf-gneiss holding little augen, with other rocks of the nature of amphibolite or pyroxene-granulites often holding quartz; as well as with a few bands of this rusty garnetiferous sillimanite-gneiss and some calcareous gneiss or very impure limestone. Both the augen-gneiss and the amphibolite-gneiss occasionally hold garnets. The rusty-weathering gneiss is seen under the microscope to be composed essentially of garnet, sillimanite, orthoclase and quartz, with pyrite, rutile and biotite in very subordinate amount. The garnet, as before,

Garnet.

* Beiträge zur Lehre von der Regionalmetamorphose—Neues Jahrbuch für Mineralogie, IX Beilage Band. S. 107.

is in the form of irregular-shaped masses, having a sponge-like character owing to the numerous inclusions of biotite, felspar, sillimanite and rutile which it contains, it is as in the rock last described quite isotropic. The pyrite occurs filling little cracks and was apparently infiltrated after the crystallization of the rock. No graphite is to be seen in the specimen or slide. This rock, like that from near St. Jean de Matha, shows no evidence of cataclastic structure, but has apparently resulted from an entire re-crystallization *in situ* under pressure. The same is true of the quartzose garnetiferous gneiss interbanded with this rusty gneiss.

There can be no doubt in the case of these exposures, that the augen-gneiss and the leaf-gneiss produced from it, are of igneous origin.

Two other occurrences of this peculiar rusty-weathering gneiss may also be referred to; in these, however, the orthoclase has a granulated appearance, although no absolute proof of its cataclastic origin can be obtained.

Garnetiferous Sillimanite-Gneiss—Road between the Township of Kildare and Lake Rocher—Seigniory of D'Argenteuil. (Section 302.)

Kildare.

At this locality there are a series of exposures representing a very considerable thickness of strata made up of an alternation of grayish quartzose gneiss, with thick bands of white garnetiferous quartzite and of this rusty-weathering gneiss. There is also in one place a band of white crystalline limestone, holding grains of dark-green serpentine. This is exposed for a width of twenty feet, and occurs interstratified between a band of white quartzite and one of the rusty gneiss. All these rocks frequently hold a little graphite. The rusty-weathering gneiss as before consists of garnet, orthoclase, quartz and sillimanite with pyrite and a little rutile and graphite. The contrast between the very rusty weathered surface of this gneiss and the pale-gray almost white colour of its surface on a fresh fracture is very striking.

Garnetiferous Sillimanite-Gneiss—Township of Kildare, near the line between Ranges XI. and XII. (Section 436.)

This locality is just to the west of Lake Français, and on a continuation of the same section as that in which the last-mentioned rock occurs, but about three miles further west. It is the first exposure on the road, to the west of the anorthosite band which passes under the lake. The rock consists essentially of garnet, sillimanite, quartz and orthoclase, the garnet often inclosing the sillimanite. It is almost identical in character with the rusty-weathering gneiss of the other localities described above.

As examples of the second set of these rocks before mentioned, which, while very similar to those just described, do not contain pyrite, and consequently are not distinguished in the field by the rusty sand-like disintegration product, the following may be selected :—

Garnetiferous Sillimanite-Gneiss—3 miles north-west of St. Jean de Matha—Seigniory of De Ramsay. (Section 563.)

North-west of St. Jean de Matha.

This rock occurs three miles in a straight line north-west of St. Jean de Matha, at the bridge where the road from this place to Ste. Emilie crosses the Black River. The gneisses here lie practically horizontal. The rock is red in colour, and highly garnetiferous.

Under the microscope the rock is seen to be composed of garnet, sillimanite, quartz and orthoclase, with smaller amounts of rutile, serpentine, pyrite, graphite and biotite. The general characters of these minerals are the same as those which they present in the rocks of the last set just described.

The garnet is perfectly isotropic. The sillimanite is present in considerable amount, in prisms whose long axes lie parallel to the foliation of the rock. The quartz contains a great abundance of minute, black, hair-like inclusions, quite straight and arranged in several intersecting series. The orthoclase has a distinctly fibrous appearance, owing, in part at least, to the presence of little, rod-like inclusions, some black and nearly opaque, others transparent and nearly colourless. The rutile is present in deep brown, nearly opaque grains, sometimes having a tolerably good prismatic form, but generally more or less rounded. The serpentine occurs in a few large grains derived from the alteration of some mineral, which has now entirely disappeared. Graphite is scattered through the rock in numerous little flakes. The biotite occurs in very small amount, often inclosed in the garnet. Only a very few small grains of pyrite are present.

The rock, as has been stated, is very highly garnetiferous, the garnet occurring in lumps of a pink colour, making up a large part of the rock, the other constituents of the rock being much more fine in grain and flowing round the large garnet lumps, thus giving rise to an indistinct foliation in the direction of the motion. The structure, however, is quite different from that of augen- or leaf-gneiss, for the study of the thin sections affords no indication of granulation. The large garnet lumps crystallized *in situ* and are uncrushed. They are not remnants of larger masses which have escaped complete granulation. The sillimanite appears to be somewhat broken in places, but this is not certain, and a study of the thin sections proves that at least some, if not all, the constituents of the rock have been produced by a process of re-crystallization.

Sillimanite-Gneiss.—West shore of Trembling Lake. (Section 591.)

Trembling Lake gneiss

The geology of Trembling Lake, which large sheet of water lies near the north-west corner of the accompanying map, is of especial interest. Along the eastern shore of the lake rises Trembling Mountain, the highest point in this part of the Dominion, and which, as already stated, is cited by Logan as the typical occurrence of his fundamental gneiss. The gneiss composing Trembling Mountain is very uniform in character and, as has been shown on page 43 J, consists of a great mass of squeezed igneous rock. Running up through the lake, and exposed at its southern extremity, as well as on the islands in the lake, is a heavy band of white crystalline limestone. Associated with this, and well exposed on the shores of the southern portion of the lake, especially on the western side, are garnetiferous and sillimanite gneisses in considerable variety. On the eastern side these form a narrow border, in some places graphitic and holding interstratified bands of quartzite, which is succeeded by the Trembling Mountain gneiss a short distance inland. At the north-western end of the lake coarse granite-gneiss, with scarcely perceptible foliation and no banding, comes in.

One variety of the gneiss, occurring on the west shore of the lake and about a quarter of the way up the lake from the southern extremity, was selected for examination.

The rock, which weathers somewhat rusty, is fine-grained and dark purplish-gray in colour on fresh fracture, looking somewhat like a fine mixture of pepper and salt. It consists essentially of orthoclase and quartz with a large amount of biotite in little flakes. Running through the rock are little interrupted wavy streaks, white in colour, and apparently parts of what were once continuous little bands. These consist essentially of sillimanite in minute acicular crystals (Plate IV., Fig. 4) and, having a rudely parallel direction, give to the rock, which is otherwise massive, an indistinctly foliated appearance.

Figure 6.—Sillimanite-Gneiss, west shore of Trembling Lake. Sillimanite, Quartz, Orthoclase, Biotite and Pyrite. × 38.

The accompanying figure (No. 6) shows the appearance of the rock under the microscope, portions of two bands rich in sillimanite with an intervening band rich in biotite being shown. As accessary constituents present in small amount, the rock contains garnet, titaniferous iron ore, a few grains of pyrite and of a mineral which has the characters of allanite, pleochroic in pale brownish and green tints and deeper in colour in the interior of the grain. These constituents are bounded by well defined, sharp lines; there is no granulation, and no twisting of the grains. The rock has the appearance of having been entirely recrystallized, and resembles certain altered rocks found in the contact zones about great granite masses.

It bears as strong a resemblance to a metamorphosed sediment on one hand as the rock of Trembling Mountain does to an igneous mass on the other—resemblances which in each case are emphasized by the chemical composition of the rock. Resemblance to altered sedimentary rocks.

Garnetiferous Sillimanite-Gneiss.—Darwin's Falls on River Ouareau, near Village of Rawdon, Township of Rawdon. (Sections 637, 638.)

At Darwin's Falls, which are about a quarter of a mile below the lower bridge at Rawdon, the river cuts its way through a gorge of Laurentian rocks which are well banded and dip to the west at a high angle, the attitude being nearly vertical. The gneiss is in most places highly garnetiferous, the pink garnets occurring in lumps sometimes as much as an inch in diameter, and is interstratified with bands of white quartzite (described on page 62 J), some of which are highly garnetiferous, while others are nearly free from garnet. There are also bands of felspathic quartzite. The bands of these various rocks, which have all the appearance of beds, are from a few inches to several feet in thickness.

Darwin's Falls

In one place a little string of crystalline limestone about an inch wide was found, but no larger band could be discovered: to the north, however, nearly on the strike of these exposures, a heavy band of crystalline limestone appears, which may possibly cross the river just above the village, where the banks are heavily drift-covered. This locality has already been referred to in describing the distribution of the limestone bands on page 25 J. The microscopic character of the quartzite interbanded with the gneiss, is described on page 62 J.

The gneiss contains much garnet and sillimanite, but differs from the gneisses of the class before described, in that it is much more highly quartzose.

The garnet occurs in numerous irregular-shaped grains with the peculiar arm-like extensions running out into the web of the rock in all directions and inclosing individuals of the other constituents. Orthoclase, quartz, sillimanite, biotite, rutile and iron ore have been observed thus inclosed in the garnet, so that the latter mineral would appear to

Figure 7.—Garnet holding inclusions of other constituents of the rock—Garnetiferous Sillimanite-Gneiss—Darwin's Falls, near Rawdon.

Garnet with inclusions.

have been developed later than any of the other constituents of the rock. This peculiar mode of growth on the part of the garnet is seen almost invariably in the garnetiferous gneiss of the Laurentian, as well as in the highly altered sedimentary strata folded into the Alps

(Bundner Schiefer) and elsewhere, and has already been noted as occurring in some of the rocks described above. The mineral appears to add to its substance in all directions in which material which will yield garnet can be reached, and even seems to be assimilating or in some way getting rid of grains of the most diverse minerals which it has inclosed, minute irregularly rounded remnants of many of these alone remaining in the interior of the garnet individuals, while the peripheral portions are often still full of inclusions. How this is accomplished it must be left for future investigation to decide, for, in the manner in which these garnets and other minerals developed by metamorphic processes grow in solid rocks, there is much which is as yet mysterious and not by any means thoroughly understood. The garnet filled with inclusions, in its want of continuity often resembles a sponge, or a great Amœba whose substance is barely sufficient to inclose the miscellaneous collections of objects on which it is feeding. In addition to the garnets and quartz, orthoclase and sillimanite are abundant, while biotite, rutile, iron ore, pyrite, and zircon(?) are present in small amount, all these minerals presenting the normal characters of the several species.

The rock has an indistinct foliation, due in part to the arrangement of the various minerals with their longer axes in one plane, and in part to a certain variation in relative abundance of the different minerals in different planes. The quartz and orthoclase show effects of pressure, but no undoubted granulation or distant cataclastic structure is seen in the slides, neither are there any augen. The garnet and sillimanite are certainly due to re-crystallization, and the evidence goes to show that the rock as a whole has resulted from this process. It has, however, since re-crystallization, been subjected to a certain amount of pressure, for although in some cases the quartz and orthoclase show slight evidences of pressure this has not affected the garnet at all.

Chemical Composition of the Gneisses of Class II.

In order to ascertain whether the gneisses of Class II., which differ so distinctly in mineralogical composition and structure from those of Class I., present differences in the chemical composition of the rock as a whole, three of the most typical gneisses of the class were selected from those described and were analyzed. The results of these analyses are given below. No. III. was made for me by Mr. Nevil Norton Evans, of McGill University, and Nos. IV. and VII. by Mrs.

Chemical composition of gneisses of Class II.

Walter C. Adams, B.A.Sc. To both gentlemen I desire to acknowledge my great indebtedness.

	III. GNEISS. — St. Jean de M.	IV. GNEISS. — Trembling Lake.	V. SLATE. — Wales.	VI. SLATE. — Melbourne.	VII. GNEISS. — Rawdon.	VIII. SLATE. — Tinzen.
Silica	61·96	57·66	60·50	64·20	74·70	79·97
Titanic oxide	1·66	....	....	....	....	....
Alumina	19·73	22·83	19·70	16·80	8·88	8·62
Ferric oxide	....	....	....	....	9·64	6·63
Ferrous oxide	4·60	7·74	7·83	4·23	....	....
Ferric sulphide	4·33	....	....	....	....	....
Manganous oxide	trace.	trace.	trace.	....	·50	....
Lime	·35	1·16	1·12	·73	1·07	·76
Magnesia	1·81	3·56	2·20	3·94	1·87	1·52
Soda	·79	·60	2·20	3·07	·42	·64
Potassa	2·50	5·72	3·18	3·26	·95	2·30
Loss on ignition	1·82*	1·50	3·30	3·42	1·05	....
	99·55	100·77	100·03	99·65	99·08	100·44
Total alkalies	3·29	6·32	5.38	6·33	1·37	2·94

* Water.

III. Gneiss from about one mile west of St. Jean de Matha. A fine-grained garnetiferous sillimanite-gneiss, containing much quartz and orthoclase. Graphite and pyrite are also present, the latter causing the gneiss to weather to a very rusty colour. It occurs in thick bands interstratified with white garnetiferous quartzite, the whole lying nearly flat. (See page 49 J).

IV. Gneiss from the west shore of Trembling Lake. A fine-grained dark gray gneiss, composed of quartz and orthoclase, with much biotite and sillimanite. It occurs near a band of crystalline limestone which occupies the bed of Trembling Lake. (See page 54 J).

V. An ordinary roofing slate from Wales. Analysed by T. Sterry Hunt. (Phil. Mag., 1854, p. 237.)

VI. A similar roofing slate of Cambrian age from the large quarries in the Township of Melbourne, in the southern portion of the province of Quebec. Analysed by T. Sterry Hunt. (Geology of Canada, 1863, p. 600.)

VII. Gneiss from Darwin's Falls, near the village of Rawdon, province of Quebec. It is a highly quartzose garnetiferous gneiss, and occurs in well defined bands interstratified with quartzite, which is often highly garnetiferous, the bands being from a few inches to several feet in thickness. (See page 56 J).

VIII. Red slate from near Tinzen, in the district north of the Engadine, Switzerland. Highly siliceous, containing 9·12 per cent of silica as quartz. (Vom Rath, Z. D. G. G., 1857, p. 242.)

Different in composition from any igneous rock.

It will be seen, on comparing the analyses of these three gneisses (III., IV. and VII.) with the analysis of the Trembling Mountain gneiss, given on page 43 J, that they are quite different in composition. They are, in fact, quite different in composition from any igneous rock. On the other hand, the high content in alumina (in III. and

IV.), the low percentage of alkalies, and the great preponderance of magnesia over lime, characteristic of shales and slates, will be noted. The rocks thus present chemical evidence of having undergone a leaching process. (See page 35 J.)

The high percentage of alumina with low alkalies is due to the presence of sillimanite, a mineral very common in the crystalline schists, but seldom or never found in large amount in unaltered igneous rocks.

Composition of granites and shales.

The marked difference in composition between granites and shales or slates is distinctly seen on comparing the analyses of a series of granites with those of a series of slates, as, for instance, those given in Roth's "Gesteins Analyzen." The latter are seen to be on an average considerably higher in alumina and much lower in alkalies, while at the same time they are lower in silica, which has been separated both as sand and in combination with the alkalies which have gone into solution, and in most cases contain more magnesia than lime instead of more lime than magnesia, as is usual in granites.

The average percentage of alkalies in the thirty-seven analyses of granites from various parts of the world given by Roth in his work above mentioned is 7·35 per cent, while twenty-three primitive clay-slates (Urthonschiefer) contain on an average only 4·70 per cent and twenty-five slates of Silurian age 4·82 per cent of alkalies. The slates thus contain on an average about two-thirds of the amount of alkali present in the average granite.

Effects of decomposition of granites.

The changes which a granite undergoes when it is decomposed by the action of the weather have been well brought out by an excellent study of the chemical composition of the fresh and the decomposed granite of the district of Columbia, by Prof. Merrill, in which the decomposed rock was found to have lost 25·21 per cent of lime, 28·62 per cent of soda, 31·98 per cent of potassa and 14·89 per cent of silica, but only 3·23 per cent of alumina, and 1·49 per cent of magnesia.* A result which, so far as the alkalies are concerned, agrees very closely with the average loss indicated in the case of the forty-eight slates referred to above.

A typical slate is thus distinctly different in chemical composition from an ordinary granite, although sediments having an intermediate composition are frequently produced by the disintegration of granite

* Referred to in a paper entitled Disintegration and Decomposition of Diabase at Medford, Mass., Bull. Geol. Soc. of America, 1896, p. 357.

without complete decay, giving rise to such rocks as arkose, grauwacke felspathic sandstones and so on.

The strongly marked resemblance in composition to slates on the part of the gneisses from St. Jean de Matha and Trembling Lake is seen when their analyses are compared with those of the two slates Nos. V. and VI. They have, in fact, the composition of ordinary roofing slate.

No. VII., which is a gneiss so highly quartzose that it might almost be termed an impure quartzite, also has a composition differing from that of any igneous rock, but one which is identical with many siliceous slates. No. VIII. is the analysis of such a slate from the Engadine district in Switzerland, and is, as will be seen, almost identical with No. VII. Siliceous bands from some of the Canadian slate quarries, also have a similar composition. The alumina in this case is low on account of the preponderance of quartz, which also lowers the alkalies. The magnesia, as before, preponderates over the lime. No. VIII. lost 1·92 per cent on ignition before analysis, and these figures do not, therefore, appear in the analysis as given above.

Analyses of slates.

That there is nothing remarkable in the interstratification of bands of gneiss differing greatly in composition in the same series of exposures as at Darwin's Falls, supposing them to be highly altered sediments, is well shown by the following analyses of two varieties of slate taken from different bands in the same quarry, in rocks of Cambrian age, at the Danville Slate Quarry, in the province of Quebec, south of the St. Lawrence. They were made by Dr. J. B. Harrington, and have not hitherto been published.

	IX. Slate. — Danville.	X. Slate. — Danville.
Silica	55·75	67·85
Alumina	17·87	9·10
Ferrous oxide	9·07	11·14
Manganous oxide	·70	·79
Lime	1·14	·98
Magnesia	5·81	3·23
Soda	1·12	1·80
Potassa	2·97	·44
Loss on ignition	5·26	4·55
	99·69	99·88
Total alkalies	4·09	2·24

Amount of carbon present.

The amount of carbon present was determined in No. IX. and found to be ·26 per cent; all the iron was found to be present in the ferrous state. These two slates, as will be seen, contain the proper relative proportion of constituents for the formation of gneisses like those just described. No. IX. might, if submitted to the proper conditions for its metamorphosis, produce a gneiss similar, in a general way, to that from Trembling Lake, but poorer in sillimanite, while No. X. would crystallize into a gneiss like that from Darwin's Falls (No. VII.), but less quartzose.

In these gneisses which have been classed as of sedimentary origin, we have therefore rocks which have the chemical composition of shales or slates, a mineralogical composition quite different from that of the gneisses of Class I., and a structure which shows that they have been produced essentially by a process of re-crystallization. These facts, it is believed, taken together, establish the right of these rocks to be considered as altered sediments. The effects produced by the dynamic metamorphism are along the same lines as those observed by Heim in the Alps, the same force which crushes the highly crystalline rocks into finely granular schists, re-crystallizes the sedimentary rocks, often developing large individuals of various new minerals in them. It is not, however, claimed that all granulated rocks in the Laurentian are of igneous origin or that all re-crystallized gneisses are altered sediments.* If any arkoses or coarse felspathic sandstones were deposited with the shales, those being very similar to granite in character would probably be altered by crushing and granulation to gneisses almost identical in appearance, and under the microscope with those produced from granites; futher study may indeed show this to be the origin of some of the quartzose orthoclase-gneisses associated with the garnetiferous sillimanite-gneisses above described. It is also possible that certain igneous rocks have undergone a complete re-crystallization during metamorphism. It is desired in the present contribution to our knowledge of these rocks merely to show that certain of these gneisses have had a sedimentary origin, and that certain others can be recognized as altered igneous rocks, while very many still remain whose origin is, as yet, undetermined.

All granulated rocks not igneous.

Distinct from the little strings and veins of quartz which are often found cutting the rocks of this as of all other great districts of crystalline strata, are the well defined and often very thick bands of quartzite which occur regularly interbanded or interstratified with the gneiss and crystalline limestones of the district. Of these the following three occurrences may be selected as typical:—

Quartzites.

* See C. J. Smyth, Jr., Metamorphism of a Gabbro occurring in St. Lawrence County, N.Y. Am. Jour. Sci., April, 1896, p. 280.

Garnetiferous Quartzite—About one mile west of the Church of St. Jean de Matha, Seigniory of De Ramsay. (Sections 573, 661).

Garnetiferous quartzite.

This rock occurs interstratified with and overlying the garnetiferous sillimanite-gneiss described on page 49 J, forming great exposures extending off to the north-west. One great cliff of these rocks, interstratified with garnetiferous quartzose gneiss, is represented in the photograph reproduced in Plate III. The beds, as will be seen in the photograph, are practically horizontal.

The quartzite is of medium grain and brownish-gray colour, and holds numerous garnets, often as much as an inch in diameter. Bands richer or poorer in garnet or showing other slight differences in character alternate with one another. Under the microscope the rock is seen to consist essentially of quartz and garnet. Sillimanite is present in considerable amount with accessary orthoclase, plagioclase, biotite, and rutile. The indistinct foliation of the rock is caused by the arrangement of the various constituents with their long axes in one direction.

St. Jean de Matha.

The quartz consists of larger grains with streams of little ones running between them, almost every large grain showing well marked strain shadows. It presents the appearance of having been crushed or granulated, the broken material often sweeping in curves around the large garnets. The garnets are isotropic and hold many inclusions of quartz, sillimanite, and rutile. The sillimanite occurs in the long and slender individuals, with parallel extinction and small axial angle already described from the associated gneisses. The rutile is brown in colour, a single elongated individual often penetrating several grains of quartz. The felspars and biotite do not occur in all sections.

Although no augen of quartz are seen, for this mineral, as has been shown, does not usually develop augen on crushing—the rock presents the appearance of having been greatly crushed.

Quartzite—Darwin's Falls, near the Village of Rawdon, Township of Rawdon. (Sections 633, 635.)

Darwin's Falls.

The rock occurs in beds or bands, from a few inches to several feet in thickness, regularly interstratified with the garnetiferous sillimanite-gneiss described on page 56 J. Some of the bands are highly garnetiferous, others are free from garnet, while others again contain a considerable amount of felspar. Under the microscope the rock closely resembles that just described from west of St. Jean de Matha. It consists of quartz, with small quantities of orthoclase and garnet and accessary biotite, rutile, zircon, ilmenite, leucoxene and pyrite. The rock is seen to be foliated owing to the presence of a few little lines of felspar grains running through it in one direction, and it may be considered as a very quartzose variety of the associated gneiss above referred to.

The quartz consists of larger grains, surrounding which and running into them in irregular bays and arms, are areas consisting of much smaller quartz grains. The large grains show strongly marked pressure phenomena when examined between crossed nicols, being divided into areas differing slightly in orientation, although the continuity of the grains is preserved. It contains great numbers of minute black hair-like and dust-like bodies, the former quite straight, which traverse the rock in somewhat wavy lines and in a direction nearly at right angles to the foliation, passing from one grain into another without deviating from their course, and were evidently developed after the rock had its present texture. The orthoclase is present in small amount, and frequently shows strain shadows. Its appearance suggests granulation, although there are no augen remaining to prove this. The garnet is present in the form of more or less rounded grains, often somewhat elongated in the direction of the foliation. It is isotropic, and as usual holds a few inclusions consisting of the other minerals of the rock. The other constituents possess the usual characters. On the whole the evidence, while not conclusive, goes to show that the rock has undergone a granulation previous to the crystallization of the garnet, or in which the garnet was not broken. Professor Rosenbusch believes that in some of these Rawdon quartzites original clastic quartz grains with enlargements due to the deposition of secondary silica can be detected.

Quartzite—Pont de Dalles, River L'Assomption (Section 667).

This locality is rather over a mile to the east of Ste. Béatrix. The rock occurs interstratified with several varieties of gneiss, some of them holding raspberry-red garnets as much as two inches in diameter. It is composed almost exclusively of quartz in elongated grains, giving a foliation to the rock. A few grains of garnet and a few scales of graphite can be detected by the unaided eye. While under the microscope, orthoclase, sillimanite, rutile and zircon are seen to be present in small amount as accessary constituents. The weathered surface exhibits numerous scolithus-like holes, which, however, are not continuous for any considerable distance, and are found on examination to be due to the weathering out of garnets. The flattened quartz

Pont de Dalles.

grains have as a general rule an extinction making an angle of 40° to 45° with their long axes, and contain the same dark inclusions described in the quartzite from Darwin's Falls, similarly arranged. The grains come together along irregular serrated lines and show a marked uneven extinction, although little or nothing in the way of actual granulation can be detected.

Crystalline limestone.

The petrography of the Laurentian limestones, so far as these can be studied macroscopically, has been exhaustively treated by Sterry Hunt in his Report on the Laurentian Limestones of North America.* The limestones of the district at present under consideration differ in no way from those of other Laurentian districts described in the report in question. They are usually comparatively pure and only a few of the fifty-four minerals described by Hunt as occurring in the Laurentian limestones have been recognized in them. Of these graphite, mica, pyroxene, serpentine and quartz are most frequently seen. They are usually rather coarse in grain, never very fine-grained or compact and where exposed to the weather disintegrate into masses of calcite grains resembling coarse white salt in appearance, or else are dissolved away by the rain leaving smooth undulating surfaces. Considerable quantities of the disintegrated limestone occurs on some of the islands in Trembling Lake. Although white or nearly white on a fresh fracture, these limestones, like those of other parts of the Laurentian, often weather black, apparently owing to the growth upon exposed surfaces of a very minute black lichen.

Effect of weathering

The limestone usually possess a more or less distinct banding due to the presence in varying quantities of one or more of the accessary minerals present, and are, as has been before mentioned, usually associated or interstratified with bands of rusty-weathering garnetiferous or sillimanite-gneiss having the composition of ordinary argillaceous sediments, or with bands of quartzite.

Associated sedimentary gneisses.

Serpentine is not usually abundant in the limestones of this area, and no trace of Eozoon has been found.

The limestone from two localities was submitted to microscopical examination.

*Report of Progress, Geol. Surv. Can., 1863-66, reprinted in the Report of the Regents of the University on the New York State Cabinet of Natural History for 1867, Appendix E.

Crystalline Limestone—Township of Rawdon, Range X., Lots 27 and 28 (near lime-kiln)—(Sections 632, 636).

These exposures are among the largest in the whole area and have already been referred to on page 27 J. The rock is well banded, some bands consisting of a white and almost pure limestone containing only a few scales of mica, while other bands are filled with grains of dark-green serpentine. In some of these serpentinous bands the serpentine is present in the form of large lumps, and on breaking open a number of these some were found to contain rounded cores of white pyroxene. These cores are readily detached from the inclosing serpentine by the tap of a hammer and fall out leaving hemispherical depressions. They are precisely like those described by Merrill* in the serpentine of Montville, New Jersey, and clearly show that the serpentine in the limestone has originated from the alteration of grains and lumps of pyroxene originally present in it. The vexed question of the origin of the Laurentian serpentines is, therefore, so far as this occurrence is concerned, clearly answered. Rawdon. Serpentine altered pyroxene.

Under the microscope (Plate V., Fig. 4) the rock is seen to consist of calcite, with serpentine in rounded grains, varying in amount in the different sections, and a few scales of mica. The calcite forms a mosaic of grains of uniform size, having sharp well defined boundaries, with no intervening lines of smaller grains or other evidences of granulation. It presents the usual optical characters of the species, with the rhombohedral cleavage and often the twinning according to $-\frac{1}{2}$ R. The grains possess a uniform extinction. The serpentine is very pale green, almost colourless, in the sections, and occurs in rounded forms showing aggregate polarization. It contains, however, no cores of pyroxene, the alteration being complete in the case of these small grains. The serpentine is sharply bounded against the calcite, but the serpentine grains do not possess crystalline outlines, their borders being always curved and their outline sometimes nearly circular. A serpentine grain is often completely inclosed in a single calcite individual. In No. 632, the serpentine grains are for the most part small and are arranged in the form of little rings embedded in the calcite and filled with grains of the same mineral. These evidently result from the alteration of groups of pyroxene grains similar to those described below in the limestone from the River L'Assomption. The mica, which does not appear in all the sections and is never abundant, occurs in rather large leaves, which are almost colourless, the light passing Microscopic character.

*Proceedings of the United States National Museum, 1888, p. 105.

through parallel to the cleavage having a faint brown tint. It is uniaxial and negative and polarizes in brilliant colours, resembling closely the bleached biotites often seen in altered rocks. The extinction is occasionally slightly uneven. One striking fact in connection with the sections is that some of the calcite grains are clear and quite transparent while others are somewhat turbid owing to the presence of very minute dust-like inclusions. The same calcite individual is even in some cases clear in some parts and more or less turbid in others. This turbidity, when studied in connection with that exhibited by the calcite of comparatively unaltered limestones, such as certain beds of the Trenton, in which it is clearly seen to be derived from fragments of crinoids and other fossils about which clear calcite has been deposited in optical continuity, the outlines of the fossil fragments being frequently by no means sharp, is very suggestive of the derivation of this limestone from fossil fragments also. Against this supposition is the fact that the clearness or turbidity is usually confined to the special grain which exhibits it, instead of the grain possessing a turbid core with a clear margin, but it is nevertheless a phenomenon which merits a much more extended study than it has been possible to give it at this time.

Crystalline Limestone, River L'Assomption, about 4 miles from Lake L'Assomption. (Section 655.)

River L'Assomption

This occurrence which is exposed by the side of the River L'Assomption near the northern limit of the map has already been referred to on page 24 J. Under the microscope it closely resembles the limestone just described and consists of calcite in large grains showing no evidence of breaking, twisting or granulation, with a little pyroxene, serpentine and mica. While in places somewhat turbid, the calcite shows but little of that suggestive arrangement of the turbidity referred to in the case of the Rawdon rock. The pyroxene, which is colourless in the thin sections and pale green in the specimens, is arranged in little irregular groups or strings of small grains, much smaller than the calcite grains and which occasionally show crystalline outlines but are usually rounded in form. These groups are often completely inclosed in a single calcite individual. The pyroxene is biaxial, and shows the usual cleavages, and inclined extinction and is frequently partially altered to serpentine.

Class III.—Gneisses, &c., of doubtful origin.

In addition to the gneisses, etc., of classes I. and II., whose origin can be determined with a high degree of probability, there is a third class, comprising a large proportion of all the gneisses of the area whose origin is doubtful. Some of these resemble more or less closely the rocks of class I., while others bear a marked resemblance to those of class II. Chemical analysis would in the case of many of these gneisses, &c., throw much light on the question of the origin of the rock. Gneisses of doubtful origin.

A few of these rocks, representative of extended and widespread occurrences in various parts of the area, have been selected for description.

Quartz-Orthoclase-Biotite-Gneiss.—Township of Kildare, front of Range VII. (Section No. 352.)

This is a gneiss, gray in colour weathering white, which possesses a distinct foliation and occurs interstratified or interbanded with reddish orthoclase-gneiss, often in thin layers, forming large exposures where the road, running south-west from St. Ambroise de Kildare, crosses range VII. It is a very common variety of gneiss, occurring extensively in many parts of the area embraced by the present report.

Under the microscope, the rock is seen to consist chiefly of quartz and orthoclase. Biotite in small amount and a few grains of plagioclase are also present in each section. The orthoclase, which is present in large amount, is in the form of large grains separated by little strings or streams of smaller grains of orthoclase, all of which, instead of coming together along straight lines, have a crenulated outline. The large grains almost invariably show strain shadows, and the parallel position of the lines of smaller grains, is one of the elements which gives rise to the foliation of the rock. The quartz, in its mode of occurrence strongly resembles that described in the leaf-gneiss and in some augen-gneisses of class I., having for the most part the form of long and narrow leaves or laths much larger than the felspar grains, and whose position being parallel to that of the strings of small orthoclase grains above mentioned also serves to mark the foliation of the rock. These quartz laths, although running through the granulated orthoclase, show no signs of granulation, but consist of single individuals, occasionally broken across but showing no signs of pressure other than a slightly uneven extinction. Some of Kildare.

them are as much as sixteen times as long as they are wide, and sweep in curves around the larger felspars, while others consisting of single individuals have curiously irregular and even forked outlines. The leaves or laths are not elongated parallel to the vertical axis, their extinction generally making an angle of about 30° or 40° with the direction of their greatest length. The biotite occurs in the forms of small leaves, usually associated with the felspar, but sometimes embedded in the clear quartz laths, and arranged parallel to the foliation. It is the only iron-magnesia constituent present, with the exception of a little chlorite which in places results from its decomposition.

Miniature augen-gneiss.

The rock is thus a species of miniature augen-gneiss, and has evidently resulted from movements in a rock having the mineralogical composition of a granite or arkose.

Garnetiferous Quartz-Orthoclase-Biotite-Gneiss—Township of Brandon, Range X., Lot 4. (Section 662.)

Brandon.

The rock is rather fine grained and gray in colour, containing numerous rounded pink garnets up to a pea in size, pretty uniformly scattered through it. Under the microscope, it is seen to be composed essentially of quartz, orthoclase, biotite and garnet, the biotite being subordinate in amount, with plagioclase, sphene, iron ore and pyrite as accessary constituents. The foliation is due to the parallel arrangement of the little biotite leaves and to the existence of little strings of quartz running through the rock in a direction parallel to these.

The quartz has the form of irregular-shaped individuals, often in leaves, more or less curved and running with the foliation. These leaves sometimes consist of a single individual, sometimes of several individuals, but never of granulated material. Some small grains of quartz are also seen embedded in the felspar. The orthoclase, which is abundant, never exhibits more pronounced evidence of pressure than a slightly uneven extinction, even this is often absent, and the extinction is quite uniform. No evidence of granulation is seen, the several individuals coming together as in a mosaic, suggestive of re-crystallization. The biotite is in little leaves or rather large bunches. It does not sweep around the garnets, as is so often the case in similar rocks, but is often inclosed in grains of this mineral, which is evidently younger. It is deep brown in colour and pretty uniformly distributed throughout the rock.

Microscopical character.

The garnet, which is rather abundant, occurs in grains which are usually rounded, but sometimes sub-angular, and is quite isotropic.

It holds inclusions not only of the biotite, but also of orthoclase, quartz, sphene and other constituents, and presents the appearance of having grown around and inclosed them. The plagioclase is present in small amount, the twin lines not being bent or twisted. The rock shows no cataclastic structure or other marked evidence of pressure, either in the hand specimen or in the section, with the exception of a small eye of felspar associated with some apparently granulated material, indistinctly seen in the hand specimen, and which seems to be connected with a little pegmatite vein running parallel to the foliation.

Associated with this gneiss in the same series of exposures, which occur along the road between ranges IX. and X., are a variety of other gneisses and allied rocks, interbanded with one another and lying nearly flat. Some of these gneisses are highly quartzose, others are more basic, having the composition of a garnetiferous hornblende-gneiss. Some are the typical garnetiferous sillimanite-gneisses (Section 680) describedon page 51 J. Others again resemble amphibolites, while a few thin bands of a calcareous gneiss or very impure limestone, as well as a few of quartzite, are also present. Associated rocks.

These rocks, like that of section 662, while free from cataclastic structure and presenting an appearance suggestive of a highly altered sedimentary series, have nevertheless been submitted to great pressure, and have been rolled out like a plastic mass, for associated and intercalated with them are many small bands of augen-gneiss, and leaf-gneiss occasionally holding little augen, which belong to the first class of gneisses already described and which are undoubtedly squeezed and crushed, possibly intrusive, granites.

Garnetiferous Hornblende-Gneiss—Township of Rawdon, Range VI., Lot 24. (Section 439.)

This gneiss, which is dark in colour and contains an abundance of rounded pink garnets scattered through it, occurs in large exposures interstratified or interbanded with a series of pyritiferous gneisses rich in garnet and often holding graphite, which, having been supposed to contain gold, are referred to in the section treating of Economic Geology, on page 148 J. Garnetiferous gneiss.

Under the microscope, the rock is seen to consist essentially of hornblende, garnet, orthoclase and plagioclase, with accessary pyroxene, biotite, pyrite, iron ore and apatite. Rawdon.

The hornblende, which with the garnet makes up most of the rock, is brown in colour and pleochroic in brown and yellow tints. The garnet is quite isotropic and holds inclusions of the hornblende, plagioclase, pyroxene, pyrite, iron ore and apatite. The orthoclase and plagioclase are present in about equal amount, and taken together are present in about the same proportion as the hornblende. The pale-green pyroxene occurs in small quantities associated with the hornblende, and is in part monoclinic and apparently in part rhombic. The rhombic pyroxene is partially altered to serpentine.

The felspar individuals are smaller than those of most of the other constituents, and often form a mosaic showing no very pronounced pressure effects, but elsewhere occur as lines of smaller grains about and between larger ones, in a way suggestive of granulation, actual "augen," however, are not seen. It is difficult to determine whether the hornblende and pyroxene have been produced by re-crystallization or not: they certainly have not undergone much granulation, while the garnet which makes up a large part of the rock is certainly a product of re-crystallization. The comparative absence of pressure effects, in the case of the iron magnesia constituents, as compared with the felspars, may indicate that the former in their present form originated during the pressure, or that during the movements induced by the pressure, the felspars gave way more readily, allowing the movements to be effected chiefly through their disruption. Gneisses containing such a large proportion of hornblende are not common in the Laurentian of this area.

Quartz-Orthoclase-Gneiss (Granulite)—Township of Brandon, Range VIII., Lot 22. (Section 574.)

Granite.

Another variety of gneiss which is very common in this region, and which is seen in many parts of the township of Brandon and elsewhere, resembles in many respects certain of the Saxon granulites, being reddish, fine-grained and nearly free from iron-magnesia constituents. It is, however, as a general rule, free from garnet, which is so characteristic as an accessary constituent to the Saxon granulites. The minute structure is different from, but perhaps related to, that of the gneiss of Trembling Mountain described on page 42 J. As a typical locality, lot 22 of range VIII. of Brandon, may be selected.

Brandon.

The rock here occurs in bed-like masses interstratified with thin bands of quartzite and with some thick bands of the pyroxene-amphibolite described on page 73 J. The exposures are large and the beds or bands lie nearly flat. The rock is fine in grain and of a pale reddish or pinkish colour. It has a somewhat indistinct foliation and is uniform in character over large exposures.

Under the microscope it is found to consist, for the most part, of microperthite, the individuals of which are sometimes seen to be twisted, but not in a very marked manner. Quartz, sometimes in leaf-like forms, is present in smaller amount and shows similar though less marked evidences of pressure. A few grains of black iron ore, probably magnetite, a small amount of a chloritic decomposition-product derived from some bisilicate which has entirely disappeared, with a few little colourless rounded grains of zircon or possibly monazite, are the only other constituents of the rock. The minute structure differs from that of the Trembling Mountain rock in being fine in grain throughout, the larger individuals described in that rock being absent. It resembles, in fact, the fine groundmass of the Trembling Mountain rock, consisting of minute angular and more or less rounded fragments indiscriminately mixed together.

Probably a crushed granite.

From a study of the sections, no decided proof can be obtained that this is cataclastic structure, but it is just the structure which would be produced if the process of granulation, described in the case of the Trembling Mountain gneiss as in progress, were completed, the original structure being entirely destroyed. If the banded character of the rocks of the district has been produced by a process of stretching or rolling out, the movements and concomitant granulation must have been very much more intense than was necessary to produce merely an indistinct foliation as in the Trembling Mountain rock; or the original rock may have been finer in grain. The evidence of pressure in the case of the orthoclase would, as has been shown in the case of the Trembling Mountain rock, be less marked in the finely granulated material than in the larger remnants, if any remained.

Therefore, although the rock may have been produced in some other manner, its minute structure is just such as would be caused by the intense crushing of a granite rock, and Professor Rosenbusch believes it to be merely a crushed granite.

Another class of rocks found associated with the orthoclase-gneisses in all parts of the area, but very abundantly in the township of Brandon and the adjacent parts of the eastern portion of the area, are pyroxene-gneisses and pyroxene-granulites.

Pyroxene-gneisses and pyroxene-granulites.

These rocks differ from the orthoclase-gneiss in colour, being usually yellowish, brownish or black on the fresh fracture. Although usually indistinctly foliated, they are frequently nearly massive and uniform in character over large exposures, in this way differing from the usual run of the associated acid gneisses. Their constituent minerals cannot as a general rule be determined from the study of a hand specimen, but under the microscope the rocks are found to have a composition which varies but little.

Rhombic and monoclinic pyroxenes.

Pyroxene is always present as an essential constituent, both rhombic and monoclinic varieties usually occurring together. Hornblende, usually green but sometimes brown in colour, is sometimes but by no means always present. Biotite when present at all is very subordinate in amount. Plagioclase is usually the predominating felspar, but orthoclase is very often present as well, and is sometimes as abundant as the plagioclase. Magnetite, apatite and a few other accessary constituents occur in small amount.

Character of the rocks.

These rocks are very seldom coarse in grain, being generally rather fine-grained to nearly compact. They may be separated into two classes which, however, have no sharp dividing line and pass into one another by imperceptible gradations. One class would embrace the coarser grained varieties, which are usually somewhat poorer in the iron magnesia constituents and occur in large bodies, and which may be called pyroxene-gneisses. The other class comprises the fine-grained and nearly black varieties, which occur very frequently interbanded with granulite and other forms of orthoclase gneiss, in all parts of the area, and which from their resemblance in character and mode of occurrence to the "trap-granulites" or "pyroxene-granulites" of the Saxon granulite gebirge may be called pyroxene-granulites.

Quite distinct from normal granulites.

This latter name has certain disadvantages,* among others the fact that the rock bears no resemblance to true granulite, but as the name already has a status in petrographical nomenclature from the thorough description which has been given of the petrographical character and mode of occurrence of the rock in the Saxon granulite gebirge, as well as owing to the circumstance that every other name already in use and which might be applied is attended with equally great objections, it will here be employed to designate the rocks in question. These pyroxene-granulites when they become rich in hornblende and poor in orthoclase might be termed pyroxene-amphibolites.

As typical examples of these pyroxene granulites and pyroxene amphibolites the following rocks may be taken.

* See Zirkel, Lehrbuch der Petrographie, vol. III., p. 251.

Pyroxene-Amphibolite—Range VIII., Lot 22, Township of Brandon. (Section 571.)

In the hand specimen, the rock is seen to be rather fine in grain, nearly black in colour, and to possess an indistinct foliation, with occasional narrow bands in which one or other constituent predominates. Pyroxene-amphibolite.—Brandon.

It occurs in thick bands interbanded or interstratified with the granulite described on page 70 J.

Under the microscope, the rock is found to consist essentially of hornblende, pyroxene and plagioclase felspar, with a small amount of orthoclase felspar and a little magnetite, apatite, and probably a few grains of quartz. The hornblende is deep brown in colour and strongly pleochroic, and is present in large amount. There is no evidence that it has been derived from the pyroxene and it often occurs in comparatively large individuals. The pyroxene, which is also present in large amount, is in part hypersthene, showing the usual pleochroism in yellow, red and green tints and a parallel extinction. Some monoclinic pyroxene is also present. None of the constituents have even an approximately idiomorphic development. All are in irregular-shaped grains.

The foliation, which is parallel to the banding, is indistinctly seen in the thin sections, but there is a development all through the sections of granulated material in little strings or streaks running in one direction. This is composed largely of plagioclase, but hornblende and pyroxene are also seen in a granulated condition, mixed with the plagioclase. Almost every one of the larger grains of plagioclase shows the effects of intense pressure, in well marked strain-shadows, twisting of twin lamellæ and breaking into smaller grains. It is a fact of interest that, in this as in many similar cases, the hornblende and pyroxene, although in places granulated, do not when in large grains show uneven extinction, while what in ordinary light appear to be grains of plagioclase of similar size, invariably, when examined between crossed nicols, are seen to be crushed aggregate of small plagioclase grains. Microscopical character.

The examination of this rock under the microscope makes it certain that whatever the origin of the banding may be, the foliated structure is not original, but has been produced by movements in the rock which were accompanied by a granulation of its constituents. The hornblende may possibly be a secondary product.

Chemical composition.

A specimen of the rock analysed for me by Mr. Walter C. Adams, B.A.Sc., was found to have the following composition :—

XI.

Pyroxene-Amphibolite—Township of Brandon.

	Per cent.
Silica	49·76
Alumnia	17·53
Ferric oxide*	10·62
Manganous oxide	36
Lime	10·57
Magnesia	7·96
Soda	3·05
Potassa	·80
Loss on ignition	·34
	100·99

It is thus identical in composition with many gabbros and diabases.

This rock passes over on lot 19 of range VII. into a pyroxene-granulite (section 561) free from hornblende, and consisting of pyroxene, plagioclase and orthoclase, with a considerable amount of iron ore scattered through the rock, and usually associated with the pyroxene. It is nearly massive, a foliation being merely indicated by the presence of a few parallel strings somewhat coarser in grain than the rest of the rock. In this rock also the constituents show evidence of much twisting and present an uneven extinction. The felspar has undergone a certain amount of granulation. The sections show that the rock has been subjected to a certain amount of motion as a result of pressure; but whether this motion has been very great, cannot be decided from their study alone.

Pyroxene-Granulite—Range VI., Lot 13, Township of Brandon. (Section 684.)

Pyroxene-granulite Brandon.

Occurs interstratified with granulite, the whole being cut transversely by pegmatite masses which have been crushed to an augen-gneiss, the foliation of which coincides with the banding of the series (see Figs. 4 and 5).

The rock has an indistinct foliation when seen in large exposures, but no foliation can be noticed in hand specimens. It is dark in colour and rather fine-grained.

*All the iron is calculated as ferric oxide.

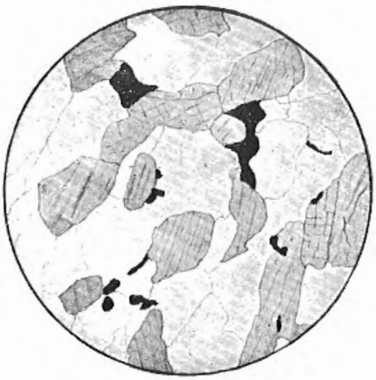


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

PLATE V.

FIG. 1.—PYROXENE-GRANULITE, RANGE VI., LOT 13, TOWNSHIP OF BRANDON—Plagioclase, Pyroxene and Iron Ore. × 29.

FIG. 2.—PYROXENE-AMPHIBOLITE, TREMBLING MOUNTAIN—Hornblende, Pyroxene, Plagioclase and Iron Ore. × 29.

FIG. 3.—PYROXENE-GNEISS, ST. JEAN DE MATHA—Pyroxene, Felspar and Iron Ore. × 30.

FIG. 4.—SERPENTINE-LIMESTONE, RANGE X., LOT 27, TOWNSHIP OF RAWDON—Calcite (in places twinned) and Serpentine. × 11.

It is composed of pyroxene, which is for the most part augite, pale-green in colour and with barely perceptible pleochroism, together with plagioclase and a good deal of iron ore. There are also a very few grains of pyrite. The rock contains no hornblende, biotite or orthoclase. The structure is allotriomorphic, and although the felspar shows faint indications of strain the pyroxene is never granulated, and the rock looks as if it had been crystallized *in situ* (Plate V., Fig. 1).

The granulite (Section 685), which is interstratified with it does not form continuous bands, but thins away when followed along the strike. It is composed of quartz and orthoclase, and has an appearance which is highly suggestive of extensive granulation, for although all the grains are small, there are often smaller ones which appear to have been formed by the breaking down of the larger, and in a few places the peripheral granulation of the orthoclase could be observed. That both rocks must have undergone a decided rolling out under pressure, in the direction of the bands, is proved by the conversion of the inclosed pegmatite veins into an augen-gneiss with a foliation in this direction.

Pyroxene-Granulite—Range VIII., Lot 12, Township of Brandon, (Section 683),

Forms a large mass which is the northerly continuation of the occurrence last described. It shows, however, distinct differences in mineralogical character, proving that the rocks of this class vary somewhat in their nature from place to place, even in the same masses. The augen-gneiss and granulite are here absent.

The pyroxene is pale-green in colour as before, but most of it is rhombic in character, with strong pleochroism in reddish and greenish tints and parallel extinction. An untwinned felspar which is probably orthoclase is also present, and is more abundant than the plagioclase. Very small amounts of hornblende, biotite, pyrite and zircon are also found, as well as a considerable amount of apatite in rather large individuals. Iron ore occurs in rather large amount, often partly inclosing the pyroxene, as is frequent in these rocks. The appearance of the rock under the microscope, is suggestive of granulation.

Pyroxene-Granulite—Range VIII., Lots 9 and 10, Township of Brandon (Section 356).

Other pyroxene-granulites from Brandon.

This rock forms large exposures about one mile to the east of the occurrence last described. The rock is here fine grained, very uniform and nearly massive. It is never banded, and in places no foliation can be detected. Between these exposures and those last described the pyroxene-granulite is associated with granulite plainly derived from a granite by crushing, as it frequently contains remnants or augen of as yet uncrushed orthoclase. The rock is composed of rhombic pyroxene and plagioclase with some orthoclase (untwinned), but also contains much hornblende and biotite. A small amount of augite may also be present. Iron ore, pyrite and apatite are accessary constituents. The hornblende, which is green in colour, is about equal to the pyroxene in amount, and the biotite to about one-half the amount of either. All three minerals are intimately associated. There is no evidence that the hornblende or mica are secondary, although the mode of occurrence of the latter suggests that seen in certain contact rocks such as hornstones. The plagioclase is broken and twisted in places and the rock looks like a granulated one, but if so there are no large remnants left.

Pyroxene-Granulite—Range IX, Lot 16, Township of Brandon, (Section 682).

Other pyroxene-granulites from Brandon.

This rock, which in the field closely resembles the last two, occurs rather over a mile to the west of No. 683, which it closely resembles also in composition and microscopical character, and from which it is separated by bands of granulite and other varieties of gneiss. It contains large intercalated masses of augen-gneiss, whose foliation coincides in direction with the banding of the whole series.

The pyroxene is chiefly rhombic, but monoclinic pyroxene is also present. Both minerals are pale-green in colour, and can be distinguished only by their optical properties. The rhombic pyroxene (probably hypersthene) shows the regular pyroxene cleavages with parallel extraction in sections parallel to the vertical axis. Prismatic sections exhibiting the cleavage parallel to $\infty P\breve{\infty}$, when examined in convergent light show this to be the plane of the optic axes. The mineral is distinctly trichroic. $\mathfrak{a}$ = red, $\mathfrak{b}$ = yellow, $\mathfrak{c}$ = green. The monoclinic pyroxene is not pleochroic, has a higher double refraction and shows an inclined extinction.

The plagioclase and an untwinned felspar, probably orthoclase, are present in about equal amount. Biotite and green hornblende occur in very small quantity, associated with the pyroxenes. A few grains of pyrite and apatite are present in each section, as well as some iron ore, which usually incloses grains of pyroxene—a peculiar mode of occurrence often found, however, in these rocks. (See page 79 J.)

None of the constituents have good crystalline form. The foliation is produced by the arrangement of the pyroxene grains with their longer axes in one direction. Almost every grain of felspar shows strain-shadows or fractures. It is difficult to say whether the peculiar granular character of the rock has been produced by movements or not. The pyroxene does not show any evidence of granulation although it occasionally shows strain-shadows. Under a low power, however, the sections exhibit an appearance of extensive granulation and suggestive of the possibility of the rock having been deformed by the granulation of the felspar with a certain movement of the pyroxene individuals through the granulated mass. Origin of structure.

Separated from the pyroxene-granulite on the east by a mass of very rusty-weathering gneiss, and associated with granulite proper, is another rock resembling the one here described in appearance, but which is, in places, rich in garnet. A section (No. 686) of the garnetiferous variety, however, showed the rock to be composed essentially of red garnet and dark green hornblende with some pyroxene. The garnet is quite isotropic and felspar is absent.

Pyroxene-Amphibolite—Trembling Mountain. (Section 536.)

In describing the geology of Trembling Mountain (see page 42 J) it was mentioned that the existence of thin bands or stratiform masses of a black pyroxene-amphibolite at long intervals interrupted the uniformity of this great mountain-mass of granulated gneiss. Pyroxene-amphibolite. Trembling Mountain.

This pyroxene-amphibolite is identical in character with some of the pyroxene-granulites just described. It consists essentially of hornblende, pyroxene and plagioclase, with very small amounts of iron ore, apatite and biotite as accessary constituents. The hornblende is green or sometimes brownish-green in colour and strongly pleochroic, as in the associated gneiss. The pyroxene, which is chiefly rhombic in crystallization, is not quite so abundant as the hornblende. The plagioclase is present in large amount and in well twinned grains. There is no evidence that the hornblende has been derived from the pyroxene.

Although in the hand specimens the rock looks more massive than the associated gneiss, when examined in thin sections under the microscope it is seen to possess a distinctly foliated structure (Plate V., Fig. 2). None of the constituents have any approximation to an idiomorphic form, the rocks consisting of a mosaic of irregular-shaped grains. The felspar grains, while irregular in shape are about equal Microscopical character.

in all dimensions, and form a sort of groundmass, in which the hornblende and pyroxene, which have a tendency to assume elongated forms, are distributed as irregular, discontinuous, anastomosing strings.

This rock, although, from its existence in the foliated gneiss shown to have been submitted to enormous pressure and probably squeezed out by this into its present band-like form, affords no absolute proof of the granulation so well seen in the gneiss which incloses it. The felspar grains, nevertheless, may have been produced by granulation. The bisilicates often occur in little granules like those seen in the granulated anorthosites, although they usually assume the rather elongated forms, above referred to. It is in fact in all probability a granulated rock, although the absence of large remnants makes proof of this impossible.

It is probable that these occasional interrupted bands or elongated masses of pyroxene-amphibolite in the crushed granite represent basic secretions in the original rock, such as are found in granites in all parts of the world.

Pyroxene-Gneiss—St. Jean de Matha, near the church. (*Section 358.*)

Pyroxene-gneiss. — St. Jean de Matha.

The rock is dark-gray in colour and while distinctly foliated has a pretty uniform character over large exposures. In the thin sections it is seen to consist essentially of pyroxene, felspar and iron ore. Biotite and hornblende are present, but in very subordinate amount, together with a few grains of pyrite and apatite.

The pyroxene is in part hypersthene and in part augite, the relative proportion of the two varying in different sections, but the hypersthene on the whole preponderating. The hypersthene shows the usual trichroism in reddish, greenish and yellowish tints and is free from all schillerization inclusions. The augite closely resembles the hypersthene in appearance, but has an inclined extinction and is not pleochroic. The two pyroxenes are intimately associated.

Two felspars.

Two felspars are present in about equal amount. One is a well twinned plagioclase, presenting the usual characters; the other is an untwinned felspar, which is frequently observed in these rocks and which is in all probability orthoclase, its most noticeable characteristic being the appearance of pale bluish and brownish tints respectively, when between crossed nicols the section is turned slightly on either side from the direction of maximum extinction. The phenomenon appears to result from a slight dispersion of the bisectrices.

The iron ore, which is, after the pyroxenes and felspars, the most abundant constituent, is black and opaque, and when examined by reflected light often presents certain bands and spots differing slightly in lustre from the rest of the grain, which indicates the intergrowth of two sorts of iron ore probably differing in content of titanium, as described in the case of the Morin anorthosite. Its mode of occurrence, however, is very peculiar, being found in between the bisilicates generally in long, narrow grains, and often nearly or completely surrounding the latter (see Plate V., Fig. 3). It was in one case observed to have the form of a narrow band cutting across a pyroxene grain and continuous with a mass of iron ore on either side. It was evidently formed after the bisilicates had crystallized. The same phenomenon was observed in the case of certain anorthosites very rich in iron ore (see page 100 J). Distinct evidence of crushing, in the existence of augen or marked twisting of constituents, is absent, but the rock nevertheless looks as if it might have undergone a thorough granulation. Traces of this are, as usual, much more marked in the felspars than in the pyroxenes. Intergrowth of iron ores. Iron ore crystallized later than bisilicates.

A pyroxene-gneiss (Section 305), almost identical with that just described, forms large exposures in lot 16 of range XI. of the township of Brandon, between the Lac Corbeau and the second anorthosite band.

Pyroxene-Gneiss—Seigniory of D'Ailleboust, about one mile N.E. o Range III. of the Township of Cathcart. (Section 299.)

This rock was chosen as a typical representative, not only of large exposures in the immediate district, but of the basic gneiss, intimately associated and interbanded with the red quartzose orthoclase gneiss, in very many widely separated parts of the area covered by this report. The rock is bluish on the fresh fracture, but weathers gray, and has an indistinct foliation coinciding with that of the associated quartzose orthoclase-gneiss. Pyroxene-gneiss. D'Ailleboout.

Under the microscope it is found to consist essentially of pyroxene and plagioclase. A considerable amount of untwinned felspar, some of it probably orthoclase, is also present, as well as a little hornblende, biotite, iron ore, pyrite, apatite and calcite. The pyroxene is for the most part hypersthene, identical with that in the rock last described. The hornblende, which is green in colour, is apparently derived, in part at least, from the alteration of this pyroxene. The iron ore, as before, is often found partially inclosing the pyroxene. The occasional presence of leucoxene as an alteration product indicates that it is a titaniferous variety. The calcite is secondary. In addition to the plagioclase, presenting the ordinary characters as seen in those gneisses, there are a number of individuals which are very clear and polarize brightly, resembling the secondary plagioclase often developed in crushed rocks.

Evidence of granulation.

As in the case of the pyroxene-gneiss just described from St. Jean de Matha, although there is no absolute proof of granulation, it is almost certain that the rock has been subjected to this process; strings of fine grains are everywhere seen in and about the larger grains, and the appearance is that of a granulated rock. Here again the evidence is principally seen in the felspars.

Pyroxene-gneiss in in Saguenay region.

Pyroxene-gneisses identical in character with those just described, as has been mentioned, are very abundant in the area embraced by the accompanying map, but especially in that part of it lying to the east of the Morin anorthosite. They are also found widely distributed in the Laurentian elsewhere, as, for instance, in the Saguenay district. They differ from the associated acid gneisses not only in composition but in having a darker colour (never red like the orthoclase gneisses), a more uniform character, and more massive appearance. They never contain quartz.

Common in Lower Archæan.

These pyroxene-gneisses and pyroxene-granulites, formerly thought to be very uncommon rocks, have in recent years been described from a great number of localities in all parts of the world, and will probably be found to be one of the constant elements of the lower Archæan wherever that is extensively developed. A brief review of these various occurrences, with full references to their literature, is given in a recent paper by Professor Judd.*

Origin of pyroxene.

The origin of these rocks is a question concerning which, even in the localities where they have been most thoroughly investigated, there have been great diversities of opinion. In the district in which pyroxene granulites were originally described, for instance, the granulite region of Saxony, Nauman believed them to be eruptive, Stelzner and others consider them to be metamorphic products, while Lehmann, who has made a more recent and very thorough study of them, considers the question of their origin as still an open one. The mode of occurrence of the pyroxene-granulite in Saxony and the intimate rela-

*The Rubies of Burma and Associated Minerals, their mode of occurrence, origin and metamorphoses. Phil. Trans., 1896, p. 192.

Also A. Lacroix—Contributions à l'étude des Gneiss à Pyroxene—Bull. Soc. Min., France, April, 1889.

tion which it bears to the normal granulite, the two rocks being connected by a complete series of intermediate varieties, points very strongly, in the case of the Saxon occurrences, to the origination of both rocks in the differentiation of an original igneous magma. The chief difficulty in considering the pyroxene-granulites of Saxony as differentiation products from the same magma that gave rise to the normal granulite, is the fact that they are practically massive and have been considered to show no evidence of crushing, while the accompanying granulite is seen to have been crushed and granulated in a very marked manner. Gneisses and granulites.

The pyroxene-granulites of the district embraced in the present Report, differ from those of Saxony chiefly in being a little coarser in grain and in possessing, as a general rule, a more or less indistinct schistose structure. Garnet also is a less frequent constituent. Saxon occurrences.

That these Canadian rocks, whatever be their origin, have been greatly compressed and rolled out like plastic masses (although no conclusive evidence of the fact can be seen in the minute structure of the rock) is placed beyond a doubt by the presence in them of sharply folded, crushed and foliated masses of pegmatite converted into augen-gneiss and leaf-gneiss by the pressure, the foliation running in one plane through the whole body of the rock and being quite independent of the position of the pegmatite masses. That the present attitude of the rocks was not their original one, is also plainly shown in Figure 8, where a dark-coloured pyroxene-gneiss, containing a good deal of quartz, is seen to lie as a series of sharp folds in a mass of leaf-gneiss. The axis of these folds is now the strike of the rock, but it is evident that the pyroxene-gneiss originally formed a band, dyke or arm in the lighter coloured quartzose orthoclase rock, running Crushed pegmatite masses.

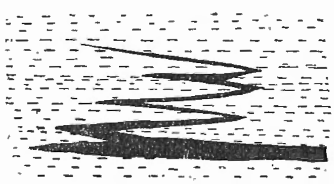


Figure 8.—Dark Pyroxene-Gneiss folded in a mass of Leaf-Gneiss, Range VIII., Lot 18, Township of Brandon. Scale 8 feet to 1 inch.

in a direction highly inclined or possibly at right angles to the present strike. This is by no means an isolated case or confined to this locality; the same phenomenon can be observed in very many places in this as well as in other Laurentian areas in various parts of the Dominion, and when the folds are longer and more compressed their resemblance to interstratified bands, especially in small exposures, is much more marked.

Microscopical character unlike that of gabbro.

The microscopic structure of the pyroxene-granulites, as a class, is quite distinct from that of the undoubted igneous rocks having the same mineralogical composition (the gabbros), but after the study of a large number of sections of these rocks from various parts of Canada, as well as from the Saxon granulite region, I am unable to see that their structure precludes them from being considered as granulated rocks, although no direct evidence of crushing may be afforded by them. The indications of granulation in the case of the Canadian rocks have already been referred to in the description of the sections.

Much light might be thrown on the origin of these peculiar rocks by a thorough study of their chemical composition, with a view to ascertaining whether they all, like the pyroxene-amphibolite from Brandon (No. 571), have the composition of gabbros and diabases, or whether some of them have a composition different from that of igneous rocks.

At present the origin of these Canadian occurrences must remain a matter of doubt, although the argument in favour of a metamorphic origin in the case of the Saxon rocks, from alleged absence of granulation and other pressure phenomena, does not, as has been shown, apply with equal force to the pyroxene-granulites of Canada.

Orthoclase-Scapolite-Pyroxene-Gneiss—Township of Rawdon, Range VII., Lot 20. (Sections 597, 630.)

Scapolite-gneiss.

This gneiss, which weathers to an exceedingly rusty colour, occurs in bands interstratified with a grayish-weathering, garnetiferous gneiss, traversed by many little veins of quartz. Across the road on the same lot is the band of garnet rock described on page 84 J. It is fine-grained, greenish-white in colour, and on a fresh fracture presents a finely-speckled appearance. As has been mentioned, it weathers very rusty and disintegrates so readily that it is difficult to obtain specimens which are really fresh. It has a very indistinct foliation.

Rawdon.

Under the microscope, it is seen to be composed essentially of orthoclase, pyroxene and scapolite, with accessary pyrite, pyrrhotite, graphite and sphene. The pyroxene, which is very pale green in colour, has the characters of malacolite. The scapolite is colourless, uniaxial and negative, with cleavages crossing at right angles on basal section, and parallel extinction in sections in the plane of the vertical axis. The sulphur, if calculated as pyrite, would show the presence of nearly four and a half per cent of that mineral, but, although much pyrite is present, there is a good deal of pyrrhotite present as well, the two minerals being intimately associated. These two minerals almost certainly represent a later impregnation, occurring, as they do, in little irregular-shaped masses, with minutely banded structure parallel to their sides, as if filling cavities. They are sometimes decomposed to hæmatite, the pseudomorphs being often remarkable in that they consist of a single individual. The ferric hydrate which stains the weathered surface of the rock is also derived from their decomposition.

Microscopical character.

The graphite occurs as little flakes, and is often intimately associated with the pyrite, suggesting some genetic connection in the case of the two minerals; as, for instance, the formation of the sulphides from the reduction of iron-bearing solutions through the agency of organic matter, a portion of which still remains as graphite. The sphene, which is seen in every slide, is pale brownish in colour, and occurs in more or less elongated grains lying in the direction of the foliation. It has the usual high index of refraction and high double refraction, with an extinction generally inclined at a small angle to the longer axis of the grain, and is often twinned. The rock presents the appearance of having been produced by a complete crystallization or re-crystallization of the various constituents *in situ*, the grains of felspar having sharp polygonal outlines, and the individuals of the several minerals fitting together like the pieces of a mosaic, no signs of granulation being visible.

Chemical composition.

A specimen of this gneiss was analysed by Mr. Walter C. Adams, B.A.Sc., and was found to have the following composition:—

XII.—Orthoclase-Scapolite-Pyroxene-Gneiss—Township of Rawdon, Range VII., Lot 20.

	Per cent.
Silica	54·89
Titanic oxide	1·66
Alumina	13·67
Ferric oxide	1·35
Ferric sulphide	4·43
Manganous oxide	·62
Lime	5·63
Magnesia	4·70
Soda	1 95
Potassa	8·34
Water and graphite (by difference)	2·76
	100·00
Total alkalies	10·29

This gneiss, as will be seen, differs entirely in composition from any of those of which the analyses have already been given. The low content of alumina, combined with low silica, the high alkalies and the preponderance of lime over magnesia, mark it off as quite distinct from the slates and sedimentary gneisses before considered. If it be an altered sediment, it is one which has suffered very little leaching during deposition, and must have been of the nature of a tuffaceous deposit, or one formed from the rapid disintegration of an igneous rock having the composition of a basic trachyte or syenite. It is, therefore, a rock which, so far as its composition is concerned, might be either an altered sediment or an altered igneous rock; and it is impossible, consequently, to draw from its chemical composition any definite conclusions as to its origin. The graphite, however, points to a sedimentary origin.

Specimens of another band of gneiss (Section 385) similar in general appearance to that just described, and occurring near it, were found upon microscopic examination to differ from it in holding a considerable amount of garnet and plagioclase, as well as some quartz, but no scapolite. The pyroxene is very pale brown in colour, and the garnet, which as usual in the Laurentian gneisses is quite isotropic, holds as inclusions grains of the various other constituents of the rock.

Garnet rock

Intimately associated with the garnetiferous gneisses, and probably representing an extremely garnetiferous variety of them, are the bands of garnet rock described from two localities under the heading of Economic Geology (p. 150 J.)

At the first of these localities—the rear of lot 20 of Range VII. of the township of Rawdon—several bands of the garnet rock are found, the widest being about two feet thick. They occur interstratified with fine-grained garnetiferous gneiss and white quartzite. In some parts of the bed the garnet rock is almost pure, while in others it is seen to contain a little quartz, biotite or felspar. The purer portions (Sections 440, 654) when examined under the microscope are seen to consist almost exclusively of pink garnet. Some iron ore, with a little biotite, and in one section a grain of green spinel, are the only other constituents. The garnet occurs in very large individuals, which are isotropic and almost free from inclusions, with the exception of a few grains of biotite. The iron ore is black and opaque and occurs chiefly in the form of large angular grains. The surfaces of the garnet grains are often stained with a little ferric hydrate. The biotite and iron ore are inclosed in the garnet and have the appearance of having originated contemporaneously with it. In some sections (No. 654) a little plagioclase is present.

On lot 22, of range IX., of the township of Rawdon, a heavy band of granular brown pyroxene rock occurs, associated with garnetiferous graphitic gneiss and crystalline limestone. Owing to the fact that the exposures are not continuous, it is impossible to ascertain the precise width of the band, but it is probably about twenty feet wide. Pyroxene rock.

Under the microscope (Section 366) the rock is seen to be made up almost exclusively of a pyroxene, very pale pinkish brown in thin sections. The cleavage is imperfect and the mineral shows a very faint pleochroism, and in sections at right angles to an optic axis is seen to be biaxial, the axial angle being large. With this pyroxene is associated a colourless uniaxial and negative mineral, probably a scapolite, and a very few grains of pyrrhotite.

An analysis of the pyroxene gave the following results:—

XIII.—Pyroxene—Rawdon, Range IX., Lot 22.

	Per cent.
Silica	49·289
Alumina	8·388
Ferrous oxide	4·611
Manganous oxide	undet.
Lime	25·376
Magnesia	12·723
	100·387

The Anorthosites.

THE MORIN ANORTHOSITE.

Stratigraphical Relations.

As shown in the accompanying map, there is, in the region under consideration, one large area of anorthosite, constituting its chief geological feature, and several smaller occurrences of the same rock quite subordinate in extent. This large area will be referred to as the Morin anorthosite mass, from the township of Morin, which for the most part lies within it, while the smaller areas will be distinguished by similar local names, as the Lakefield area, the St. Jérôme area and so on. Morin anorthosite.

The Morin area consists of an almost circular mass of anorthosite, from the south-western side of which there proceeds a long arm-like extension. The mass has a diameter of about 37 miles, and, with the arm-like extension just mentioned, an area of 990 square miles. It is surrounded on all sides by the gneisses and associated rocks of Size.

Laurentian age, with the exception of the extremity of the arm, which extending much farther to the south than the rest of the area, runs underneath and becomes covered up by much more recent strata of Cambro-Silurian age (Potsdam and Calciferous) bounding the protaxis in this direction. The limits of the mass have been carefully traced out by myself, except where it crosses the townships of Howard and Montcalm, where the boundary had already been determined by Sir William Logan (See Atlas accompanying Geology of Canada, 1865), and in the southern part of Wolfe, where it had been traced out by Mr. Vennor. Along this portion of its course the boundary is a well marked topographic feature, the anorthosite rising as a cliff or abrupt line of hills from the rolling country underlain by the Grenville series. (See Plate I.) The exact course of the boundary across the very wild, unsurveyed and unsettled township lying to the north-west of the township of Lussier is uncertain. Its direction as laid down on the map, however, must be a near approximation to the correct one, as the country immediately to the north of it has been examined and found to be underlain entirely by gneiss.

Boundaries.

Character of anorthosite country.

The country underlain by this anorthosite, leaving out of consideration the arm-like extension above mentioned, is very hilly, the hills seldom rising to such height as to be properly designated as mountains, and while often rugged and precipitous still preserving the smooth flowing contours seen everywhere in the Laurentian in this part of Canada. Between these hills are valleys or plains, generally of no great size, occupied by drift, which valleys as well as the hill sides are year by year being cleared of their forest growth and converted into farms supporting a hardy population.

Scattered through these valleys are a great number of lakes, some of considerable size, where the North River and other streams take their rise, the waters of which eventually find their way into the Ottawa or St. Lawrence.

The highest hills in the area are those about Duck Lake in the township of Cartier, and those in the district about the Montagne Noire in the township of Archambault. On the whole, this anorthosite area is rather more rugged than that underlain by the surrounding gneiss.

Arm-like extension of anorthosite.

As has been shown on page 13 J, and as will be seen by consulting the map, the gneissic series through which this anorthosite has been intruded, is, so to speak, closely wrapped around the anorthosite mass, its strike for the most part following the sinuosities and curves of the contact; the most notable exception to this being along a portion of the southern boundary. Its foliation is thus evidently, in part at least, a secondary structure, induced subsequent to the intrusion of the anorthosite by great pressure, which pressure has affected the anorthosite as well—for the anorthosite, especially near the contact on the eastern side, possesses a distinct foliation coinciding in direction with that of the gneiss. The arm-like extension of the anorthosite through the gneiss to the south-east becomes somewhat wider as the plains underlain by the Palæozoic are approached, being divided longitudinally by a wedge of gneiss which runs into it from the south, and which with the anorthosite becomes covered up by the overlying Palæozoic rocks. The anorthosite of this arm, like the gneiss itself, dips to the west, being therefore on the western side overlain by gneiss. The angle of dip, however, varies much in different places.

Contact phase.

Although in many parts of the circumference of the area, the anorthosite comes against the gneiss without producing any perceptible alteration, yet in some places, and especially between Shawbridge and Chertsey, a dark heavy rather massive rock, rich in bisilicates and often holding a little quartz and some untwinned felspar, borders the area and may possibly be a contact product of some kind. The boundary of the typical anorthosite against this intervening rock is usually pretty sharp, while the latter passes over gradually into the gneiss of the district. It is, however, difficult to decide whether this rock is to be considered as a peculiar and abnormal (possibly altered) variety of gneiss, or as a contact phase of the anorthosite. What is apparently the same rock, or a very similar one, occurs largely developed at the north-west corner of the area, between the typical anorthosite and the gneiss. Stratigraphical as well as microscopical evidence indicates that here it is a peculiar variety of gabbro, nearly or quite massive, but sometimes showing a *schlieren* structure. This breaks through the gneiss, but is apparently continuous with the rest of the anorthosite mass. Continuous exposures from one rock into the other, enabling the relations to be determined, have, however, nowhere been found, but the evidence goes to show that this gabbro forms part of the anorthosite area and is not a separate intrusion, although the transition is rather abrupt.

Gneiss inclusions.

At a number of places near the limits of the area, especially about the dividing line between the rear ranges of Wexford and Chertsey, near the road to St. Donat, very large masses of orthoclase gneiss occur inclosed in the anorthosite, and afford additional proof, if any be required, of the intrusive character of the latter. Those occurring about the line between Wexford and Chertsey, lie approximately in the direction of the prolongation of the strike of the great tongue of gneiss which runs up between the main mass of the anorthosite and the arm-like protrusion from it, and probably represent a former extension of the gneiss in this direction, shattered and invaded by the anorthosite.

Similar inclusions of gneiss are also seen near the margin of the Morin area in the rear of the township of Doncaster, being exposed on the road running south from Lake Archambault to Ste. Lucie, and along the River Ouareau where it crosses range VIII. of Chilton.

Pegmatite veins.

A very large mass of gneiss, some five miles long and two miles wide, is also inclosed by the anorthosite near the east side-line of the township of Chertsey.

The anorthosite is in many places penetrated by coarse pegmatite veins. These are especially abundant near the edge of the area, cutting both gneiss and anorthosite, so much so, that an approach to the boundary may often be surmised from their appearance in large numbers. These pegmatite veins, however, are by no means restricted to the margins of the area but are abundant in places near its centre. They are composed of quartz and orthoclase, often with a little iron ore, and are thus quite different from and apparently uninfluenced by, the composition of the anorthosite through which they cut. A number of other occurrences in the township of Wexford, which are probably of the same nature, were found to hold the same bisilicates as the anorthosite. None of the rarer minerals frequently found in such veins were observed, except one which occurs in the thin sections of a single specimen, and which resembles allanite

In the township of Wexford, along the road which runs south-west from Lac des Iles between ranges VIII. and IX., there is a great body of highly quartzose rock, much of it an almost pure quartzite, inclosed in the anorthosite. It extends along the road for about two miles, varying considerably in width, but near the lake being over a quarter of a mile wide. This mass may be an inclusion of gneiss, such as those referred to above, but much of the quartzite has an appearance suggestive rather of vein origin (Section 437).

Both the anorthosite and the gneiss are cut by numerous dykes of diabase and augite porphyrite.

In order to understand why Logan, and other good observers following him, regarded these anorthosites as constituting a distinct overlying series, a brief review of the grounds on which he based this view may here be presented.

Sir William Logan's views.

On working out the geological structure of the Grenville district, which district lies immediately to the west of that embraced in the present report, the two overlapping somewhat, Logan recognized three principal bands of crystalline limestone which he called the Trembling Lake band, the Green Lake band, and the Grenville band respectively. The limestone above mentioned as abutting against the anorthosite at St. Sauveur, was believed to be a portion of the Green Lake band, Sir William referring to the band as having been "interrupted" by the Morin anorthosite. Further to the north, in the township of DeSalaberry, he found that two of the limestone bands again came in contact with this anorthosite mass, one of them being this same Green Lake band and the other the Trembling Lake band. Sir William refers to this occurrence as follows (Geology of Canada, 1863, p. 838): "The higher of the two bands * * * is interrupted by a mass of anorthosite or labradorite rock which apparently covers it up. A similar phenomenon appears to occur in Morin (St. Sauveur), where the limit of the labradorite rock * * * immediately flanks the limestone band on the north," and goes on to say: "If, on exploration to the eastward of the Trembling Mountain, it should be farther ascertained that the two inferior limestone bands of the Grenville series disappear on reaching the margin of the anorthosite, it may be considered as conclusive evidence of the existence in the Laurentian system of two immense sedimentary formations, the one superimposed unconformably on the other, with probably a great difference in time between them."

Limestones are cut off by the anorthosite at St. Sauveur.

A careful examination of this district in company with Dr. Ells, of the Geological Survey, has since shown, however, that one of the supposed interruptions really is not seen, the anorthosite mass mapped on the first range of the township of Grandison, and which was probably reported to Sir William by one of his assistants, having no existence, and that the drift is so heavy in this region that even if the other limestone bands did come against the anorthosite the contact could not be observed. A careful examination of the contact on the south-west corner of the area in the neighbourhood of the village of St. Sauveur, leaves little doubt that the limestone is really cut off by the anorthosite at this point. The limestone underlies a plain, protruding here and there in large exposures through the drift, whilst the anorthosite rises from this plain as a steep wall or cliff. The limestone is exposed 200 yards from the foot of the anorthosite wall, but the drift covering then becomes so thick that the character of the contact itself cannot be determined. Both to the east and to the west the associated gneiss is cut off in a similar manner.

At Lake Ouareau.

On the north-east side of the anorthosite area there was found, moreover, another limestone band which runs through Lake Ouareau, and forms in it a number of small islands. It is also well exposed on the south shore of this sheet of water. This bed disappears at the edge of the anorthosite a short distance from the south end of the lake, and no further traces of it are seen until what is probably its continuation appears again interstratified with the gneiss at the south-east corner of the anorthosite area.

In order to understand why Logan regarded the anorthosites as belonging to a sedimentary series, a fact must be borne in mind which will be referred to at greater length in considering the structure of these rocks, namely, that in places the anorthosite shows a more or less distinctly foliated structure, which structure was believed in accordance with the views generally accepted at that time to represent a partially obliterated bedding.

Sections from St. Jérôme to New Glasgow.

This is especially true of the anorthosite near its contact with the gneiss and is especially well marked in the long arm-like protrusion from the south-east corner of the area, which, as above mentioned, runs into the gneiss in the direction of its foliation, and finally, with it, becomes covered up by the overlying Palæozoic to the south. There is, moreover, at St. Jérôme a smaller isolated area of a more or less foliated anorthosite intercalated in the gneiss, and this was supposed by Logan, who from lack of time was unable to examine the whole area carefully, to form part of the great Morin area, which really terminates many miles to the north. Starting from a point to the west of St. Jérôme and going in an easterly direction across the strike of the rocks to New Glasgow, he passed from gneiss over the St. Jérôme anorthosite and then over a series of gneisses interstratified with quartzites and a band of crystalline limestone to the arm-like protrusion of the Morin anorthosite referred to above, which has a foliation parallel to the strike of the gneiss, and over it to gneiss once more. Misled by this section, which is here a most deceptive one, he concluded that the whole consisted of a great sedimentary series of anorthosites with interstratified quartzites limestones and gneisses, which series formed the southerly development of the anorthosites that he had observed interrupting the Grenville series in DeSalaberry and the other townships to the north. Accordingly, in Section No. 6 of the Atlas accompanying the Geology of Canada, this "Upper Laurentian" is made to include the limestone at St. Jérôme and to underlie the whole stretch of country from the supposed contact with the Grenville series at the River Gagnon to the west of St. Jérôme, south-eastward to the state of Vermont, although for the most part covered by newer strata. Instead of this we really have the

Grenville series with certain areas of the fundamental gneiss, continuous throughout the whole district embraced by the map accompanying the present Report, except where it is interrupted by intrusive masses of anorthosite. The foliation of the anorthosite, therefore, being now recognized as a distinctly dynamic phenomenon, and there being no evidence of any series of gneisses except the Grenville series and the fundamental gneiss in the district, this "Upper Laurentian" series of Logan passes out of existence.

Logan's "Upper Laurentian" has no existence.

Petrography of the Morin Anorthosite.

The earlier geologists who first explored the great stretches of Laurentian rocks underlying various parts of the Dominion, in many widely separated districts met with enormous masses of a rock differing entirely from the common orthoclase rocks which make up the greater part of the Laurentian system. This rock was composed principally and sometimes exclusively of plagioclase felspar, but often varied considerably in structure from place to place, being sometimes massive, sometimes schistose, sometimes coarse and sometimes fine in grain.

Petrography of Morin anorthosite.

These rocks they called anorthosite. In the Geology of Canada, (p. 22) Sterry Hunt refers to the rock in the following words: "Since all these varying triclinic felspars are anorthic in crystallization, and approach more or less to anorthite in their composition, Delesse thus proposed to designate them by the common name of anorthose, as distinguished from orthose or orthoclase, and the rocks characterized by their presence as anorthosite. In accordance with this we have adopted the generic name of anorthosite for these rocks."

The name anorthosite.

This term anorthosite has often been misunderstood, having been confused with anorthite and supposed to designate a rock consisting of anorthite, a felspar which rarely occurs in these rocks. The word "anorthose" suggested by Delesse, is synonymous with the word plagioclase, which has now supplanted it in common usage, and consequently the term anorthosite simply means "plagioclase rock," a designation which serves both to define its composition and to emphasize the difference between these anorthosites and the predominating orthoclase rocks of the rest of the Laurentian region.

The place of this anorthosite is in the family of the gabbros, where it occupies a position at one extremity of the series corresponding to that of the pyroxenites at the other extremity. An ordinary gabbro when it becomes very rich in felspar passes into an anorthosite; when, on the other hand, the felspar decreases in amount, so that the

Composition of anorthosite.

pyroxene predominates largely, a pyroxenite results, while if in the case of an olivine gabbro the pyroxene decreases in amount, leaving plagioclase and olivine as the essential constituents, a troctolite results.

Almost pure plagioclase.

Hunt has estimated that three-quarters of the anorthosites of Canada do not contain over five per cent of minerals other than plagioclase.

This anorthosite, which occurs not only in Canada, but in Norway, Russia and other countries, constitutes a well defined rock type, and one which, not only on account of its peculiar composition, but also owing to the enormous size of the masses in which it occurs and the constancy of its character, occupies an important position in the petrographical series.

Minerals occurring in Morin anorthosite.

The anorthosite of this Morin area exhibits a great variation in structure and colour and in certain places even a considerable variation in composition, but is in mineralogical composition a gabbro or norite free from olivine and very rich in plagioclase. Hand specimens from about fifty different places in the area have been sliced and microscopically examined, and the following description of these rocks is based on the results thus obtained. The number of minerals which the rock contains is not large, the variations in composition resulting principally from their irregular distribution. The following minerals have been observed in the rock :—

Plagioclase	Muscovite and Paragonite	Epidote
Augite	Bastite	Zoisite
Hypersthene	Chlorite	Garnet
Ilmenite	Quartz	Zircon
Orthoclase	Magnetite	Spinel
Hornblende	Apatite	
Biotite	Calcite	

Of these plagioclase, augite, hypersthene and ilmenite are by far the most important.

Plagioclase.

As above mentioned, Hunt adopted the name anorthosite for these rocks on account of the great preponderance in them of plagioclase or anorthose. He considered the type which contains only felspar as the true anorthosite and estimated that three-fourths of the anorthosites in the Dominion did not contain over five per cent of other minerals.*

Like the other constituents of the rock, the plagioclase is quite fresh, showing but very rarely any traces of decomposition, and when it is not granulated (that is protoclastic or cataclastic in structure) presents

*T. Sterry Hunt—On Norite or Labradorite Rock, Am. Journ. Sc., Nov., 1869.

in hand specimens, almost without exception, a dark violet, but more rarely a reddish colour. This colour is still plainly visible in thin sections, although naturally much fainter, and is seen to be caused by the presence of an immense quantity of minute opaque black rods and extremely small opaque dark points, which give the mineral in thin sections a peculiar turbid appearance. The latter probably represent in part cross-sections of the rods, but are more usually round or slightly elongated individuals of the same substance as the rods and occurring with them. Vogelsang* estimated, in connection with his studies of the anorthosite of Labrador, that these inclusions amount to from one to three per cent of the volume of the mineral, and goes so far as to say: "Le nombre des microlites contenus dans un volume déterminé est susceptible d'être apprécié avec plus de précision; les résultats toutefois s'écarteront beaucoup entre eux, suivant l'échantillon qu'on aura choisi et le point dans lequel on l'aura examiné. Dans le labradorite violet figuré le nombre de microlites s'élève au minimum à 10,000 par millimètre cube; mais pour autres variétés jaunes et gris foncées le calcul m'a donné un nombre au moins dix fois plus considérable de sorte qu'il y avait ici, dans l'espace borné d'un centimètre cube plus de cent millions de petits cristaux étrangers." The larger rods are surrounded by a zone of clear felspar. Some inclusions are transparent, and have a reddish-brown colour resembling hæmatite; these appear in small scales which often show a somewhat distorted hexagonal outline. Objects which closely resemble the above mentioned rods are often seen, when very highly magnified, to be cavities, partly filled up by the dark material of the rods. These inclusions are pretty uniformly scattered through the felspar individuals, and not confined to certain places, nor present more abundantly in some places than in others, as is the case with the gabbros described by Williams† or by Judd.‡ Minute fluid inclusions may often be observed arranged in rows; in these there appears now and then a moving bubble. In one or two cases small cubes were perceived in them, and in one case it was thought that a double bubble could be recognized. In two or three localities the otherwise normal felspar contained but few of these inclusions, and consequently was almost white in colour. The nature and origin of these dark inclusions, which occur so frequently in the felspar and

Minute inclusions.

* Vogelsang—Archives Néerlandaise, T. III., 1868.

† G. H. Williams—Gabbro and associated Hornblende Rocks in the neighbourhood of Baltimore, Md.—Bull. U. S. Geol. Surv. 28, p. 21.

‡ J. Judd—Gabbros, Dolorites and Basalts of Tertiary age in Scotland and Ireland—Q. J. G. S., 1886, p. 82.

other constituents of the gabbro, in the most widely separated localities of the globe, have been frequently discussed.

Their character.

The inclusions are so minute that they cannot be isolated and chemically examined. Their form is not defined with sufficient sharpness and constancy to enable their crystallographic character to be determined. Some investigators have endeavoured to gain some information as to the nature of these minute bodies by observing their deportment when treated with concentrated acids, but the results obtained are contradictory. Judd (l. c.) found that they resist concentrated hydrochloric acid. Vogelsang (l. c.) treated a small piece of felspar from Paul's Island, Labrador, which contained them, with hot hydrochloric acid for four days. He found that the acid had strongly attacked the felspar, but could perceive no alteration in the needles, except that they had become slightly paler. Hagge,* however, found that in the same rock from Labrador all the brown scales were dissolved when treated with the acid for a time too short to effect a decomposition of the felspar. He considered that they were probably göthite.

Prof. Judd's examination.

Probably titaniferous. iron ore.

They are evidently some iron compound, and the peculiar colour of the transparent individuals, taken in connection with the fact that, as will be shown under certain conditions, they unite to form small masses of titanic iron, leads to the belief that the view of Professor Rosenbusch is correct, namely, that they consist principally of titanic iron ore or ilmenite. The transparent ones have the form of the mineral known as micaceous titanic iron ore, which Lattermann† found intergrown with magnetite in the nephelinite of the Katzenbuckel. The peculiar colour of this mineral, moreover, resembles perfectly that of these inclusions. The diverse results which the several investigators have obtained in the matter of the solubility of these inclusions may perhaps be explained by the titaniferous iron ore in some hand specimens being richer in titanic acid than in that of others.

In this connection it must be mentioned that titanic iron ore is a mineral which is constantly found in these anorthosites in Canada, often in enormous quantities, so that it is considered as particularly characteristic of them, while in the Laurentian proper the iron ores, in the greater number of cases, contain no titanic acid. Lacroix,‡

* Hagge, Microskopiche Untersuchung über Gabbro and verwandte Gesteine, Kiel, 1871, S. 46.

† Lattermann in Rosenbusch Mass. Gest, p. 786.

‡ Lacroix—Contributions à l'étude des gneiss à Pyroxene, p. 141—Bull. Soc. Min. France, April, 1839.

who has investigated somewhat similar inclusions in certain Norwegian gabbros, which, however, are double refracting, thinks that they are pyroxene, especially as they frequently appear to be grouped together, forming larger grains which may be determined as belonging to this species: "Les grains en question semblent avoir attiré à eux les particules pyroxéniques en suspension dans le feldspath et les avoir incorporées à leur masse." It is quite possible that these inclusions so often found in gabbros and allied rocks, consist of the heavier minerals of the rock, in some cases pyroxene and in others iron ore, which were finely disseminated through the magma while the rock was crystallizing, or which, perhaps, separated, but as the several constituents crystallized. My best thanks are due to Professor Judd for a small collection of thin sections of typical gabbros and peridotites from the north of Scotland, which he has described and on which he has principally established his theory of "schillerisation." An examination of these revealed the fact that nowhere in them are the inclusions in the plagioclase so numerous and well defined as in the Canadian anorthosites. The peculiar arrangement of these inclusions in the Scottish rocks along cracks, fissures, &c., which Professor Judd has described, and which especially supports his theory of their secondary origin, is not observed in these Canadian rocks. Their inclusions are on the contrary distributed thickly and pretty uniformly through the whole felspar individual, generally indeed throughout the felspar of the whole rock. They disappear, as above mentioned, only when it has been granulated. This remarkable fact will be referred to again.

Schillerisation.

The uniform distribution of these inclusions does not prove that they are not schillerization products, for if the rock were completely schillerized these products might be quite evenly distributed in it. Only in a few places in this Morin area does the plagioclase exhibit that play of colours which is produced by these inclusions in the felspar from Labrador and elsewhere.

The plagioclase is almost invariably excellently twinned, according to both the albite and pericline laws, the two sets of twin lamellæ crossing one another at right angles in the thin sections. This twinning is apparently sometimes secondary and produced by pressure, as for instance when the lamellæ appear along a certain line or crack, or when they appear in places where the plagioclase individual is twisted.

In most cases, however, they are of primary origin. Frequently in the sections there are a few untwinned individuals of plagioclase which are probably cut parallel to $\infty P \breve{\infty}$ (010). But in certain hand-specimens there is a considerable percentage of untwinned felspar,

Twinning plagioclase.

resembling in all other respects the plagioclase which shows a well defined twin structure. In order to determine whether in these cases two felspars were really present, separations by means of heavy solutions were made, on material from three hand specimens from different localities, in the thin sections of which these untwinned felspars occurred in considerable quantity. Since, however, in a solution having a specific gravity of 2·67 all the constituents sank, these untwinned individuals cannot be more acid than labradorite, to which variety the remaining felspar likewise belongs. Similar occurrences of untwinned plagioclase have been often observed. Hawes*, who investigated some of them, gives an analysis† of an ordinary specimen of typical labradorite of St. Paul's Island and adds : "Some of the anorthosites described by T. Sterry Hunt in the Geology of Canada, 1863, were proved by his analyses to be composed of pure labradorite, and some sections of the same which he submitted me for examination were found to be composed of a multitude of small grains, none of which were twinned."

Composition of the plagioclase.

An examination was made of the well twinned plagioclase from two other localities. The first was a hand specimen of a typical anorthosite which is found five miles north-west of Ste. Adèle in the Morin district. Its specific gravity was between 2·65 and 2·67, and it had, therefore, also the composition of an acid labradorite, a fact confirmed by the values of the extinction-angle measured on a small fragment separated by means of Thoulet's solution. The second was from the village of Ste. Adèle itself, which lies at the corner of the Morin area. Here the anorthosite is porphyritically developed with large plagioclase crystals which are sometimes as much as four inches long. These had the following extinction angles: on $\infty P \bar{\infty}$ (010) $24\frac{1}{2}°$ to 26°, on O P (001) = 6°. An analysis of the bluish opalescent plagioclase from the Morin district will be found in the table of analyses given on page 130 J ; here again the felspar is a labradorite.

The plagioclase of the anorthosite from these six different localities is, therefore, in all cases labradorite, and there is every reason to believe that the felspar throughout the whole area belongs to this variety. Although it is generally quite fresh, yet a partial decomposition was observed in one or two cases, where it is altered to a mixture of calcite, epidote and zoisite, as mentioned in the description of these minerals. A peculiar variety of the rock, having a saussuritic habitus, was observed at New Glasgow. This is an entirely local

* Hawes—On the determination of Felspar in thin Sections of Rocks. Proc. Nat Mus., Washington, 1881, p. 134.

† See table of analyses, p. 130 J.

occurrence connected with the small zones of disturbance which here run through the anorthosite. In thin sections of this rock, which is almost entirely composed of plagioclase, mixed only with a few small grains of iron ore, the plagioclase is seen to have undergone a peculiar alteration. The alteration product is a mineral usually having a fibrous structure, and occurs in the plagioclase in little spots. It has the optical character of a bastite or pseudophite, and the decomposed felspar resembles, therefore, to a certain extent that of Waldheim in Saxony, described as pyknotrope by Breithaupt. In another hand specimen of the same rock from New Glasgow, the felspar is changed into a colourless mineral which forms small feather-like clusters. It shows magnificent polarization-colours and has a distinct cleavage to which the extinction is parallel. The mineral possesses the optical properties of muscovite but may be paragonite, which cannot be distinguished from muscovite under the microscope, and is a more probable alteration product of plagioclase.

Alteration product.

Augite.

The augite is, with a few exceptions, generally present in much smaller quantity than the plagioclase, but is next to it the most abundant constituent. Rhombic pyroxene is present, however, in nearly, if not quite equal amount. The augite occurs in irregularly shaped grains of a light-green colour, which are either non-pleochroic or exhibit a scarcely perceptible pleochroism in greenish tints. In sections which are nearly parallel to the base, the typical cleavages characteristic of pyroxene are seen cutting each other almost at right angles. They are often intersected by a third more perfect cleavage which is parallel to $\infty P \bar{\infty}$ (100) as shown by its position relative to the plane of the optical axes. In the prismatic zone the mineral shows an extinction-angle from 0° to 45°.

In many sections of the pyroxene, there are brownish-black tables or small black rods which resemble very much the inclusions in the plagioclase, above described. Where these occur they are frequently parallel to $\infty P \bar{\infty}$ (100); in other cases instead of being scattered throughout the whole individual they are confined to certain spots. The augite can often be observed to have grown around grains of iron ore. It is generally quite fresh, but in many hand specimens is decomposed. The products of decomposition consist sometimes of a finely granular mixture of chlorite, and a rhombohedral carbonate with occasional quartz grains, the whole constituting a gray almost opaque mass. In other specimens, the augite is changed into a yellowish bastite, which then fills up not only the space originally occupied by the augite, but also penetrates into the small fissures of the rock and forms thread-like veins and scales even in the felspar grains. In some specimens again it is converted into a mineral resembling serpentine. When both pyroxenes occur together in the rock, the augite is generally intimately associated with the rhombic pyroxene.

Rhombic pyroxene. Hypersthene.

The rhombic pyroxene, which occurs so often in association with the augite, does not essentially differ from the latter as far as can be ascertained from its thin sections, either in index of refraction, in double refraction or in colour. It is however strongly pleochroic with the following colours:

$$\mathfrak{a} = \text{red}, \quad \mathfrak{b} = \text{yellowish green}, \quad \mathfrak{c} = \text{green}.$$

The absorption is $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$, the difference between $\mathfrak{a}$ and $\mathfrak{b}$ being very small.

Its rhombic character, was established by the following observations in the case of a hand specimen from the township of Chilton, in which the mineral occurred in fresh condition and in larger quantity than usual. Sections parallel to the base showed the two cleavages of the prism which intersected almost at right angles, as well as a third more perfect set of cleavages, to which small black rods were often parallel. Since the direction of the extinction was also parallel to this latter cleavage, it must be in the direction of a pinacoid. In convergent light, there was seen on the basal section a bisectrix, but not an optic axis as n the case of a monoclinic pyroxene. When a section in which an optic axis appears was examined, the above-mentioned pinacoidal cleavage was found to be parallel to the plane of the optic axes. The pinacoid in question was therefore $\infty P \breve{\infty}$, that is to say it cuts off the acute prismatic angle as $\infty P \bar{\infty}$ does in the case of diallage. In sections which showed an optic axis and only one set of cleavages to which the small rods lay parallel, the cleavage was seen to be parallel to the plane of the optic axes.

In all sections which contain the mineral, many grains are found which show only one good cleavage to which the extinction is parallel.

In general it is like the augite quite fresh, in a few sections it appears, however, changed into bastite, and in a few others into a serpentine-like mineral. It sometimes contains the dark scales and rods so often found in hypersthene, but very often these are entirely absent. It is indeed a remarkable fact that in these Canadian rocks, the iron-magnesia minerals contain but a few of these inclusions, while the associated felspar is filled with them, the exact opposite being true in the case of the gabbros and associated rocks of the Scottish Highlands, which have been described by Prof. Judd.

Hornblende does not occur in the anorthosite of Morin except in a few places near the contact with the gneiss. In these cases it is always found in intimate association with the pyroxenes, in the form of irregularly defined grains generally about the border of the granulated masses of the pyroxene. It occurs as a general rule only in very small quantity. It is usually green in colour, but is often brown. It shows the cleavages, the small extinction angle, and the characteristic pleochroism of the species. In a hand specimen from the neighbourhood of the contact on Lake l'Achigan, the maximum extinction-angle was found to be 15° and the following pleochroism was observed : Hornblende

$\mathfrak{a}$ = greenish yellow, $\mathfrak{b}$ = yellowish green, $\mathfrak{c}$ = green.

The absorption was $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$.

In another hand specimen, quite close to the contact, about six miles north of New Glasgow, a brown hornblende was likewise found in small amount. The extinction-angle was 18°, with the following pleochroism :

$\mathfrak{a}$ = light brownish yellow, $\mathfrak{b}$ = deep brown, $\mathfrak{c}$ = deep brown, with the absorption as before, $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$.

It also occurs in the peculiar rock which has been referred to above as a gabbro, which was found in a number of places between the true anorthosite and the gneiss.

Biotite never occurs in large amount, but is present rather frequently in very small amount as an accessary constituent. It is usually found with the iron ore or with the hypersthene, and shows characteristic brown colour, strong pleochroism and parallel extinction. Biotite.

The occurrence of muscovite or paragonite has been referred to in describing the plagioclase. Muscovite or paragonite

Chlorite occurs occasionally in small quantity as a decomposition product of pyroxene or biotite. Chlorite.

It is doubtful whether quartz ever occurs in the anorthosite as a primary constituent. It occurs, however, in small amount in the form of little grains scattered through the anorthosite on lot 36 of range VI. of the township of Wolfe, near the contact of the anorthosite with the surrounding gneiss. Again on the west side of the Achigan River, near New Glasgow, it is occasionally found in the anorthosite, and has the appearance of a primary constituent. Here again, however, the occurrence is near the contact with the gneiss, and it is certain that some secondary quartz is present as a decomposition pro- Quartz.

duct of the pyroxene, so that the quartz which has the appearance of a primary constituent may also be of secondary origin.

In the gabbro which occurs as above stated in many places between the typical anorthosite and the gneiss, quartz is quite frequent. But in this rock many facts point to the secondary origin of the quartz. It often occurs, for instance, in more or less sharply defined veins, made up of large individuals. When it occurs in the form of separate irregular grains, those extinguish uniformly, although they are often more or less fissured, but they are by no means so much broken as might be expected if they were primary ingredients in view of the extremely broken condition of the felspar and the other constituents of the rock.

Ilmenite and magnetite.

In nearly every section of anorthosite, some irregularly shaped grains of an opaque black iron ore are seen. These are usually few in number. The quantity of iron ore is considerable only in a few places, and as in these the percentage of pyroxene increases in the same proportion, the rock here assumes a very dark colour, so that it is often taken for an iron ore. These portions of the anorthosite rich in iron ores are only few and local, and they pass over into the normal gabbro of the area. which, as above mentioned, is very poor in iron ore.

If these iron ore grains are examined by reflected light, they are found to be black, and in a few cases they can be seen to be partly changed into a gray decomposition product, evidently a variety of leucoxene. This circumstance proves that the mineral contains titanic acid in considerable amount.

In three hand specimens from widely separated parts of the area, an intermingling of two iron ores was distinctly seen. In that from the township of Wexford, lot 7, range I., one of the above-mentioned localities where the anorthosite is rich in iron ore (Section No. 398), careful observation in reflected light showed the iron ore to occur partly as a bluish-black coarse-grained variety, and partly as a brownish black finely granular variety, both being irregularly intermingled and distinguishable only by reflected light.

When the section was treated for about half an hour on a water-bath with warm concentrated hydrochloric acid, the coarsely granular variety was entirely dissolved and the acid became strongly coloured with iron, while the finely granular variety was apparently not at all affected. There is here evidently an intergrowth of magnetite with ilmenite or at least with a titaniferous iron ore.

In another hand specimen (from the neighbourhood of Lake Ouareau) a similar intergrowth was observed; the grains had a banded appearance in reflected light, one variety crossing the other in a single or double set of interrupted bands. When the section was treated with cold concentrated hydrochloric acid for 48 hours, no effect was produced; but when treated with warm concentrated acid in a water-bath, one variety of iron ore was dissolved as before, while the other again remained undissolved. In this case the intergrowth is probably parallel to the face of an octahedron or rhombohedron. A similar intergrowth has been described in the iron ore of the Carrock Fell gabbro, and in the nephelinite of the Katzenbuckel,* except that in the latter case, the titanic iron ore occurs in the form of micaceous titanic iron ore, not as the coarse and opaque variety found in the above-mentioned rocks.

Intergrowth of different iron ores.

It has been the invariable experience in Canada, that the large iron ore deposits common in these anorthosite rocks, contain so much titanic acid, that it has been impossible hitherto to work them profitably. Recent experiments, however, lead to the hope that in the future some of them at least may be smelted with profit. (Appendix II.) In order to determine whether the iron ore which is disseminated in small grains throughout the whole rock was also rich in titanic acid, the iron ore of three hand specimens of the anorthosite from different parts of the area was separated and tested. In every case the mineral was but faintly magnetic and gave a strong titanic acid reaction.

Titanium in iron ores of anorthosites.

Two specimens of iron ore from the pegmatite veins, which cut through the anorthosite and the gneiss at the contact of the two formations, west of St. Faustin, and therefore do not belong to the anorthosite, showed strong magnetism and gave only a faint reaction for titanic acid. The iron ore bed, a short distance west of St. Jérôme, in the orthoclase gneiss, also consists of magnetite and contains no titanic acid. We therefore find that these investigations confirm the conclusion that the iron ore of the anorthosite is very rich in titanic acid, while the iron ore of the Laurentian gneiss generally contains no notable quantity of this substance.

Iron ores of gneisses usually free from titanium.

In the variety of anorthosite very rich in iron ore from lot 7, range I., of Wexford, the evidence obtained from the thin sections, shows that the iron ore crystallized later than the pyroxene, as it can be observed frequently completely inclosing individuals of this mineral. The same fact was noted in the case of the pyroxene granulites. (See page 79 J).

* Latterman, in Rosenbusch, Physiographie der Massigen Gesteine, p. 786.

Pyrite. A few small grains of pyrite often occur in the thin sections of the anorthosite. They are generally found associated with the iron ore.

Apatite. Apatite is seldom observed in the anorthosite. When it does occur it is in the form of more or less rounded grains. It is more frequently found in the varieties rich in iron ore in the township of Wexford and other localities, than in the normal anorthosite.

Calcite. Calcite was found in but two hand specimens. One of these was fresh, and contained a small amount of calcite which might possibly be a primary constituent. The other was from New Glasgow, and in this the calcite appears together with zoisite, epidote, etc., as a decomposition product of the plagioclase.

Epidote. The only locality where epidote occurs is also near the village of New Glasgow. It is found in several sections of the anorthosite from this place, along with chlorite and quartz, as a product of the alteration of the pyroxene, and as above mentioned with calcite and zoisite as a product of alteration of the plagioclase. In one or two places it also occurs in small bands, cutting diagonally across the anorthosite, following the line of small faults. The epidote is everywhere secondary.

Garnet. Garnet does not occur as a constituent of the normal anorthosite, but is often found near its contact with the surrounding gneiss. It has a pinkish colour, and is seen under the microscope in small irregular masses, which are often mixed with or completely surround the grains of iron ore. In the sections of the variety of anorthosite rich in iron ore from the township of Wexford, lot 7, range I. (and from other places above mentioned), a pale-pink garnet occurs forming a small zone of uniform breadth around every grain of iron ore or pyroxene where these would otherwise come in contact with the plagioclase. Between the pyroxene and the iron ore there is however no garnet. It is quite isotropic and has grown out from the iron ore or pyroxene into the felspar, against which it is bounded by sharp crystalline outlines. These zones of garnet are analogous to the zones of actinolite and hypersthene around the olivine of the anorthosite from the Saguenay River, and those which have also been described in olivine gabbros of many other localities.

Zircon. Zircon is not found in the normal anorthosite, but it occasionally occurs in this rock near its contact with the gneiss. It is seen only in small quantity, and especially in the peculiar contact variety which occurs, as above mentioned, in some places between the anorthosite and the gneiss. It was observed in this in many localities. It has the form of small stout prisms, always with more or less rounded edges, which are characterized by a parallel extinction, high refractive index and strong double refraction.

Spinel was observed in a single hand specimen, in the form of small rounded isotropic grains, deep green in colour, occurring as inclusions in plagioclase and pyroxene. Spinel.

The Structure of the Morin Anorthosite.

The macroscopic structure of these anorthosites, as well as that of most of the crystalline rocks forming the Laurentian system, is best studied on the great glaciated surfaces of the roches moutonnées, which protrude through the drift in all directions. On a freshly fractured surface, or even on a smoothly glaciated surface which has been protected from the weather, comparatively little of the structure may be seen; but when the glaciated surface has been exposed, during the interval which has elapsed since the disappearance of the ice, to the etching action of the weather and the dilute solution of carbonic acid known as rain water, the structure of the rock is brought out in a wonderfully clear and striking manner, just as the structure of wrought iron or of various alloys is brought out by the treatment of their polished surfaces with the stronger acids. Such weathered surfaces, moreover, being many square yards in extent, enable the structure of considerable masses of the rock to be determined and the relations of different structures to one another to be clearly seen. Structure of Morin anorthosite.

If any large weathered surface of the anorthosite, such as is found in the roches moutonnées anywhere within the Morin area, be examined (leaving out of consideration for the present the arm-like extension and that part of the main area adjoining it), it will be noticed that the rock, which is coarse-grained and of a deep violet colour, has not that regularity of structure which we see in a typical granite, but presents a more or less irregular structure. This irregularity is sometimes scarcely noticeable, but is at other times striking, and is due to the presence of the bisilicates and iron ore in larger amount in some parts of the rock than in other parts. The portions richer in bisilicates may take the form of large irregular-shaped patches occurring at intervals through the rock, or of many small patches occurring abundantly in certain parts of the rock which elsewhere is nearly free from them. In some cases these are arranged so as to form irregular wavy streaks instead of patches, which sometimes take a rudely parallel direction, giving a sort of strike to the rock, but which in other places are quite irregular in Glaciated surfaces. Irregular structure arrangement. Between these patches or streaks rich in bisilicates, and rather badly defined against them, are portions of the rock which are very poor in or often quite free from bisilicates. The structure is well represented in Plate VI., which is a photograph of a large anorthosite boulder on lot 5 of the ninth range of Chertsey. Here the iron ore and bisilicates are aggregated together in irregular-shaped more or less rounded portions of the rock, while the remainder of the rock is almost absolutely free from iron-magnesia constituents. Of these portions containing the bisilicates and iron ore, these constituents form about one-third of the rock, the rest being plagioclase. Large individuals of plagioclase, irregular in shape and which will be referred to again, occur quite abundantly in the parts of the rock free from bisilicates, but are very rarely found in the patches containing the bisilicates. With the exception of the larger individuals of plagioclase, the rock is uniform in grain throughout. The portions containing the bisilicates weather more readily than the rest of the rock, and thus leave hollows on the weathered surfaces, while when the patches are elongated, as is usually the case, irregular sausage-shaped cavities result. In the occurrence represented on Plate VI. it will be noticed that one of the masses rich in bisilicates and much larger than the others, forms a rude band across the lower portion of the boulder. In such cases, the bisilicate individuals are arranged with their larger axes in a direction rudely parallel to the band.

Variation in relative amount of constituents.

Often in connection with this irregularity in the relative proportion of the several constituents present in the rock, but often quite independent of it, there is a rapid and frequently abrupt variation in size of grain from place to place, certain spots or streaks being, as before, finer or coarser than the mass of the rock. More or less well pronounced irregularities, due to one or both of the causes above mentioned, are met with in all the anorthosite areas of Canada which have been examined, but are not peculiar to them, being found in gabbros and allied basic plutonic rocks in various other parts of the world. Thus Dr. George H. Williams in his paper entitled The Gabbros and Associated Hornblende Rocks occurring in the neighbourhood of Baltimore, Md., says on page 25: "The most striking feature in the texture of the unaltered gabbro is the repeated and abrupt change in the coarseness of the grain which is seen at some localities. It was undoubtedly caused by some irregularity in the cooling of the original magma from a molten state, for which it is now difficult to find a satisfactory explanation. The coarsest grained varieties of the Baltimore gabbro occur in the neighbourhood of Wetheredville and there these sudden changes in texture are most apparent. Irregular patches of the coarsest

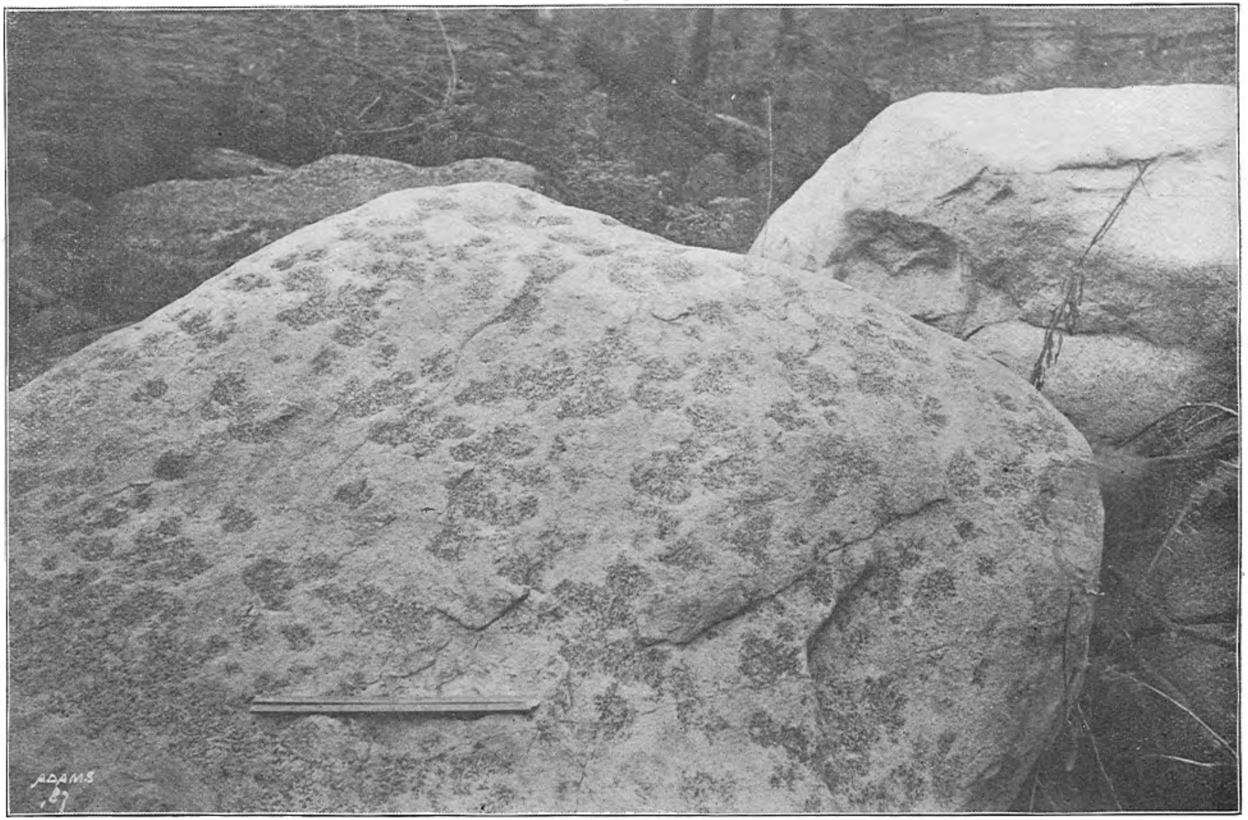


Plate VI.—ANORTHOSITE, SHOWING SEGREGATION OF THE DARK COLOURED CONSTITUENTS IN CERTAIN PORTIONS OF THE ROCK.

kinds lie embedded in those of the finest grain without any regard to order. In other cases a more or less pronounced banded structure is produced by an alteration of layers of different grain or by such as have one constituent developed more abundantly than the others. Such bands, are not, however, parallel, but vary considerably in direction and show a tendency to merge into one another as though they had been produced by a motion in a liquid or plastic mass."*

Similar coarse-grained patches are sometimes seen in the gabbro diorite quarried at Kühlengrund, near Eberstadt, in Hessen, in a rock which is otherwise perfectly massive and pretty regular in grain. Other similar cases might be cited. Similar elsewhere.

One of the most remarkable occurrences, and one especially noteworthy as showing how a transition takes place from a perfectly normal and massive rock, through one in which these irregular coarse-grained patches are developed, into one showing an imperfect banding such as is sometimes seen in anorthosite, was observed in the great Saguenay anorthosite area, along the course of the River Shipshaw, which runs into the Saguenay from the north about seven miles above the town of Chicoutimi. Along the stream there are at frequent intervals immense smooth roche moutonnée exposures of anorthosite, etched by the weather and burnt clear of all vegetation by forest fires, thus presenting excellent surfaces for the study of the rock. The series of exposures in question is bounded on the north by a great dyke of gabbro, about a half a mile wide, which cuts across the anorthosite, and extends down the Shipshaw a distance of eight miles in a straight line to a point three miles from its union with the River Saguenay. River Shipshaw.

At the first-mentioned point the rock is coarse-grained, absolutely massive over large exposures and regular in grain. This continues for about half a mile, when ill defined patches which are very coarse in grain appear in the rock. In the coarse-grained portions the individuals composing the rock measure an inch or even more across, while in the mass of the rock they are much smaller. Both show a well marked ophitic or diabase structure, in which the plagioclase occurs in lath-shaped individuals, the augite filling in the intervening spaces, a structure which is occasionally seen, but is very unusual, in the anorthosite. This continues for rather over four miles, with in places a further irregularity due to a great variation in the amount of the several constituents present in different parts of the rock, the rock over considerable exposures being all plagioclase, while elsewhere it is Change in structure.

*G. H. Williams, Bulletin No. 28, U. S. Geol. Survey.

rich in diallage, which sometimes occurs in masses as much as a foot and a half in diameter. Large masses of almost pure plagioclase or diallage are thus found in the rock.

Streaked or banded rocks

After an interval of a mile, where the rock is concealed, there is another series of exposures, extending over a mile along the river, in which, as before, the ophitic structure is well developed, but in which the rock is irregularly streaked or banded owing to the fact that the want of uniformity in grain and composition, described above, is no longer displayed in the shape of irregular patches, these having been pulled out into long wavy streaks, similar to those described above by Dr. Williams. Further down the river these streaks begin to assume a rudely parallel direction, giving the rock a determinable strike, while the ophitic structure gradually disappears. A case is thus presented, where an undoubtedly eruptive rock, quite massive and with well pronounced ophitic structure, gradually passes over into one which is banded, the bands being marked by great variations in size of grain and in relative proportions of constituents; and it thus becomes evident, that the rude banding which is a common structure in certain anorthosite areas, and which was formerly supposed to represent a more or less obliterated stratification, is really a structure developed by movements in a truly igneous and massive rock.

Granulation of constituents.

But another structure is also presented by the anorthosites. When any of the anorthosites in the area embraced by the present report are carefully examined, this streaked or irregularly banded structure is seen to be accompanied in most, if not in all cases, by a peculiar breaking or granulation of the constituent minerals of the rock. This is often beautifully displaced by the large weathered surfaces. The accompanying sketch (Figure 9), taken from an exposure in the Morin area near Ste. Marguerite, shows the appearance presented in one of these cases. Here the banding is distinct, but in many parts of the area, even where no banding is seen, the rock presents this peculiar brecciated structure, fragments of plagioclase and of other constituents of the rock being imbedded in a species of groundmass made up of smaller grains. As plagioclase in most cases preponderates almost to the exclusion of the other constituents, the fragments are usually of this mineral, and, although occasionally showing an approximation to good crystalline form, they are almost invariably quite irregular in shape, often possessing absolutely tattered outlines. The groundmass of smaller grains also consists of plagioclase. In some places these fragments constitute the greater part of the rock; elsewhere they are present very sparingly and the groundmass preponderates. The larger individuals can, moreover, be frequently seen in the very act of breaking up, the several fragments having shifted their position but very slightly; and in such cases it is often evident that the breaking is not of the nature of a simple crushing, for from the same individual pieces will be found breaking off in various directions quite at haphazard.

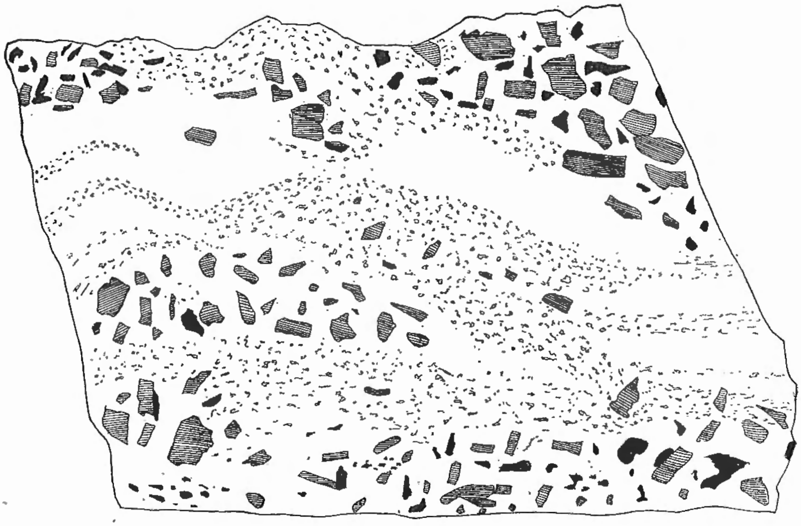


Figure 9.—Anorthosite showing a brecciated structure, near Ste. Marguerite, Township of Wexford. Fragments of Plagioclase and Hypersthene in a groundmass of the same minerals in a granulated condition. The sketch represents a width of 9 feet.

When examined under the microscope in thin sections, hardly a specimen of any coarse-grained variety can be obtained from any part of the area which does not show at least traces of this clastic or granulated structure; and if a series of specimens is studied, every step can be traced in the passage from the massive rock, showing the merest traces of this structure through intermediate breccia-like stages, to anorthosite consisting entirely of broken grains, perhaps with mere remnants of the original large individuals. The three accompanying micro-photographs illustrate successive stages in this granulation. (Plate VII.) They are taken from three thin sections of anorthosite from different parts of the Morin area, photographed in polarized light between crossed nicols and equally magnified, the enlargement in each case being 22 diameters. Microscopical character.

(A.) This section, from the large exposures about five miles north-west of the village of Ste. Adèle, in the township of Morin, before Photographs of thin sections of anorthosite.

referred to (p. 96 J), represents the massive anorthosite, showing only the merest traces of granulation on the left of the field. The size and shape of the constituent individuals of plagioclase and their polysynthetic twinning are well seen. The rock is composed almost exclusively of this mineral, the individuals of which are neither bent nor twisted, and no strain shadows are to be observed.

(B.) In this section, which was prepared from a specimen collected about three and a half miles north-east of White Lake, in the front of the township of Chilton, a distinct breaking or granulation of the plagioclase can be observed, especially in the lower portion of the slide, while the same process can be elsewhere seen, though less well marked. The large plagioclase individuals no longer meet along clear well defined boundary lines, but are irregular in shape, cracked, and separated from one another by a mosaic of broken grains. Strain-shadows, twisted twin lamellæ and other evidences of pressure are well shown. The rock shows no distinct foliation or banding.

(C.) The third section shows the appearance presented by a highly granulated variety of the anorthosite under the microscope. This specimen was obtained from the arm-like extension of the anorthosite mass before mentioned, near its western contact with the gneiss, on range XI. of the township of Rawdon. In this section, about one-half of the field is occupied by broken grains of plagioclase, while in the middle is a large plagioclase individual in process of destruction. A line of granulated material is being developed in a longitudinal direction through the large crystal, making, as is usual, an angle of about 20° with the lines of twinning, and which would, if continued, cut it in two; while about its edge little fragments of the plagioclase can be seen in the very act of breaking off—first a strain-shadow (excellently seen on the upper edge of the large individual) appearing, then a curved crack extending in from the edge of the crystal, and finally the breaking away of a small piece of the mineral, leaving an irregular indentation. The appearance is precisely that which the mineral would present if by means of a pair of small pincers little pieces were being broken off the edge. The strain having been relieved by fracture, all evidence of pressure disappears in the broken grain. And if a thin section were composed of broken grains alone, it would in most cases be impossible to determine that these had resulted from the breaking down of larger individuals. This rock is excellently foliated, owing to the finely granulated material, resulting from the breaking up of each large individual, arranging itself in the shape of a very flat lens about the crystal remnant from which it

Show stages of granulation.

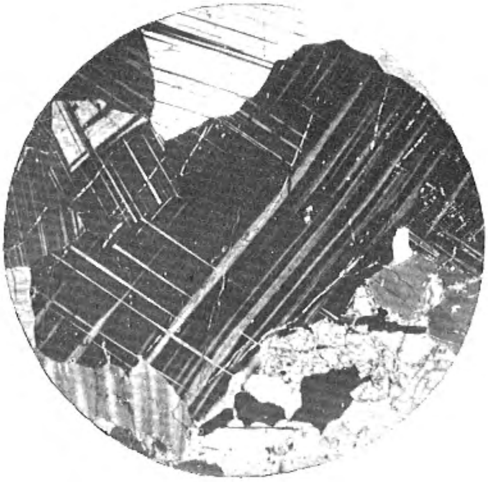


FIGURE A.

FIGURE B

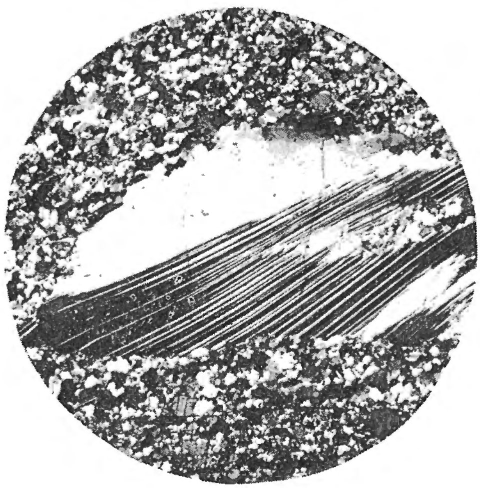


FIGURE C.

PLATE VII.—MICROPHOTOGRAPHS, SHOWING THE PROGRESSIVE GRANULATION OF THE MORIN ANORTHOSITE UNDER THE INFLUENCE OF PRESSURE. × 22.

was derived, which lens, of course, lies in a plane at right angles to the pressure, and in section appears as a long slender tail of broken grains extending from the remnant in either direction. (Fig. 10.)

The pyroxenes, rhombic or monoclinic, when present in the rock, undergo a precisely similar process of granulation with the formation of similar tails of broken grains.

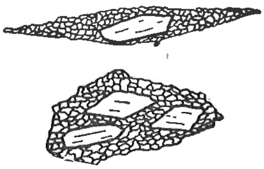


Figure 10.

Sometimes large individuals can be observed which have broken into two or more pieces during the process of granulation, the lens of broken grains thus inclosing several fragments more or less separated from one another, which from their respective outlines can be seen to have been originally one. (Fig. 10.)

Plagioclase changes colour when granulated.

A very remarkable fact in this connection, which has already been briefly referred to in describing the mineralogical composition of the anorthosite, is that the large crystal fragments of plagioclase have a deep violet colour, while the granulated plagioclase is white. This contrast is excellently seen either on the weathered surface (Plate VIII.) or when a thin section is placed on a sheet of white paper, and is due to the fact that the minute dark-coloured or black inclusions, which abound in the large individuals, are absent in the broken material. They seem to have aggregated themselves together into little grains of titanic iron ore, which occur in the granulated plagioclase, but which on the other hand are absent in the large individuals. So distinctive is this contrast of colour, that when a thin section containing plagioclase in both forms is placed under the microscope, it is possible at once to predict from the colour alone, just what portions will show granulation and what portions will not, before the actual structure has been revealed by the agency of polarized light. This might seem at first sight to indicate a recrystallization in the case of the granulated portions of the plagioclase, but the facts do not seem to support this supposition. The felspar, during the process of granulation, does not at any rate alter in composition, but merely breaks, and through the loss of the dark inclusions becomes lighter in colour.

No investigations bearing on this particular point have been made on the anorthosite of the Morin area, but the fact has been established

No change in composition of the plagioclase when granulated.

by the study of precisely similar anorthosites from several other areas. Thus it was found in the case of the anorthosite of Mount Williams, on the River Shipshaw, in the Saguenay area, that the large dark-coloured individuals and the white granulated plagioclase, were both labradorite, differing in specific gravity by only ·015, the dark felspar being naturally a trifle heavier on account of the inclusions. Again, in analyses XIV., XV., XVI. (see p. 130 J) are given the results of an examination by Dr. Sterry Hunt, of the large plagioclase individuals and the finely granulated base of an anorthosite from the Château Richer area. Both are in this case more acid, approaching andesine in composition; but here again in composition they are identical. The same circumstance has been confirmed by Leeds in the case of the anorthosite of Essex County, New York, and by Sachsse in a flasergabbro from Rosswein in Saxony*, although in these two latter cases the material analyzed was not quite pure.

Frequently, as has been stated, the production of the granulated material from the large individuals can be actually observed; and in such cases it can be seen that so soon as the fragment is separated from the large individual its colour disappears. The granulation, it would appear, in some way gives freer play to the forces which bring about the concentration of the material of the dark inclusions. When the anorthosite is composed entirely of the finely granular material, if it be almost entirely plagioclase as is usually the case, the rock can hardly be distinguished, especially on the weathered surface, from a white crystalline limestone.

White anorthosite.

This peculiar variety of white granular anorthosite, with comparatively few of the large individuals remaining, is also largely developed in the Saguenay and other of the anorthosite areas in the province of Quebec, and is described from the area in Essex County, New York, by Leeds, and from Labrador, by Vogelsang, as well as by other observers, it being found apparently to some extent, in most of the localities where anorthosite is largely developed.

Granulated varieties on sides of intrusion.

In the Morin anorthosite, and the same is true of the Saguenay area, the most granulated varieties are found near the sides of the intrusion, especially on the east side, as if the pressure had been exerted from that direction, but more or less distinct evidences of granulation can be seen throughout the entire area. The white granulated anorthosite forms the greater part of the arm-like extension of the Morin mass,

* Ueber den Feldspathgemengtheil des Flasergabbros von Rosswein i. S.—Ber. d. naturf. Ges. i. Leipzig, 1883.

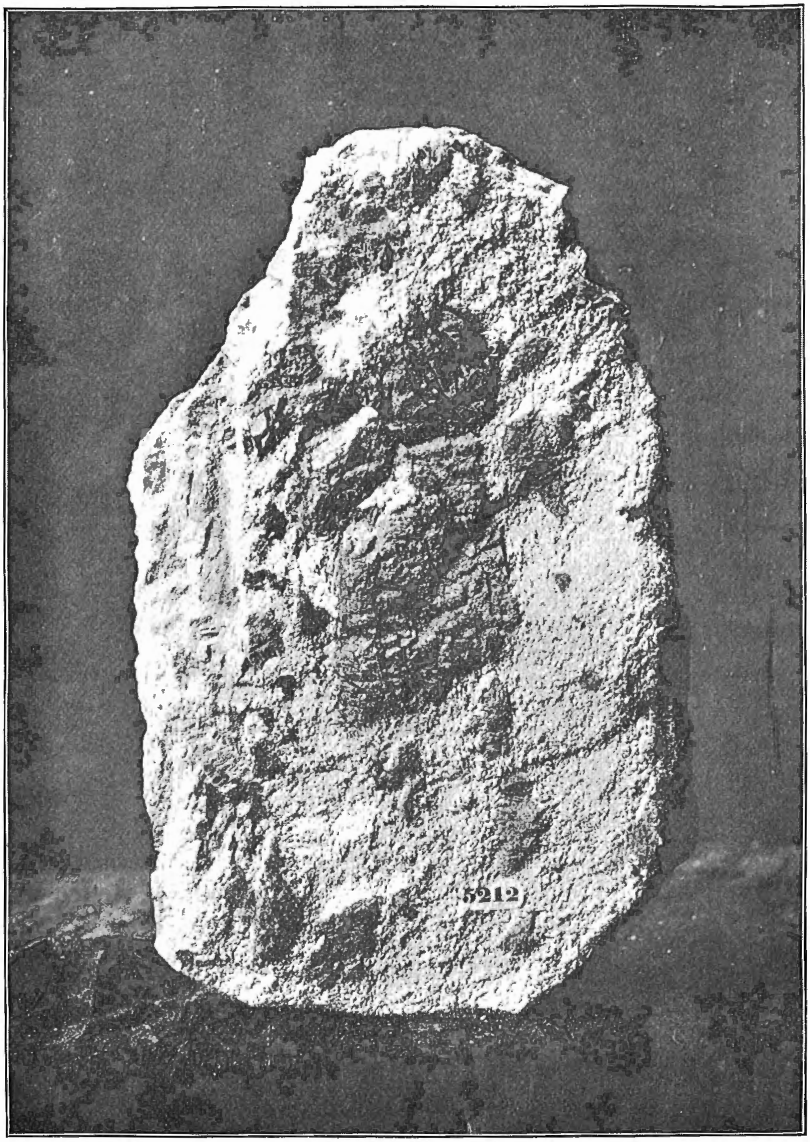


PLATE VIII.—GRANULATED ANORTHOSITE, WITH INCLUDED REMNANTS OF THE ORIGINAL ROCK, RIVIÈRE AUX SABLES, TOWNSHIP OF JONQUIÈRE, QUE.

(REDUCED ONE-HALF.)

protruding through the drift in all directions in the form of hundred of smooth white hummocks giving a striking appearance to the landscape, as for instance, about the village of New Glasgow; and this district being easily accessible by roads and railways, the structure and character of the rock can here be studied with comparative ease. Further, it can be observed that everywhere in this arm-like extension and in almost all its occurrences elsewhere, this white granulated anorthosite is more or less distinctly foliated, owing to the arrangement of the bisilicates and iron ores in more or less distinctly parallel lines or streaks. It is often quite evident that these are nothing more than the rounded patches, rich in bisilicates, described on p. 104 J, as occurring in the massive anorthosite and represented in Plate VI., which, owing to a movement in the rock, have been drawn out in one direction. The irregular-shaped patches, differing greatly in size of grain, described as occurring in the massive rock, are also here represented by elongated streaks of similar character. This foliation is best seen where bisilicates and iron ore are comparatively abundant. When, as is sometimes the case, the rock is almost free from these constituents and all the plagioclase fragments have been destroyed, it assumes a nearly uniform granular character, and no trace of foliation can be observed. The foliation, however, is usually distinctly seen, and in the arm-like extension runs parallel to the direction of the arm itself, that is to the strike of the gneiss, which it penetrates. Along the western border of the arm, the strike is exceedingly regular and remarkably well developed, as at New Glasgow, but is especially well seen along the same contact further north on range XI. of the township of Rawdon, on the road between the villages of Chertsey and Rawdon. Here the rock is seen to have a remarkably regular schistose structure, due to the alternation of thin layers of pure plagioclase with still thinner ones of pyroxene. The pyroxene bands might more properly be called leaves, as they are very thin, being frequently represented by mere parallel lines in transverse sections. When examined under the microscope, in thin sections or weathered surfaces, both they and the plagioclase layers are found to contain small cores or remnants of large individuals with trails of grains extending from them in either direction as before described. These give rise to the perfect foliation and the progress of the granulation is seen in a most astonishingly perfect manner, the cores being in the very act of breaking up (Plate VII.). These cores can occasionally be seen to be the remnants of very large individuals, which have sheared almost in the direction of the foliation. They are thus often long and narrow, some having been observed as much as twelve times as long as they are wide.

Foliated anorthosite.

Origin of several structures.

The question of the origin of the several structures described next presents itself. There is every reason to believe that those structures which have been described as occurring in the massive anorthosite, namely the irregularity in size of grain and the more or less irregular distribution of the several constituents through the rock, are original structures produced before or during its solidification. These irregularities, frequently seen in intrusive rocks, are certainly not the results of pressure; and the circumstance that the streaks or irregular bands, when present in the otherwise massive rock, assume no definite direction, but twist about as if owing to the movements in the rock while in a pasty condition, indicates that they have been produced by movements before the rock became solid. The unequal distribution of the constituent minerals in the rock, must have resulted either from irregularities in the composition of the original magma, or from processes of segregation at work in the magma during cooling and crystallization. The irregularities in the size of grain may be due to differences in the rate of cooling, differences in amount of mineralizer present, or to other causes with which we are at present unacquainted. The angular character of certain of the coarse-grained portions of the rock which are found embedded in the anorthosite of normal grain, would seem to indicate that these had crystallized where circumstances were favourable to the development of coarseness of grain, and had been subsequently broken up and imbedded in a portion of the magma which crystallized in more fine-grained form.

Movements subsequent to solidification.

On the other hand, the granulation of the coarsely crystalline massive anorthosite, usually with the concomitant development of a more or less distinctly foliated or schistose structure in the way described, is undoubtedly due to movements in the rock, resulting from pressure which acted subsequent to its solidification, for, as has been shown, the granulation begins to make its appearance in the massive crystalline rock itself. Under the influence of pressure, the massive rock gradually gave way, and, in the movements which resulted, attrition gave rise to granulation. Moreover, wherever these movements continued longest this granulation became most complete, until finally the last remnants of the larger individuals disappeared, and in the case of a pure anorthosite, a more or less evenly granular rock resulted. In the anorthosite, however, the remnants of larger individuals are seldom or never entirely absent, and in the great majority of cases the amount of interstitial material is quite small. Even when the granulation was most complete, the rock did not crumble into an incoherent powder, but remained as hard and tough as ever, the grains, being unable to separate from one another on account of the great pressure to which they were subjected, rolled over one another, remaining always within the sphere of cohesion.

In this way, any portions of the originally massive rock differing in grain or composition from the rest, would be represented by bands, streaks or even lines in the resulting granulated anorthosite; very coarse-grained portions being represented by bands or streaks containing large plagioclase remnants, fine-grained portions being represented by bands or streaks where these are very small or even absent, while corresponding differences would appear in the case of areas differing in mineralogical composition.

These foliated or schistose anorthosites then, were produced by movement in a massive igneous rock, and are not altered sediments, the structure which they present being, as has been shown, a cataclastic structure. Schistose anorthosites not altered sediments.

But although this granulation and its accompanying phenomena are certainly the results of pressure to which the rock has been subjected, the effects of this pressure are in certain respects quite different from those usually observed. As a general rule, in the case of schistose structures produced by shearing, of which so many excellent examples have been described by Lehmann and others, the breaking up of the constituents takes place principally along certain definite lines. Along these lines or bands, which are sometimes quite wide but which at other times sink to almost microscopic dimensions, the rock is reduced to a comminuted state, forming, if not subsequently compacted, the so-called "rutschmehl" of Heim. Between these shearing planes the rock presents comparatively little evidence of pressure. Where, moreover, great movements accompany dynamic action, and especially along lines of motion, or if these be not present, then throughout the whole rock, certain peculiar alterations in the minerals constituting the rock are found. Of these may be especially mentioned the alteration of pyroxene to hornblende, and of plagioclase into a mixture of zoisite, albite and other minerals known by the name of saussurite.

So far as can be ascertained, no undoubted occurrence of a sheared gabbro or allied rock has been recorded, where hornblende either compact or in the form of uralite and saussurite have not been formed. In a paper on the sheared gabbros of the Lizard in Cornwall,* in which a perfect foliation has been induced by pressure, giving rise to rocks closely resembling the foliated anorthosites of the Morin area, except that the mineralogical changes above mentioned have taken

*Geological Magazine, November, 1886.

place, Teall says "there is no reason to believe that foliation of the kind referred to in this communication can take place without molecular re-arrangement."

Peculiarities in structure of granulated anorthosites.

On the other hand, the anorthosites possessing this cataclastic structure present the following peculiarities :—

1. The cataclastic structure is not developed along certain lines, but may be observed more or less distinctly throughout the rock, being, however, most marked towards the sides of the area, and especially toward the eastern side.

2. Where it occurs there is neither saussurite nor uralite. However granular the plagioclase may be, no trace of saussurite can be seen. In like manner, no uralite is detected, even though the granulation of the pyroxene is so far advanced that only the smallest remnants of the original individuals remain. Now and then some small grains of compact hornblende occur with the pyroxene in the neighbourhood of the contact with the gneiss, exactly as in many normal gabbros. But even these are by no means invariably present; the finely foliated rock, consisting of alternate layers of unaltered pyroxene and plagioclase, while remnants of the large individuals of both constituents, from which the granulated portion has originated, are still seen. The only place in which saussurite occurs is, as before mentioned, near New Glasgow. It forms here, like epidote, strings and veins which have no relation with the foliation of the rocks, but represent small crushed zones, which have originated at another much later period. These very occurrences show most distinctly how different the products of the normal dynamic agencies are from the structure now under consideration.

3. In the main portion of the area, the granulation is not accompanied by foliation, and in the large weathered surfaces plagioclase individuals can be observed which are in the act of breaking in every possible direction. In the arm-like extension from the south-east part of the area, where the rock, as already mentioned, is often distinctly foliated, this foliated structure originated, as shown by a careful study, from the movement in one direction, of a mass whose iron-magnesia constituents were irregularly distributed, being especially concentrated in some places. (Plate VI.) The more or less rounded spots where the iron-magnesia constituents are abundant, became pulled out into irregular, ill-defined streaks, and parallel to these run portions of the rock, which still contain in large numbers fragments of plagioclase individuals.

These phenomena have been caused by movements in the rock. These movements probably took place under the following conditions:— Conditions under which movements took place.

1. When the rock was still so far beneath the surface of the earth and so weighted down by the overlying rocks that breaking and shearing with the movement of the resulting masses was impossible. The alterations in the character of the mass were probably induced very slowly, the constituents became granulated and the small broken parts moved one over another. The granulation progressed with the duration and intensity of this movement up to a certain point. Such a motion would present certain resemblances to that of a very tough pasty mass. While deeply buried.

2. While the rock was still very hot and perhaps even near its melting point. This would explain why the pyroxene, which, according to the experiments of Fouqué and Michel-Lévy, represents the stable form of the molecule at a high temperature, is not changed into amphibole, which represents the more stable form at a low temperature, as is usually the case in crushed and pulverized rocks. It is perhaps owing to the same cause that no saussurite is formed; still, the conditions necessary to the formation of these minerals are so little understood that opinions on this point cannot be ventured upon as yet. While very hot.

A clastic structure in many respects similar to that above described, in which plagioclase grains are twisted and broken or even suffer peripheral granulation, occurs in certain specimens of the theralite of the Montreal Mountain, which also present a streaked appearance marked by variations in size of grain. Here it must also be regarded as evidence of motion, but of motion which in all probability took place before the complete solidification of the rock, being an instance of what Brögger has termed "protoclastic structure," for the field relations of this old volcanic plug show that it has not been submitted to any great pressure since the mass solidified. This structure, however, is only developed very locally in the rock, and in many sections no trace of it can be found; nevertheless its occurrence here is of interest showing as it does that the mere detection of such a structure here and there in an igneous rock is not indubitable proof that the rock has been submitted to great pressure and has been crushed. Protoclastic structure.

It would thus seem that the clastic structure described as occurring in these anorthosites occupies, in a way, a position intermediate between the protoclastic structure of Brögger and the cataclastic structure commonly observed in sheared rocks.

In the Morin area, then, we have a great intrusive mass of anorthosite, or gabbro very rich in plagioclase, breaking through the Laur- Résumé.

entian, cutting off successive horizons, including portions of the gneiss, sending an apophysis into it, and in some places bounded by a zone of rock which exhibits many characteristics of a contact product. This mass in most places shows irregularities in size of grain and in some places a streaked or irregularly banded structure, while in one part of the above-mentioned apophysis it is well foliated, which foliated structure there is reason to believe is a secondary one. It certainly does not represent a partially obliterated bedding as the earlier observers seem to have believed, while the other supposed evidences of the existence of a great overlying sedimentary series, of which it was supposed to form part, are also wanting; the gneiss and limestone with which it was thought to be interstratified, really belonging to the Grenville series, while the apparent interstratification of the anorthosite is due to intrusion.

Anorthosite possessed its present characters in Cambrian times.

The whole is furthermore unconformably overlain by flat unaltered strata of Potsdam and Calciferous age, and thus possessed in Cambrian times the characters which it now presents, while the nature of the anorthosite and its relation to the Laurentian, lead us to suppose that it is much nearer in age to the latter than to the overlying Cambro-Silurian probably not much more recent than the Grenville series itself.

Other Anorthosite Masses.

Stratigraphical Relations and Petrography.

Other anorthosite masses.

In addition to the Morin anorthosite, there are in the district embraced by the present report twelve other occurrences of anorthosite lying to the south and east of the Morin area and much smaller in size.

These are—commencing the enumeration from the west:—

(1.) The Lakefield area—an area lying to the east of the village of Lakefield, situated partly in the Gore of the township of Chatham and partly in the parish of St. Columban.

(2.) The St. Jérôme area, on which is situated the town of that name.

(3.) Three elongated and approximately parallel areas in the township of Kildare and its Augmentation.

(4.) Two rather larger areas on the east side of the township of Cathcart.

(5.) Two occurrences, much smaller than the rest—one by the side of the River L'Assomption near the Pont des Dalles and to the east of the village of Ste. Beatrix, the other a short distance to the west of the village of St. Jean de Matha.

(6.) Three bands of anorthosite intercalated in the nearly horizontal gneisses of the township of Brandon.

These anorthosite masses are from one hundred to several hundred yards in width, the greatest length of any one area being about seven miles. They run parallel to the strike of the gneiss, in which they are intercalated, and are usually well defined against it, the most notable exception being the St. Jérôme occurrence. The gneiss, however, sometimes appears to be more basic near the contact.

The anorthosite varies somewhat in character in the different areas. It is usually coarsely crystalline, frequently showing a great variation in size of grain and resembling that of the Morin area, but it is perhaps on the whole richer in iron-magnesia constituents, and often contains minerals such as hornblende, biotite and in one case scapolite, which occur very sparingly, or are entirely wanting, in the Morin anorthosite. The anorthosite of these several areas also frequently contains garnet near its contact with the gneiss. It frequently exhibits in an eminent degree the granulated structure described in the Morin anorthosite, and has a more or less well marked arrangement of the constituent minerals parallel to the longer axis of the areas.

As the several areas present certain differences, they will be considered separately.

The Lakefield Area.

This is four and a half miles long and about a mile wide. The anorthosite of the peripheral portions is fine-grained, foliated, very poor in bisilicates and weathers white. In the inner part of the area it is more massive and appears on the whole to be rather richer in iron-magnesia minerals, which vary in amount from place to place, often giving to the rock an irregularly banded structure. It is crossed, as shown on the map, by two roads, while a third passes immediately to the north of it. The Lakefield anorthosite.

In this area a rapid change in strike is observable, the anorthosite and its accompanying gneiss in the southern part striking, on an average, N. 45° W., while all about the northern extremity both rocks strike N. 20°–50° E.

A thin section from a specimen collected near the eastern side of the area, on the most southerly of the roads above mentioned, shows the rock at this point to be a typical anorthosite, the plagioclase preponderating very largely, while the iron-magnesia constituents are represented chiefly by augite, in addition to which there are very small quantities of green hornblende and brown biotite. Less than a mile south of the southern edge of this area, at the very edge of the Laurentian escarpment, a diabase dyke cuts through the gneiss which is here the country rock. The diabase, however, contains a great number of angular fragments of white anorthosite, which in many places are so abundant that they make up the greater part of the dyke. Under the microscope this anorthosite is seen to be a rather fine-grained variety composed almost exclusively of plagioclase, with a few grains of iron ore. The plagioclase, is however, largely altered into mica, the little mica scales being arranged principally in two directions parallel to the cleavage of the felspar (Section 415). These fragments, which were brought up by the molten diabase, probably mark an interground extension of the Lakefield area to the south.

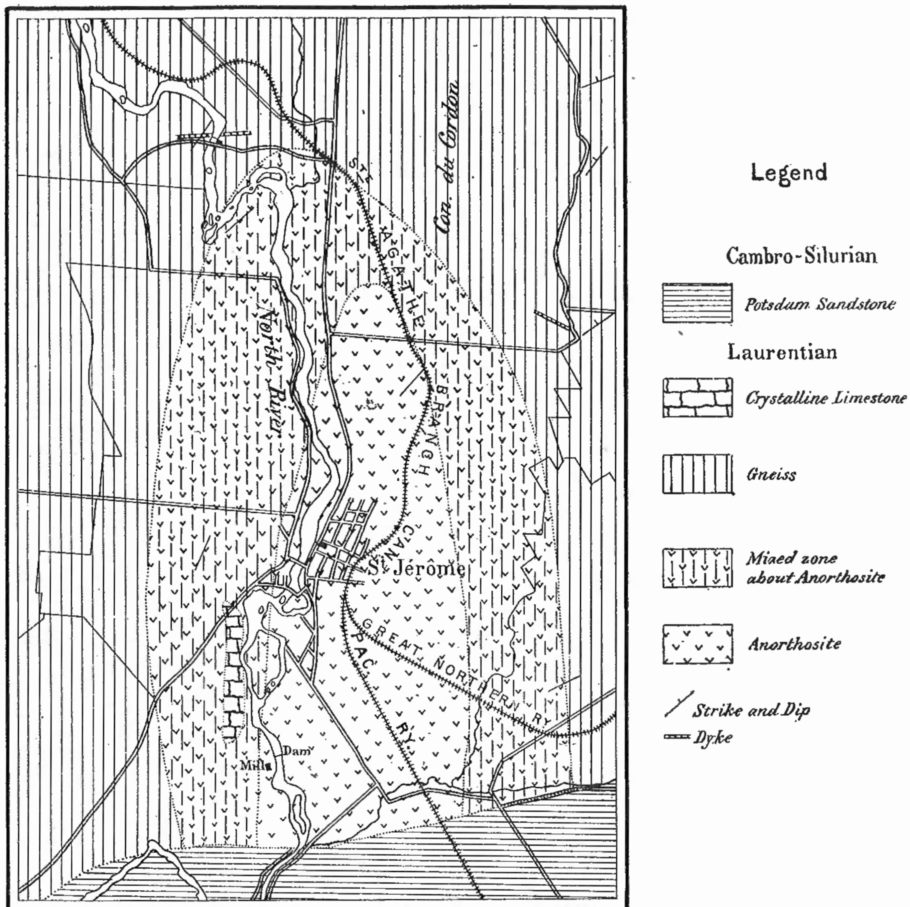
The St. Jérôme Area.

The St. Jérôme anorthosite.

Only a portion of this area, situated, as it is, immediately at the edge of the Laurentian region, is exposed to view. The southern part of it is covered up by the flat-lying Palæozoic strata, which come in a short distance to the south of the town. What proportion of the whole mass is represented by that portion exposed to view, it is impossible to say. It differs considerably from the other areas, not only in the fact that the anorthosite composing it is not so typical in character, but also in that there intervenes between it and the gneiss a zone of rocks of intermediate character.

The anorthosite, or gabbro, as it should more properly be called, is best seen in the large exposures on either side of the Canadian Pacific railway track a few hundred yards south of the railway station at St. Jérôme. These are situated about the middle of the area as exposed, and towards its southern limit, and probably present the anorthosite in its most typical development, freest from contact effects, and nearest to the actual centre of the mass.

Here the rock is fine-grained, usually foliated in structure, and weathers brownish-gray. In some places it possesses a more or less distinctly banded structure, due to the alternation of portions rather rich in bisilicates with others consisting almost entirely of plagioclase. Individuals of dark-coloured plagioclase, usually small in size, but



Drawn for photo-lithography by L.N.Richard.

PLAN

Vicinity of St. Jérôme

Terrebonne County, Que.

Scale

Chains 80 — 0 — 1 Mile

FIGURE 11.

sometimes as much as six inches in length, are abundant in places. They are frequently seen to be curved or twisted, and are usually without good crystalline outlines.

Microscopical character.

Under the microscope, the rock is seen to be composed essentially of plagioclase and pyroxene, the former preponderating largely, with hornblende, biotite, garnet, iron ore and pyrite as accessary constituents, and with a few grains of quartz, calcite, chlorite and apatite. The pyroxene is light-green in colour, and is for the most part augite, which is often decomposed to calcite and chlorite. Some of it, however, is trichroic, in red, yellow and green tints, and is probably hypersthene. The hornblende, which is green in colour, and the biotite are present in but very small amounts. The garnet is pink and perfectly isotropic; it is often well crystallized, and usually has some approximation to good crystalline form. It is generally associated with the iron ore, but often occurs in little strings through the rocks. The iron ore is black and opaque, and is often present in considerable amount. As in certain parts of the Morin anorthosite, there are probably two kinds of iron ore associated with one another, one rich in titanium and one poor in, or free from, that element. A portion of it is titanic iron ore, for leucoxene often appears as a decomposition product. The calcite is always present as a decomposition product, and the quartz, which is found in very small amount, is associated with the bisilicates, and may also be secondary.

Little strings an inch or less in thickness, consisting of quartz and orthoclase felspar, and which run through the rock sometimes parallel to the stratification and sometimes across it, are rather abundant in places, and are evidently distinct from the anorthosite and of later origin.

The rock in its present form probably represents an advanced stage of granulation, for although but little is seen in the way of twisted grains and strain-shadows, these, as has been shown in describing the Morin anorthosite, are not distinct when the granulation is complete. The large remnants of plagioclase, on the other hand, which occur abundantly in many places, in view of the light thrown on their origin by the study of the Morin anorthosite, point very strongly to an advanced stage of crushing.

Cataclastic structure.

At the bridge over the North River at St. Jérôme, at the western edge of the area, as well as at a point about a mile and a quarter north of the above-mentioned exposures and near the northern end of the area, the same anorthosite is well exposed. At the latter place, however, an exceedingly well marked cataclastic structure is seen when the rock is examined under the microscope, the large individuals of plagioclase being twisted in a marked manner, broken apart, and embedded in a mass of granulated material derived from them.

This anorthosite mass is surrounded by a zone of rocks of varied character, many of which strongly resemble the anorthosite in appearance but which are quite different in composition. They are well exposed back from the North River to the west of St. Jérôme, and by the side of the river to the north of the town.

This zone includes a large amount of ordinary orthoclase gneiss, and in it occurs the band of crystalline limestone to the south-west of the village, but it consists chiefly of rocks which in addition to augite and plagioclase contain variable amounts of hornblende, orthoclase and quartz, and which are thus intermediate in character between the gneiss and the anorthosite, some of the many varieties represented approaching more nearly to gneiss and others more nearly to the anorthosite in character and composition. It is thus a matter of great difficulty to trace upon a map the exact limits of this zone. In the map (Fig. 11), however, this has been done as accurately as possible, with the aid of a microscopal examination of the rocks from a number of points, which served to determine the actual character of such specimens.

This zone surrounding the anorthosite probably represents a peculiar border facies of the latter, which, in many places, has been intruded into the gneiss parallel to its foliation, giving an appearance of interstratification, while movements induced by pressure subsequent to the intrusion, have served to render this appearance more pronounced. Like the anorthosite, the rocks of this zone frequently present evidence of a more or less complete granulation, while the appearance of a certain amount of quartz in the anorthosite near its contact with the gneiss, is a phenomenon observed in several of the other anorthosite bands described below. Border facies of anorthosite.

About eight miles to the north-east of St. Jérôme, cutting the Morin anorthosite close to its western contact at New Glasgow, and running north for about six miles in a direction very nearly parallel to that of the limestone band in the gneiss just west of the contact, is a band of peculiar gabbro, nearly black in colour, which protrudes through the drift in a series of great roche moutonnée bosses, contrasting in a marked manner with the white anorthosite through which it cuts. The band is narrow, and immediately to the north of New Glasgow New Glasgow gabbro.

sends out an arm about a quarter of a mile long from its eastern side, which cuts across the foliation of the anorthosite. To the north this gabbro disappears on reaching the Beauport River, being exposed between the gneiss and anorthosite, and apparently cut off by a fault. It is seen again about a mile in a north-easterly direction from the point where it disappears, by the side of the road running from St. Calixte to St. Lin, and is then lost. Under the microscope the rock presents an extremely well marked cataclastic structure, the constituent minerals having been completely granulated under the great pressure to which they have been subjected.

Areas in the Township of Kildare and its Augmentation.

Kildare anorthosites.

These areas, three in number, are long and narrow, running with the strike of the gneiss, and might be referred to as bands. They are parallel to one another in position, and two westerly bands averaging a little over a quarter of a mile in width, while the most easterly is somewhat wider, being on an average rather over half a mile wide. They have lengths of six, five and seven miles respectively. Although in places covered with drift, they are generally well exposed, and being crossed by a number of roads are easily accessible. The three bands resemble one another closely in petrographical character. The rock is on the whole richer in bisilicates than the Morin anorthosite, approaching more nearly a normal gabbro or norite in composition. A specimen from the most westerly band, collected on lot 4 of range I. of the Augmentation of Kildare, proved when examined microscopically to be a typical norite, being made up of plagioclase and pyroxene in about equal amount. The latter is chiefly hypersthene, though a certain amount of augite is also present as well as a very small amount of biotite. Under the microscope the rock shows a very distinct granulation. Toward the middle of each band it is coarsely crystalline and sometimes shows but little foliation; usually, however, in this position, a more or less distinct foliation, parallel to the length of the band and conforming to the strike of the surrounding gneiss, is to be observed. This is sometimes accompanied by an indistinct banding of fine and coarser grained portions of the rock coinciding in direction with the foliation, and identical in character with the banding described in the Morin area.

At their borders the bands become finer in grain, distinctly foliated and richer in bisilicates. The finer grained character of the marginal portions may, however, be due, not to more rapid cooling, but to more intense granulation. Garnet is very frequently seen. Quartz also makes its appearance near the contact, and the rock having thus altered its character considerably, it is often difficult to determine its exact limits against the gneiss where the latter has been shattered and penetrated by the gabbro in a direction parallel to the strike.

Basic developments.

It is especially difficult to determine the exact position of the extremities of the several bands, these not only consisting of basic developments of the rock, but running into the gneiss for long distances parallel to its foliation. Such basic rocks composed essentially of hypersthene, hornblende, plagioclase, and probably some orthoclase, and which may be a contact facies of the gabbro, occurring intimately associated with the ordinary orthoclase gneiss, are found as much as two miles to the south of the limit of the most westerly of the three gabbro areas as represented on the map. In the most easterly of the three bands also, no exposures are seen on the line between ranges VI. and VIII. of Kildare, the country being drift-covered, but to the south of the road there are large exposures of certain basic rocks in line with the strike of this area, which are supposed to belong to the gabbro, and the area has accordingly been represented on the map as extending southward as far as range VI.

Areas in the Township of Cathcart.

Cathcart anorthosites.

On the eastern side of this township are two areas of the anorthosite separated by a narrow band of gneiss. They extend southward a short distance into the Seigniory of D'Aillebout, but how far they extend to the north-west beyond the ninth range of Cathcart has not been determined, the country in that direction being covered with heavy forest and very difficult of access. Judging from the dimensions of the areas, as measured on the two roads which cross them transversely, as well as from the position of their southern limits and the shape of the other areas on the same strike further to the south, the northern limits assigned to them on the map are believed to be substantially correct.

The rocks constituting these areas are well exposed on the two roads above mentioned, which roads run approximately on the lines between ranges VI. and VII., and VIII. and IX., respectively, as well as on a road connecting these two and running through the western anorthosite area in the direction of its longer axis. The gneiss band separating the two areas, as exposed on the more northerly of the two roads, consists of a finely foliated quartzose orthoclase-gneiss, with some bands of quartzite, while on the southerly road it takes the form of a coarse-grained basic gneiss, often resembling augen-gneiss in structure and frequently holding pyroxene and some plagioclase as well as intercalated masses of the anorthosite.

Variation in size of grain.

The anorthosite varies considerably in character from place to place, and is most typically developed in the western area. Here it is often very coarsely grained, almost massive, and shows the great variation in size of grain even in different parts of the same exposure, described in the Morin area. In other parts of the area, it shows the indistinct banding, so common in anorthosites, and often a more or less pronounced foliation. The proportion of bisilicates varies considerably; hypersthene and titanic iron ore are readily recognized on the weathered surface and in certain places many large broken individuals of plagioclase are also seen.

The anorthosite thus strongly resembles that of the Morin area, though probably on the average richer in bisilicates and thus approaching more nearly in composition to an ordinary gabbro. It is, however, in the case of the easterly band more intermixed with the surrounding gneiss, the two rocks being in some places apparently interbanded, owing to the intrusion of the anorthosite into the shattered gneiss about the contact, and the development of a more or less distinctly foliated or banded structure in the whole by subsequent squeezing.

Specimens of this rock which were examined microscopically, resembled very closely that of the anorthosite bands in the township of Brandon, described later on. Hypersthene is the chief iron-magnesia constituent, a few grains of augite and biotite being also present. Plagioclase is the most abundant constituent.

The rock in a great majority of cases is in an advanced state of granulation, the whole process being exhibited in a striking manner by the thin sections.

Area near Pont des Dalles on the River L'Assomption.

Pont des Dalles anorthosite.

This comparatively small occurrence is situated on the River L'Assomption at a point rather over one mile in a straight line east of the village of Ste. Beatrix. It is well exposed about a quarter of a mile west of the Pont des Dalles on a road which runs close to the river, but is still better seen where the river cuts through the mass in a high cliff on the south bank. The rock is coarsely crystalline and shows the usual variation in size of grain with here and there large masses of augite and hypersthene, and an indistinct parallel arrangement of the constituents in the direction of the prevailing strike of the surrounding gneiss.

When examined on the face of the cliff above referred to, the rock often presents an approximately horizontal foliation, by apparently following lines of motion. A specimen of this horizontal foliated variety which was collected and examined microscopically, was found to present a feature of interest in the presence of a large amount of scapolite, a mineral which has not been found in any of the other Canadian anorthosites. The iron-magnesia constituents were found to be represented by augite and hypersthene in large amount, with a good deal of biotite and a little hornblende. The non-ferruginous constituents consist of plagioclase and scapolite, which are both present in abundance. Iron ore and pyrite, present in very small amount, complete the list of constituents. The scapolite is uniaxial and negative, polarizes in brilliant colours and presents the usual prismatic cleavages with parallel extinction. The augite and plagioclase present the appearance of having been subjected to a process of granulation, but the grains do not show strain-shadows or twisted lamellæ. This, as has been shown, is usually the case in the plagioclase of thoroughly granulated anorthosite. The biotite does not show such distinct evidence of granulation, while the scapolite occurs in large, clear, unbroken grains with uniform extinction, which like the other constituents run in strings, sometimes in the plagioclase but usually between the plagioclase and the bisilicates. It is possible that the biotite may be a secondary mineral, and it is highly probable that the scapolite is an alteration product of the plagioclase, as in the case of the "spotted gabbro" of Norway and certain allied rocks in Canada and elsewhere.* Scapolite.

Anorthosite near St. Jean de Matha—Seigniory of De Ramsay.

About half a mile south-west of the village of St. Jean de Matha, on the road running toward the River L'Assomption, large exposures of garnetiferous quartzose gneiss are succeeded by others of anorthosite. The latter rock is exposed for a width of about one hundred yards along the road and is succeeded by drift. It shows considerable variation in size of grain, weathers white, and is without foliation. St. Jean de Matha anorthosite.

When examined under the microscope, it is found to be a typical anorthosite composed almost entirely of plagioclase. The iron-magnesia constituent is augite. Biotite and apatite, both in very small quanti-

* Michel Lévy—Sur une roche à sphène, amphibole et wernérite granulitique de Bamle-Norvège. Bull. Soc. Min. France, No. 3, 1878.

Michel Lévy—Sur le gisement de l'amphibolite à wernérite granulitique d'Oedegaard près Bamle-Norvège. Bull. Soc. Min. France, No. 5, 1878.

F. D. Adams,—On some Canadian Rocks containing Scapolite. Can. Rec. of Science, Oct., 1888.

ties, with a little titaniferous iron ore and pyrite complete the list of constituents. The rock has undergone a certain amount of granulation.

Anorthosite Bands in the Township of Brandon.

Anorthosite in Brandon.

In the western half of this township there are three important areas of anorthosite, which occur interbanded with the nearly horizontal gneisses of this district. The most easterly of these, which is also the smallest, forms a hill on lot 14, range IX., by the side of the road which crosses near the front of the lot. It disappears beneath the drift to the south of the road, and is not met with on the concession roads further south, nor is it again seen to the north, the township along its strike in that direction being so heavily mantled with drift that very few exposures are met with. The associated gneisses strike N. 25° W. and dip at low angles to the east, the gneiss immediately to the east of the anorthosite being a basic variety poor in quartz, while that to the west is rather fine in grain and highly quartzose. The anorthosite has the appearance of an interbanded or interstratified mass, an appearance probably due to the rolling out of the whole complex under the great pressure to which it has been subjected. The rock is in some places massive, but elsewhere shows great irregularities in size of grain, or is distinctly foliated, with strings of bisilicates arranged in a direction rudely parallel to the longer axis of the band and to the strike of the adjacent gneiss. On weathered surfaces large crystals of plagioclase, much cracked and broken, can occasionally be seen, but the rock usually presents the appearance of having been subjected to such prolonged movements that the large plagioclase individuals have been entirely destroyed.

Three bands.

Like most of the small anorthosite bands described in this Report, these from the township of Brandon are usually richer in bisilicates than a true anorthosite should be, and resemble in this respect certain varieties of anorthosite rich in bisilicates which occur in the eastern portion of the Morin area.

The central of these three anorthosite bands in Brandon, seldom attaining and never exceeding a width of half a mile, runs through the township in a north-westerly direction, conforming to the strike of the gneiss, from lot 19 of range V. to lot 17 on the front of range XII., a distance of six and a half miles. It pinches out on range V., being bounded by almost continuous exposures of gneiss to the south, while on range XII., where but small exposures are seen, it disappears under the drift about Lake Mattabon. It closely resembles, both in stratigraphical relations and petrographical charac-

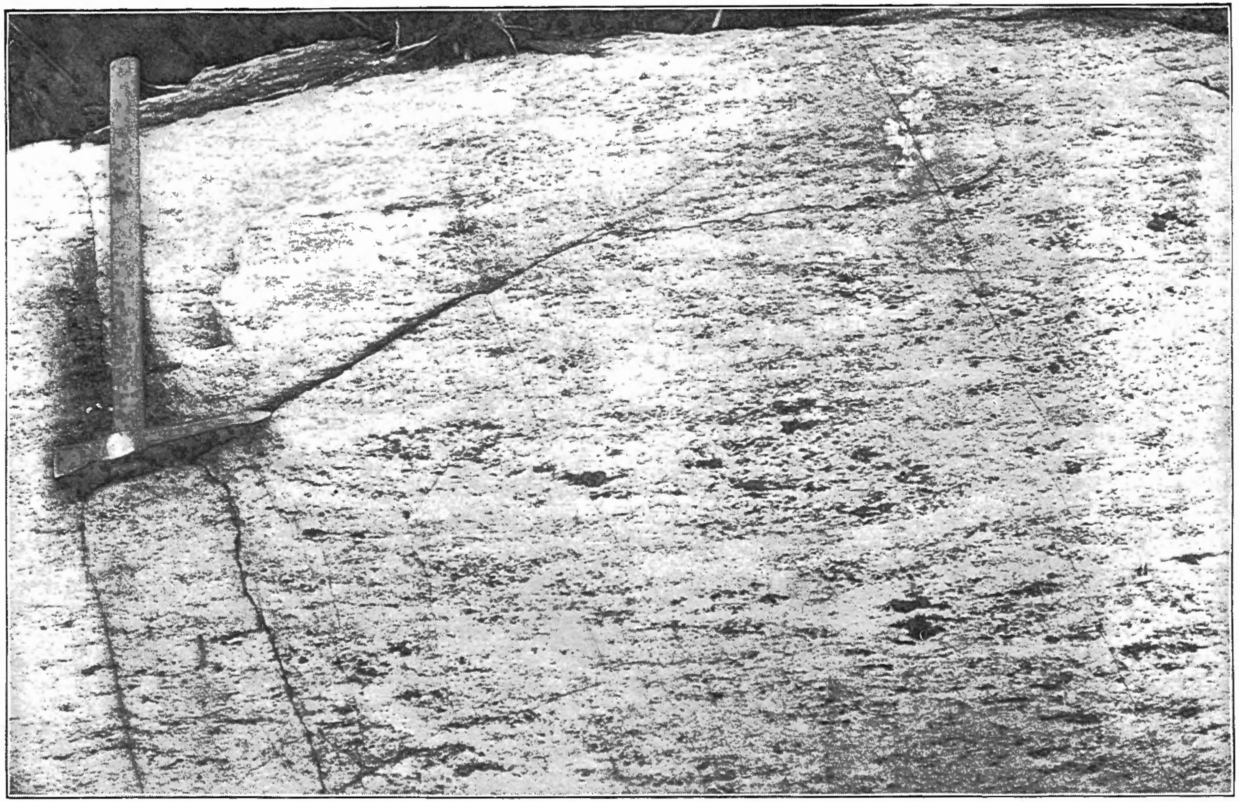


PLATE IX.—ANORTHOSITE, SHOWING PARALLEL ARRANGEMENT OF HYPERSTHENE MASSES, BETWEEN LAC NOIR AND LAC CORBEAU, TOWNSHIP OF BRANDON.

ter, the more easterly band above described, like it being apparently interbanded with the gneiss, the whole series as before dipping to the east at a low angle. At the contact near Lake Mattabon, elongated fragments of the anorthosite or gabbro were observed in the gneiss, having been apparently detached from the main mass by the movements which induced the foliation. The rock is coarse-grained, and as before the proportion of bisilicates, chiefly hypersthene, is rather large, and the rock should be termed a norite rather than an anorthosite. Toward the middle of the band the tendency of the constituents to arrange themselves in strings or bands is very obscure, and the rock is almost massive. It is frequently very irregular in grain, displaying coarser or finer grained patches, the former often containing masses of hypersthene, sometimes measuring from five to six inches across. The usual irregular-shaped remnants of large plagioclase individuals indicate that the rock has suffered an intense granulation. Toward the side of the band, a parallel arrangement of the hypersthene masses usually makes its appearance, coinciding in direction with that of the adjacent gneiss. (Plate IX.)

The most westerly of the three bands, is first seen about the middle of lot 22 of range III., in the line of hills which forms the northern boundary of the drift plain occupying the southern corner of the township. It then runs in a north-westerly direction to the side-line of the township, which it meets on lot 22 of range V., where it attains a width of about a third of a mile, appearing in large exposures, and is flanked on either side by gneiss. It was not observed, however, beyond the limits of the township, the country in the line of its strike in that direction being again drift-covered. In character and composition it is identical with the other two bands just referred to, under the microscope thin sections of the anorthosite composing the several bands resembling one another so closely that they cannot be distinguished apart. The iron-magnesia constituent is pyroxene, occurring in the foliated specimens as long strings of grains marking the foliation of the rock. It is for the most part a rhombic pyroxene (hypersthene), with strong trichroism in reddish, greenish and yellowish tints, but in most cases a certain amount of monoclinic pyroxene, intimately associated with the hypersthene and resembling it in appearance, but having an inclined extinction and no pleochroism, is also present. In every slide, a small amount of biotite and a few grains of iron ore are found. The felspathic constituent of the rock is essentially plagioclase, well twinned, and presenting the usual characteristics. An untwinned felspar is also present, usually in comparatively small amount, with rather strong dispersion of the

Westerly band.

Microscopical character.

bisectrices, giving rise to pale bluish and brownish tints respectively on either side of the line of maximum extinction. This may be orthoclase. A few grains of pyrite and a few more or less rounded individuals of apatite are the only other constituents found in these rocks.

The thin sections also afford indubitable evidence that these rocks have suffered great internal movements. The large grains of felspar can be seen to have been twisted and fractured, and are often clearly seen to be in the very act of breaking up into smaller grains. The same is true, though less noticeably so, in the case of the pyroxene, giving rise to a mosaic of grains of various sizes and shapes, which grains are seen to have moved over and around one another, but in one plane, that, namely, of the foliation of the rock, which foliation in fact results from this movement. All the evidence goes to show that this granulation of the rock is a purely mechanical process. The pyroxenes are quite unaltered, and there is no evidence of any re-crystallization or alteration in the case of the felspar. The resulting foliated rock differs from the original massive one only in being fine in grain and in the possession of a foliated structure, due to the granulation as above described.

Another fact before referred to in connection with the Morin anorthosite, and exemplified by all these granulated rocks—ordinary gneiss as well as anorthosites—is that in those portions of the sections where the granulation is complete, but little in the way of conclusive evidence of any granulation could be obtained were these to be studied alone. In such cases mosaics of little angular grains are seen, each individual of which has an even or almost even extinction. That this must be so, is realized when a large grain in process of breaking up is studied under the microscope; for the strain to which such a grain is subjected, is seen to cause it to become resolved into a number of optical areas bounded by strain-shadows, but within such areas little or no strain is developed, so that when the next step is reached and the large grain actually breaks along the lines of maximum strain the resulting grains, representing the areas in question, never show more than very faint strain-shadows while most of them, the strain being relieved, have a uniform extinction. A mosaic thus results, which while produced by intense granulation bears, when studied apart from its surroundings, little or no evidence of its origin, and might be considered to have originated in other ways. It thus becomes evident that if the whole rock had reached the final stage of granulation, which stage would be reached much sooner in the case of rocks fine in grain than

No evidence of cataclastic structure when granulation is complete.

in those composed of large individuals, but little conclusive evidence as to its true origin might be obtained from a study of thin sections. The very thoroughness of the granulation would mask its existence, and it might be concluded that the rock had crystallized in its present form. This fact is an important one to bear in mind when studying rocks such as those at present under consideration. In this process of granulation, the pyroxenes while presenting all the phenomena above referred to, usually retain their form much better than the felspars.

Rock crystalline when movements occurred.

The examination of the sections shows, furthermore, that the movements in question must have taken place when the rock, if not completely crystalline, was almost so. All the minerals are granulated and must, therefore, have been crystallized out before the movement took place, and if any residual magma whatever was present when the movement took place, no sign of it can now be detected.

Occasionally in a section a little line of faulting or shearing can be observed traversing the foliation obliquely and apparently developed at a later date. Along such lines the granulation is exceedingly fine, differing in a marked manner from that of the rest of the rock and being in many cases accompanied by the development of calcite in large amount, thus showing that the conditions under which the original granulation took place were quite different from those under which the faulting originated.

A table of analyses of anorthosites and of certain of their constituent minerals is subjoined:—

Analyses of anorthosites.

TABLE OF ANALYSES OF ANORTHOSITES, ETC.

	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.
SiO_2	59·55	59·80	58·50	51·85	51·35	—	57·20	57·55	54·45	54·20	54·47	54·62
TiO_2	—	—	—	—	—	39·86	—	—	—	—	—	—
Al_2O_3	25·62	25·39	25·80	3·90	3·70	—	26·40	27·10	28·05	29·10	26·45	26·50
Fe_2O_3	0·75	0·60	1·00	—	—	—	0·40		0·45	1·10	1·30	0·76
FeO	—	—	—	20·20	20·56	56·64	—	—	—	—	0·67	0·56
MnO	—	—	—	trace	—	—	—	—	—	—	—	—
CaO	7·73	7·78	8·06	1·60	1·68	—	8·34	8·73	9·68	11·25	10·80	9·88
MgO	trace	0·11	0·20	21·91	22·59	1·44	—	—	—	0·15	0·69	0·74
Na_2O	5·09	5·14	5·45	—	—	—	5·83	5·38	6·25	[3·80]	4·37	4·50
K_2O	0·96	1·00	1·16	—	—	—	0·84	0·79	1·06	—	0·92	1·23
H_2O	0·45	—	0·40	0·20	0·10	—	0·65	0·20	0·55	0·40	0·53	0·91
	100·15	99·82	100·57	99·66	99·88	102·84	99·66	99·75	100·49	100·09	100·20	99·70
Sp. Gr.	2·66	2·66	2·67	3·409	3·409		2·68		2 69	2·68	2·72	2·70
	to 2·67	to 2·67		to 3·417	to 3·417		to 2·69			to 2·69		

	XXVI.	XXVII.	XXVIII.	XXIX.	XXX.	XXXI.	XXXII.	XXXIII.	XXXIV.	XXXV.	XXXVI.	XXXVII
SiO_2	50·33	46·28	56·0	55·59	58·1	53·56	53·43	54·00	52·23	54·34	54·26	54·36
TiO_2	0·07	0·59	—	—	—	—	—	—	—	—	—	—
Al_2O_3	3·36	7·38	27·5	25·41	27·9	27·78	28·01	27·82	26·96	29·36	29·29	29·36
Fe_2O_3	1·03	2·21	0·7	2·73		1·15	0·75	—	—	—		
FeO	19·40	14·80	—	—	—	—	—	1·50	1·98	0·22	—	—
MnO	0·71	—	—	—	—	—	—	trace	trace	trace	trace	trace
CaO	2·77	18·78	10·1	11·40	9·4	12·01	11·24	11·20	13·25	10·79	11·26	11·16
MgO	21·40	8·91	0·1	—	trace	trace	0·63	0·05	0·12	—	trace	trace
Na_2O	—	—	5·0	4·83	5·1	4·10	4·85	4·76	5·23	5·49	4·87	4·81
K_2O	—	—	0·4	0·32	—	1·68	0·96	0·43	0·23	0·46	0·48	0·63
H_2O	1·14	1·11	—	—	—	—	trace	—	—	—	0·22	0·22
	100·21	100·06	99·8	100·28	100·5	100·28	99·87	100·04	100·00	100·66	100·38	100·54
Sp. Gr.	3·459	3·386	2·697				2·673					

XIV. & XV. Large fragments of reddish plagioclase from the anorthosite of Château Richer. (T. S. Hunt, Geology of Canada, 1863). Notes to table.

XVI. Fine-grained plagioclase groundmass, in which the former are imbedded. (*Ibidem.*)

XVII. & XVIII. Hypersthene from the same rock. (*Ibidem.*)

XIX. Ilmenite from the same rock, with 4·9 p.c. of insoluble matter, quartz, etc. (*Ibidem.*)

XX. Bluish plagioclase in large fragments from another hand specimen of the Château Richer anorthosite occurring imbedded in a fine granular groundmass of plagioclase. (*Ibidem.*)

XXI. Similar plagioclase from an anorthosite boulder from the neighbouring parish of St. Joachim. (*Ibidem.*)

XXII. Very fine-grained, almost white anorthosite, from Rawdon (Morin area). (*Ibidem.*)

XXIII. Blue opalescent plagioclase from the Morin anorthosite. (*Ibidem.*)

XXIV. Bluish opalescent plagioclase from the summit of Mount Marcy in the State of New York, U.S.A. (A. R. Leeds, 13th Ann. Rep. New York State Museum of Natural History, 1876.)

XXV. Very fine-grained yellowish anorthosite from the State of New York, U.S.A. (*Ibidem.*)

XXVI. Hypersthene from the anorthosite of Mount Marcy in the State of New York, U.S.A. (*Ibidem.*)

XXVII. Diallage from anorthosite, New York State, U.S.A. (*Ibidem.*)

XXVIII. Labrador felspar, Paul's Island, Labrador. (G. Tschermak, in Rammelsberg's Mineralchemie).

XXIX. Labrador felspar, Paul's Island, Labrador. (*Ibidem.*)

XXX. Plagioclase from a fine-grained, whitish anorthosite from Labrador (granular groundmass). (H. Vogelsang, Archives Néerlandaises, T. III., 1868).

XXXI. Bluish-gray untwinned labradorite, Paul's Island, Labrador. (G. Hawes, Proc. Nat. Mus., Washington, 1881).

XXXII. Labrador-rock. The chief rock of the vicinity of Nain, Labrador. (A. Wichmann, Z. d. D. G. G., 1884).

XXXIII. Labradorite, Paul's Island. With traces of Li_2O and SrO ; v. 19 lost on ignition. (Jannasch, Neues Jahrb. für Min., 1884, II., 43).

XXXIV. Labradorite, Paul's Island. The part soluble in HCl. With traces of Li_2O and SrO. (*Ibidem*, p. 43.)

XXXV. Labradorite, Paul's Island. The part insoluble in HCl. (*Ibidem*, p. 43.)

XXXVI. Labradorite, Paul's Island. With traces of Li_2O. (Ber. Deutsch. Chem. Ges., 1891, XXIV., 277.)

XXXVII. Labradorite, Paul's Island. With traces of Li_2O. (*Ibidem.*)

Notes on the Anorthosites occurring in other parts of Canada and in Foreign Countries.

In addition to the anorthosites described in the present Report, a number of other similar occurrences, some of them of much greater extent, occur in other parts of Canada. A noteworthy fact in connection with these anorthosites is that they are distributed along the

Anorthosites elsewhere in Canada.

Relation to Archæan Protaxis.

southerly and easterly limits of the main Archæan protaxis bordering the great ocean basin in which the Cambrian rocks were deposited later on, showing that in these ancient times the eruptive rocks apparently followed the same law that now obtains in the distribution of volcanoes; namely, that they occur along the borders of the continents as belts around great oceanic depressions. By far the largest of these is the great anorthosite area about the upper waters of the River Saguenay, which is known to occupy not less than 5800 square miles, and which may stretch across the headwaters of the River Betsiamites and connect with the area lying about the headwaters of the Moisie, in which case the area of the mass will be probably double that just given. Over this great area, the rock consists almost entirely of plagioclase.

The other areas which lie chiefly along the north shore of the River and Gulf of St. Lawrence are described in my paper entitled "Ueber das Norian oder Ober Laurentian von Canada," and in other papers to which references are given in Appendix I.

Anorthosites in Norway

The largest developments of anorthosite with which we are acquainted outside of Canada, excepting those of Minnesota and the State of New York, described by Emmons, Kemp, Lawson and others, are probably found in Norway.

The rock called by the Norwegian geologists Labrador rock, as well as some of Esmark's norites and many of the so-called gabbros of that country, are anorthosites.

These rocks have been described by Kjerulf,* Reusch,† and others. They form enormous mountain-masses, and are, as in Canada, sometimes violet or brown in colour, and sometimes as white as marble. They are sometimes massive and sometimes banded or foliated. Many of them in hand specimens can not be distinguished from the corresponding varieties of Canadian anorthosite.

They are intrusive rocks, and generally break through the gneiss. But in Laerdal and Vos-Kirchspeil, according to Kjerulf, they cut through beds of Primordial age, and are therefore probably somewhat more recent than the Canadian anorthosites. An accurate comparison of the rocks cannot yet be made since the Norwegian occurrences have not as yet been investigated in detail. But so far as we know at present, the rocks of the two countries are identical.

*Kjerulf, Die Geologie des südl. und mittleren Norwegen, p. 261.
†Reusch, Die fossilien führenden krystall. Schiefer von Bergen, p. 84.

In southern Russia, near Kamenoi-Brod, in the Government of Kiew, and in many other places in the governments of Volhynia Podolien and Cherson, large areas of anorthosite also occur. In these the labradorite predominates almost to the entire exclusion of other constituents. The rock occurs in some places in a coarsely granular form, which is dark violet or almost black in colour, and elsewhere as a porphyritic variety with large dark-coloured individuals of plagioclase in a light-gray groundmass. These varieties are said to pass into one another. Where the coarsely granular variety contains pyroxene, it shows ophitical structure like that observed in some parts of the Saguenay area. According to the description of these rocks by several authors,* they must resemble in a remarkable manner the anorthosites described in this paper, and also exhibit the same varieties. They are found in the great district of granitic rocks which occupy this portion of the Russian Empire, which rocks, where they occur in the Government of Volhynia are classified by Ossowski as Laurentian. The magnificent pillars of labradorite in the Church of Our Saviour in Moscow, are from quarries in these rocks. Anorthosites in Russia.

Another occurrence of anorthosite of particular interest is found in Egypt. Sir William Dawson, while on a visit to that country in the year 1883, observed a rock that resembles exactly the banded variety of the Morin anorthosite, and which had been used for a magnificent statue of Kephren, the builder of the second pyramid. This statue now stands in the Gizeh Museum, with a few other fragments of statues of the same material. Through the kindness of the curator of the Museum, Sir William obtained a few small pieces of the rock for examination. In the hand-specimen the rock cannot be distinguished from the granular anorthosite which is found in the neighbourhood of New Glasgow in the Morin area. It is fresh,† bright gray in colour and almost entirely composed of plagioclase, with a little hornblende, which mineral is occasionally intergrown with pyroxene. It is the foliated variety of the anorthosite, and the dark lines which are caused by the presence of hornblende can plainly be distinguished in the statue, especially on the right side. Sir William did not find the rock in place, but Newbold appears to have found it among the very Anorthosites in Egypt.

*Schrauf, Studien an der Mineralspecies Labradorit. Sitzungsber Wiener Akad. 1869, p. 996.—W. Tarrasenko, Uber den Labradorfels von Kamenoi-Brod. Abhandl. d, Naturw. Ges. in Kiew. 1886, p. 1-28.—M. K. De Chroustchoff, Notes pour servir a l'étude lithologique de la Volhynia. Bull. Soc. Min. France, IX., p. 251 (containing further references).

† Dawson, Notes on Useful and Ornamental Stones of Ancient Egypt.—Trans. Victoria Institute, London, 1891.

ancient rocks which form the mountainous country to the east of the Nile, where it appears to have the same geognostical relations as in Canada. It was probably prized by the Egyptian sculptors for the reason that it possesses a pleasing colour, similar to marble, while at the same time taking a better polish and being considerably harder.

These anorthosites, therefore, are found in five of the countries where the Archæan has an extensive development: in Canada, in the United States, in Norway, in Russia and in Egypt. They are found in enormous masses in the first four countries, and their extent is not yet known in the last mentioned. To these occurrences others will probably be added as the Archæan of other parts of the world is carefully studied.

Post-Archæan Dykes.

Post-Archæan dykes.

Here and there throughout the area, but especially in its southern portion, dykes of fine-grained black rock, allied to diabase in composition, occur cutting across both the gneisses and anorthosites. As these have not been observed traversing the Palæozoic strata of the plains they are probably pre-Potsdam in age.

In mode of occurrence they present the characters commonly seen in trap dykes. The walls are well defined and approximately parallel to one another, their attitude being nearly vertical. They frequently hold fragments of the country-rock, caught up by the dyke-rock while yet in a molten condition, and can occasionally be observed to send off lateral apophyses into the surrounding rock. The dykes can frequently be seen to be much finer in grain toward the margins of the dykes, indicating that the country-rock was comparatively cold at the time of their intrusion. There is no evidence whatever to show that these dykes have been subjected to the folding and deforming forces which have so profoundly affected the Archæan rocks of the region. They have been practically undisturbed since the time of their solidification.

The prevailing course of the dykes is approximately east-and-west, but many of them run in directions almost at right angles to this.

They differ greatly in width, ranging from five or six feet to over 300 feet—several over 100 feet wide having been observed—and are usually traversed by several sets of well marked joint plains.

The rock is black on fresh fracture and usually weathers brownish.

In the south-west corner of the district, Sir William Logan noted the occurrence of black dykes in a number of localities, and considered them to be portions of three large dykes running across the country in an approximately east-and-west direction, all of which were interrupted by the syenite intrusion mentioned on page 29 J.

The most northerly of these dykes was traced by Sir William Logan as far east as lot 6 of range VI. of Chatham Gore, and what is in all probability its continuation was found on the line separating St. Columban from the Augmentation of Mille Isles, near the north-west corner of the former. It crosses the road at this point, and has a width of 300 feet. On the same course further east, what is probably the same dyke is exposed at the foot of the falls on the North River, at the pulp mill, about three miles above St. Jérôme. It is exposed for a width of 105 feet, but only one wall is seen. The course of this wall is east-and-west. Further east still, a short distance north of Ste. Sophie, a whole series of parallel dykes, thirteen in number, and aggregating 69 feet in thickness, is seen within a distance of 200 yards. These also strike east-and-west. They possess a flow structure in some cases, and hold fragments of gneiss and quartzite as well as some of white anorthosite, indicating an extension of the arm of the Morin anorthosite under this locality, as might be expected.

Dykes noted by Logan

St. Jérôme.

Although it is quite possible that these several occurrences do not represent one continuous crack or fissure, they evidently mark the same line of weakness, which may be represented by a series of shorter parallel fissures approximately in the same line, as is often seen in the case in such dykes. The line of weakness has been now traced in a direction almost parallel to the edge of the protaxis, from the eastern side of the seigniory of Petite Nation, a distance of fifty-five miles, and in all probability continues still further to the west. The other dykes represented on the map in the district between St. Jérôme and Ste. Sophie are much smaller in size.

One of the two more southerly dykes traced out by Sir William Logan, may find its eastward continuation in a dyke exposed at the immediate edge of the protaxis to the south of the Lakefield anorthosite and running N. 50° E. This dyke is filled with angular fragments of white anorthosite (although that rock does not occur in the immediate vicinity) which fragments must have been derived from an underground extension of the Lakefield anorthosite in this direction.

Two other important dykes occur further north, cutting the Morin anorthosite. The first of these is exposed on lot 16 of range VII. of the township of Rawdon. It is seventy-five feet wide, and runs N. 47° W., having been followed for a distance of a mile and a half.

Dykes cutting anorthosite.

The other occurs on the third, fourth and fifth ranges of the township of Chilton, and runs parallel to the River Ouareau, near its eastern bank, for a distance of about two and a half miles, having a width of 120 feet.

Another smaller dyke, ten feet wide and running N. 87° W., is exposed on the first range of the Augmentation of Kildare, near the line between lots 4 and 5 on the road.

St. Lin dyke.

A number of other smaller dykes which were observed do not here merit especial mention, with the exception of one which is quite different from those already referred to both in composition and mode of occurrence. This is found on the plains about one mile from St. Lin, being exposed in the bed of the Little River. The exposures, however, are not very good, so that the precise relations of the rock cannot be determined. It cuts the Chazy limestone apparently in the form of an intercalated sheet, converting it into a highly crystalline red marble, which has here been quarried. The river is paved with this trap for a distance of about fifty yards, a thickness of about ten feet of the trap appearing in a cascade which occurs at this point. The marble is referred to on page 153 J, in the section treating of economic geology.

Diabase.

The great dykes traced out by Sir William Logan in the south-east corner of the area are referred to by him as dolerites,* and would be classed as diabases in the modern petrographical system. The St. Columban dyke when examined microscopically (Section 361) is seen to possess a typical diabase or ophitic structure consisting essentially of plagioclase and augite, the former running in lath-shaped individuals through the latter. A small amount of green hornblende, which may be either primary or secondary, and a small quantity of iron ore are present as accessary constituents. The rock also contains another mineral which is not commonly found in fresh diabases, namely, quartz, which occurs in considerable amount in micropegmatitic intergrowths with felspar, in the little corners between the other constituents. The supposed continuation of the dyke crossing the North River above St. Jérôme (Sections 273, 342) is almost identical in character and composition, the hornblende, however, being replaced by a small amount of biotite. The augite, which is of the common variety usually found in rocks of this class, often occurs in long narrow forms of irregular shape, and is twinned according to both the base and the orthopinacoid, and with it a lighter coloured malacolite is frequently associated in parallel intergrowths, as in the Konga diabase of Sweden

* Geology of Canada, 1863, p. 38.

Quartz in small amount, in clear grains or micropegmatite intergrowths, is present as before.

The dyke (Section 338) occurring at the edge of the Laurentian protaxis to the south of the Lakefield anorthosite, and which may represent an easterly continuation of another of Sir William Logan's dykes, is also a diabase of the same type, consisting of plagioclase, augite and iron ore, with a very little biotite, and the same micropegmatite intergrowth of quartz and felspar in the corners between the other constituents. It is, however, much decomposed.

Quartz-diabase.

This quartz diabase with typical ophitic structure, occasionally holding malacolite, is apparently the normal rock of the great east and west dykes of the district. The quartz occurs in micropegmatitic intergrowths with the plagioclase and is in all probability primary, as it is found in the rock even where it is perfectly fresh. It belongs to the Konga type of this rock described by Törnebohm in Sweden.

Augite-porphyrite.

Some of the smaller dykes in the district about Ste. Sophie and New Glasgow, which closely resemble these diabases in appearance, and probably have essentially the same chemical composition, possess a minutely porphyritic character, phenocrysts of plagioclase and augite being imbedded in a fine groundmass composed of the same minerals with iron ore and a little biotite. This groundmass probably cooled as glass, and has since taken on a crystalline character through a process of devitrification. They belong to the spilite type of the augite porphyrites, and in one or two instances show an amygdaloidal structure. One of these dykes, twenty-five feet wide, was observed on the road about one mile north-west of Ste. Sophie, and another forty feet wide in the bed of the River Achigan on lot 16 of range IV. of Kilkenny. The two dykes above mentioned as cutting the Morin anorthosite, one on lot 16 of range VII. of the township of Rawdon (Sections 626, 427), and the other on the third, fourth and fifth ranges of Chilton (Section 364), are identical with one another in all respects, and as they have almost the same course were probably intruded at the same time. Although having the same general composition, they are distinctly different in structure from both the quartz diabase and augite porphyrite above described. The rock is of medium grain, becoming fine-grained at the margins, and is black in colour but weathers brown. Under the microscope, the Rawdon rock is seen to consist of large phenocrysts of well twinned plagioclase, having perfect crystalline forms and filled with minute dark dust-like inclusions, giving it a dark colour, with large phenocrysts of pyroxene, also having a good crystalline form, embedded in a species of ground-

Dyke in Rawdon holding micropegmatite.

mass composed of a most beautiful micropegmatitic or granophyric intergrowth of quartz and plagioclase. This latter plagioclase is free from dust inclusions, the granophyric intergrowth being thus colourless. A small amount of hornblende and biotite as well as a considerable amount of iron ore and apatite, the latter in large and well formed elongated hexagonal prisms, are also present in the rock.

The plagioclase often occurs in beautiful Baveno twins, and a careful examination of the sections, combined with the evidence obtained from a crystallographic examination of the pulverized rock after separation by heavy solutions, shows that two pyroxenes occur intimately intergrown with one another, one a monoclinic augite of the ordinary type found in diabases, and the other a rhombic pyroxene having the parallel extinction, pleochroism and other optical properties characteristic of hypersthene.

Granophyre structure.

The granophyre constitutes a very considerable proportion of the whole rock, and makes the sections beautiful objects when examined between crossed nicols in polarized light. The intergrowth of the quartz and plagioclase is in some places very fine but elsewhere rather coarse, and the polysynthetic twinning of the plagioclase in it can be plainly seen. The granophyre can often be seen to have started its growth outward from phenocrysts of dark plagioclase or of augite, as shown in Plate X. reproduced from a micro-photograph of a thin section of the dyke, showing the granophyre growing about a crystal of plagioclase. The hexagonal crystal included in the plagioclase phenocryst is apatite, while the augite with good crystal form is seen on the right. It is doubtful whether any rock of this character hitherto described contains so large a proportion of granophyre. The rock is neither a diabase nor a gabbro, having neither the ophitic structure of the former nor the hypidiomorphic granular structure of the latter. The structure is rather a porphyritic one and exactly like that sometimes seen in the Konga occurrence before referred to. The constituents of the rock have separated out in the following order:—Apatite and iron ore, augite, plagioclase—the series concluding with the simultaneous crystallization of the quartz and plagioclase of the granophyre, which has all the characters of a primary structure. The rock contains 49·66 per cent of silica.

This micro-pegmatitic or granophyric intergrowth of quartz and felspar will probably be found to be very widespread in its occurrence in the dykes cutting the Archæan in Canada, as it is known also in diabases of the township of Templeton, in the county of Ottawa, in

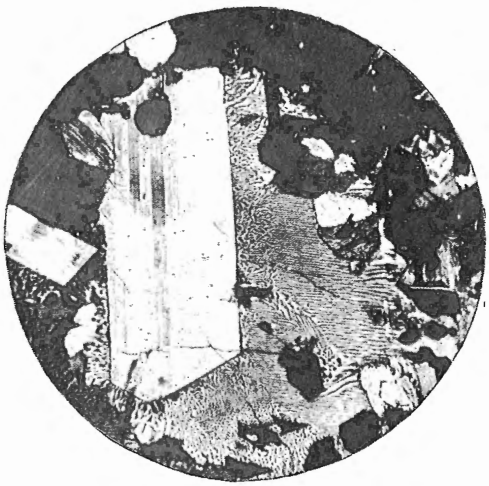


PLATE X.—GRANOPHYRIC INTERGROWTH OF QUARTZ AND PLAGIOCLASE ABOUT A PHENOCRYST OF PLAGIOCLASE—DYKE ON RANGE VII., LOT 16, TOWNSHIP OF RAWDON. × 38.

the province of Quebec, while Dr. Lawson describes it as occurring abundantly in the dykes of the Rainy Lake district to the west of Lake Superior.*

The dyke near St. Lin which, unlike the others, is found cutting rocks of Cambro-Silurian age, is also entirely different in composition. Its original character cannot be determined, as the rock is exceedingly decomposed, but it probably belongs to the class of nepheline or melilite dyke-rocks like those found associated with the nepheline syenites about Montreal and elsewhere. Hydrochloric acid dissolves about twenty-five per cent of the pulverized rock, which effervesces freely. Under the microscope (Section 389), nearly colourless augite, with rhombic pyroxene for the most part altered to a mixture of bastite and iron oxide, and biotite in large crystals bleached nearly white, can be recognized. Also in the groundmass is a colourless mineral, uniaxial and negative and readily attached by acids, which is probably nepheline. A mineral which is probably perowskite is also present, as well as a large quantity of light yellow garnet, often having good crystalline form, together with much calcite or other rhombohedral carbonates, the products of decomposition. Dyke near St. Lin.

While therefore the dykes occurring in the area are not very numerous, their study brings out a number of points of considerable interest.

Economic Geology.

Minerals and rocks of considerable economic value occur at a number of points in the area embraced by this report.

The following occurrences are referred to, either on account of their actual economic importance, or because they have been supposed to be of value and have attracted, or are likely to attract, more or less attention. Those deposits situated in the county of Argenteuil, to the south-west of the Morin anorthosite area, are not here referred to, as they have been examined by Dr. R. W. Ells, and will be described by him in a forthcoming report.

Iron Ore near St. Jérôme, County of Terrebonne.

Two and a half miles south-west of St. Jérôme, on the road which follows the northern bank of the North River, there is a deposit of magnetic iron ore. This occurs as several thin bands interstratified Iron Ore—St. Jérôme.

*Report on the Geology of the Rainy Lake Region, Annual Report, Geol. Surv. Can., Vol. III. (N.S.), p. 156 F.

with a dark hornblende rock and with the red orthoclase-gneiss of this part of the area, the whole dipping toward the river at a very high angle. At the time of my visit, in 1886, the ore had been exposed by the removal of the drift at a number of points along its strike, and a small opening had been made at one place. Subsequently, from October, 1891, until March, 1892, it was worked by the Canada Iron Furnace Co., during which time about 365 tons of ore was taken out and shipped to the company's furnace at Radnor, and there smelted. The following information has been kindly supplied to me by Mr. Arthur Cole, B.A. Sc., who was engaged in carrying out the work :—

"Most of the ore was taken out of a pit which, when abandoned, was about 35 feet deep, 10 feet broad and 12 feet long. The ore-bed varied from two and a half to three feet in width, and was for the most part free from gangue. At a depth of 35 feet the bed narrowed down to a few inches, and was then entirely lost. A drift was driven from the west end of the pit along the bed for about 40 feet, the floor of the drift being about 15 feet from the surface.

"Work was then discontinued, but was resumed in August, 1892, but this time at a point about 100 yards further west along the outcrop of the bed. The ore here was in beds varying from a foot to a foot and a half in width. These beds often widened, but then they would separate into two beds with an intervening bed of rock.

"In some places the walls of the beds were very clearly defined, while in others the ore gradually faded away into the surrounding rock. About 50 tons was taken out of this opening, about ten feet deep and thirty feet long.

"Work was finally discontinued early in September, as it was found that too much rock was being handled."

Analysis.

A sample of the ore was analysed by me and was found to have the following composition :—

	Per cent.
Ferric oxide	59·059
Ferrous oxide	26·807
Titanic acid	none.
Phosphoric acid	·015
Sulphur	·001
Insoluble matter	9·897
Metallic iron	62·191
Phosphorus	·007
Sulphur	·001

This analysis brings out in a striking manner the distinction between the iron ores of the orthoclase-gneiss and those of the anorthosite, the former being usually free from titanium, while the latter is rich in this deleterious constituent. This ore, although so near the anorthosite, is quite free from titanium, while the similar ores in the neighbouring anorthosite areas contain a large percentage of this element.

Most of the other iron ores of this area, with the exception of the bog ores, which belong to the superficial deposits, unfortunately occur in or associated with the Morin anorthosite mass, and are, therefore, highly titaniferous. To these belong the following deposits :—

Township of Rawdon—Range II., Lot 2.

This deposit is near the village of Ste. Julienne, and although it has never been worked has attracted a good deal of attention. It occurs in the Morin anorthosite, near the eastern edge of the arm-like extension before referred to. The ore is found in a foliated white-weathering variety of the anorthosite rather rich in bisilicates, with a strike varying from N. 8° W. to N. 25° W. and a nearly vertical dip. Several black dykes, apparently of diabase, occur in the vicinity. The ore varies a great deal in character, being much purer in some places than others, and often occurs in the form of bands, from a few inches to several feet in width, generally conformable, or nearly so, to the foliation of the anorthosite, but in a few cases cutting across it. Both the anorthosite and iron ore are much twisted and faulted, and it is difficult to determine whether the ore has been erupted through the anorthosite or whether the cases where it cuts across the anorthosite are to be attributed to faulting. It, however, has a general trend in the direction of the strike of the anorthosite, the principal mass being exposed for about 200 feet at right angles to this direction. The "ore" appears to be in reality a variety of the anorthosite, and in most places too poor in iron to constitute an ore in the proper sense of the term. Rawdon

It is also highly titaniferous and contains iron-pyrites as a frequent constituent. A specimen collected by me and assayed by Dr. Hoffmann was found to contain :—

Metallic iron	42·29 per cent.
Titanic acid	Large amount.

Two samples examined by Dr. B. J. Harrington*, formerly Chemist to the Geological Survey, gave the following results :—

	I.	II.
Metallic iron	38·27 per cent.	40·71 per cent.
Titanic acid	33·67 "	33·64 "

while a third specimen, in which the iron was not determined, was found to contain:

Titanic acid..........	35·09 per cent.

Township of Wexford—Range I., Lot 7.

Wexford.

On this lot a small opening has been made in a dark-coloured, heavy massive rock containing a certain amount of iron ore. The field relations indicate that this is merely a local variety of the Morin anorthosite, exceptionally rich in the darker coloured constituents of the rock, and a microscopic examination proves this to be the case.

When thin sections are examined, the rock is seen to be composed essentially of a dark-coloured pyroxene, with plagioclase and iron ore. A not inconsiderable amount of apatite, with a few grains of pyrite, garnet and biotite, are also present. The proportion of iron ore is comparatively small, this mineral being entirely absent from some thin sections.

A specimen collected to represent the richest portion of the mass was examined by Dr. Hoffmann, with the following result :—

Metallic iron..................................	20·27 per cent.
Insoluble residue....................	58·58 "
Titanic acid	Decided reaction.

Not very far from this locality, a remarkable case of local magnetic variation was observed in surveying the road between Ste. Adèle and St. Sauveur, where it runs on the side-line between the township of Abercrombie and the Augmentation of Mille Isles, on range X. of the former township, and thus near the margin of the Morin anorthosite. At one point on the road the needle suffers a deflection of 44° in a distance of 200 yards, returning again, further on, to its normal position. The road runs up a drifted valley and there are no rock exposures on it, the nearest exposures to the position of maximum deflection being 430 yards to the south-west and 70 yards to the north-east respectively, the rocks in both cases being the ordinary

* Report of Progress, Geol. Surv. Can., 1876-77, p. 475.

anorthosite of the district. Whether the variation is caused by a body of iron ore, and if so the position of the latter, can only be determined by a magnetic survey of the locality.

Township of Chertsey—Range VIII., Lots 5 and 6.

This deposit is also situated in the Morin anorthosite area, near its edge. It is, as in the case of the occurrence above mentioned, a variety of the anorthosite rich in iron. The anorthosite at this locality is rudely banded, some of the bands being poor in iron ore while others consist of a nearly pure ore. Large exposures which are very rich in ore occur all over the southern part of lot 6. The ore, although it has not been examined chemically, is in all probability, like the other iron ores occurring in the anorthosite, rich in titanic acid. Chertsey.

Township of Chertsey—Range I., Lot 9.

This deposit occurs in anorthosite which is associated with quartzose gneiss at the edge of the Morin area. Although containing a good deal of disseminated iron ore and locally considered to be of value, in no part of the deposit was the ore found to be sufficiently concentrated to be of economic importance.

Township of Kilkenny—Range VII., Lot 7.

This deposit is an impure ochre or limonite, occurring near the edge of the Morin anorthosite and apparently derived from the alteration of iron-pyrites, which occur as an impregnation in a band of anorthosite intercolated in the gneiss near the limits of the main area. The band of rock through which this limonite is distributed has a considerable width, but could not be examined everywhere at the time of my visit, owing to the fact that the forest covering the hill was on fire. No mass of the iron ore over one foot in thickness could be found, and the deposit, I should judge, is valueless as a source of iron. Kilkenny.

A specimen of the limonite collected by me was examined by Dr. Hoffmann, and was found to contain:—

Metallic iron	25·75 per cent.
Insoluble matter	Large amount.

It also contained a considerable amount of manganese, but no titanium.

Township of Kildare—Range X., Lot 11.

Kildare.

On this lot a deposit of bog iron ore was exposed in digging a drain.

A trench three feet deep was cut through the iron ore without reaching the bottom of the deposit, and it was exposed in the drain for a distance of about thirty feet. The deposit is probably of considerable size and the ore is similar in character to that so extensively worked and smelted further east in the district of Three Rivers.

Bog ore in Joliette.

A large deposit of bog ore also occurs on the line of the Canadian Pacific Railway between Joliette and St. Gabriel de Brandon, in the County of Joliette. This has been examined by Mr. Giroux.* The Canadian Iron Furnace Co. has worked this deposit and expected to take out about 200 car loads in 1891.

This company has also worked a deposit on ranges III. and IV. of the township of Joliette. That on range III. is considered to be one of the best hitherto opened up by the company. It varies from twelve to eighteen inches in thickness and is about three chains wide by five long.

All through the Joliette district, at intervals from the Laurentians to the St. Lawrence, deposits of bog ore have been discovered, and more or less has been taken out at a great many different points. The quality and richness of the ore is found to vary greatly from place to place. The Canada Iron Furnace Co. received from this district during the years 1893, 1894 and 1895 about 6000 tons of this ore.

The occurrence of bog iron ore at other points in the drift of the south-eastern portion of the area is referred to in the Geology of Canada (1863), p. 685, as follows:—

"Within four or five miles of the village of Industry (Joliette), there are several places in which bog iron ore is met with. One of these is partly in the township of Kildare, and partly in the Augmentation of the seigniories of Lanoraie and Dautraye, comprising a superficies of about nine square miles; and it exhibits patches of ore in so many of the parts which have been cleared of forest, as to lead to the hope that it may become profitable. Among other localities in this region, the ore is found on the line between the first and second ranges of Kildare,

*Summary Report of the Operations of the Geological Survey for the year 1891, p. 43 A.

Summary Report of the Operations of the Geological Survey for the year 1892, p. 44 A.

on the seventh and eighth lots; and on the seventh lot, on the road between the fourth and fifth ranges. Other localities where the ore was observed were in Côte Ste. Emelie and Côte Ste. Rose; but these portions being still in part covered with wood, it is difficult to determine the extent of the ore, although it appears to be considerable. Further to the east, this ore was also met with between the rivers Ste. Marie and Achigan and at the Seigniory of Lachenaye."

Ochre.—

A deposit of iron ochre, of a dark-yellow colour, was observed on the road between ranges II. and III. of the township of Kildare, about 600 yards north-east of the point where the road from the village of St. Ambroise de Kildare crosses this range-line. It occurs in the sandy drift which covers this district, and was exposed in an excavation about three feet deep. For a foot from the surface the ochre is impure, being mixed with a good deal of sand, but below this, as far as exposed, it was of a purer character. Ochre.

Gold.—

At intervals during the past thirty years or more, locations have been taken up at various points in this district and worked for gold. These, which are situated principally in the townships of Chertsey and Kildare, were visited and examined. None of them were promising in appearance, but with a view of determining conclusively the presence or absence of gold, a number of carefully selected specimens from several of them were collected and handed to Dr. Hoffmann to assay. They were found to be uniformly barren. As these deposits, however, have attracted much attention in the locality, and are still referred to as "gold mines," a few short notes concerning them may be of value. Gold.

The first group of these locations is in the township of Kildare, at or near the contact of the Morin anorthosite with the Laurentian gneiss, which latter here runs up as a tongue into the anorthosite, and is surrounded on three sides by the latter. The following four occurrences belong to it:—

Township of Chertsey—Range IV., Lot 11.

The county-rock is anorthosite, which here protrudes through the drift as a knoll. This anorthosite is traversed by small quartz veins, and both the anorthosite and the quartz veins in places contain a considerable amount of pyrite, giving to the weathered surface of the rock a very rusty appearance. A good deal of work was done here about forty years ago by a local company, and the location was then abandoned. Two sets of specimens selected, one to represent the Chertsey.

more pyritiferous and the other the more quartzose portions of the deposit, were, when assayed, found to contain neither gold nor silver.

Township of Chertsey—Range V., Lot 15.

The country-rock is fine-grained anorthosite, in which there are a great number of bands and strings of a coarse-grained anorthosite, varying from an inch to two feet in width, and containing in many places disseminated iron pyrites. This latter constitutes the "ore." The location was worked for three years, about thirty years ago, and some eleven thousand dollars are stated to have been expended. The principal working consists of a shaft 35 feet deep. A certain amount of surface work was also done on the face of a cliff of the anorthosite.

The rock, having been raised, was carted a distance of about a mile to the bank of the River Ouareau, where it was treated in a mill erected at that point. This, at the time of my visit, was fast going to decay. It contained a battery of five stamps as well as ten amalgamating pans. Some gold is stated to have been obtained, although the quantity was insufficient to pay expenses. A series of specimens were collected from the various parts of the exposure worked, with a view to representing an average of the "ore" which could with care be obtained. These were assayed by Dr. Hoffmann, and were found to contain neither gold nor silver.

Township of Chertsey—Range V., Lot 7.

On the south-western portion of this lot there is a cliff of bluish gray quartzite with interstratified bands of white quartzite, both rocks containing in places a little pyrite. This rock has not been assayed, but is very lean in appearance.

Township of Chertsey—Range VII., Lot 9.

Near the northern end of the lot the anorthosite is traversed by many veins of white and bluish quartz, the largest seen being three feet in width. One of these veins has been opened up but there are no indications of the presence of gold to warrant further expenditure.

Township of Kildare—Range IX., Lot 9.

Kildare.

On this lot a pit 25 feet deep was sunk about thirty years ago.

The rock worked for gold consists of white and grayish quartz, occurring as veins in the red and gray gneiss of the district, and conforming in a general way to the direction of their foliation. These sometimes attain a width of two feet but present no indication of the presence of any precious metal.

Augmentation of Kildare—Range IV., Lot 5.

The rock here consists of a more or less impure crystalline limestone associated with a gray quartzose gneiss. Both contain in places little specks of pyrite or pyrrhotite. A good deal of work has been carried on at different times. This was commenced by Mr. Dupuis, of Joliette, who many years ago formed a company and put up a battery of five stamps, with amalgamators and other appliances. He worked the pyritiferous gneiss and states that he obtained gold from it but not in paying quantities. Augmentation of Kildare.

At the time of my visit in 1888, operations had been resumed and were being carried on by a small local company. The workings consisted of a shaft about 25 feet deep and two short tunnels, the second of these, in a band of crystalline limestone flanked on either side by gneiss. Three sets of specimens were collected for assay; the first being some of the gneiss originally worked by Mr. Dupuis; the second from the roof near the entrance to the second tunnel above mentioned, from a spot from which samples assayed in Chicago were stated to have yielded $160 of gold to the ton; the third from the east wall of the same tunnel at its end.

These three sets of specimens were separately assayed by Dr. Hoffmann, and were found to contain neither gold nor silver.

The rocks worked at this locality are not such as either from their character or mode of occurrence might be supposed to contain gold in paying quantities, and the result of the assays as given above shows the correctness of these negative indications.

Township of Rawdon—Range VII., Lot 27.

A small excavation has here been made in rusty-weathering garnetiferous gneiss, which in some cases is micaceous and holds small strings of pyrite. The rock was stated to have been assayed and to have yielded gold in varying proportions. Rawdon.

Specimens collected, however, were assayed by Dr. Hoffmann, and found to contain neither gold nor silver.

Township of Rawdon—Range VI., Lot 24.

A similar rusty-weathering garnetiferous gneiss often holding a little graphite and some pyrite. The latter mineral is sometimes present in considerable amount. A series of specimens representing the average of a band of this rock about six feet in width were collected, but were found by Dr. Hoffmann, as before, to contain neither gold nor silver.

Township of Cathcart—Range V., Lot. 8.

Cathcart.

A gneiss, white on the fresh fracture, but for the most part so decomposed that excavations for foundations and other purposes several feet in depth have been chopped in it by means of an axe. The decomposed rock looks like a hard ochre and contains in places disseminated graphite. It was found by Dr. Hoffmann to contain neither gold nor silver.

"La Barrière"—Township of Courcelles.

La Barrière.

Near the south corner of the township of Courcelles, on the Mattawin road, a few hundred yards north of the line between Tracy and Courcelles, there is another "gold mine" at a place called "La Barrière." A good deal of work has been done here by the "Compagnie des mines d'or de Mattawin." A small quartz vein from six to eight inches wide and holding a little pyrrhotite was first worked, but subsequently a trench was excavated down the face of the gneiss cliff, in which the above-mentioned vein occurred, but without following any well defined vein. The gneiss is gray or sometimes white, often garnetiferous, and sometimes holds a little pyrrhotite and pyrite. It is stated that some specimens from this locality, assayed in the United States, have been returned as containing gold to the value of $434 to the ton. Others holding less gold are stated to have contained several ounces of silver to the ton. Samples collected by Mr. Giroux at the mine, and others of the quartz assayed in the United States and returned as containing considerable quantities of both gold and silver, were assayed by Dr. Hoffmann in the laboratory of the Survey and were found to contain only a trace of gold and no silver.*

Graphite.—

Graphite.

This mineral often occurs in considerable amount, in the rusty-weathering gneiss of certain parts of the area, especially in the eastern

*Summary Report of the Operations of the Geological Survey for 1891, p. 43 A.

portion of the township of Rawdon, N.N.E. of the village of Rawdon, and on the continuation of the strike of these rocks to the north in the township of Cathcart, as well as still further north on the River Assomption. At none of the localities in this part of the area, however, was the graphite found in sufficient abundance to make the deposit of economic importance, though the geological conditions are such as to render the discovery of valuable deposits of graphite in this district highly probable.

On the western side of the area, graphitic gneiss was observed on the Devil's River, in the western corner of the township of Archambault, while extensive deposits of graphite are known in the extreme south-west portion of the area embraced by the accompanying map, in Grenville and the adjacent townships. These latter are referred to in previous reports of the Geological Survey (See Geology of Canada, 1863, p. 794), but were not visited by me since, as has been mentioned, the survey of this corner of the area was carried out by Dr. Ells. Further reference to them will be found in his report.

Apatite.—

Deposits of this mineral are also known to exist in the south-western corner of the area, and will be referred to in Dr. Ells's report. The only occurrence of apatite known in the remaining portion of the area is that on range I., lot 33, of the township of Cartier. Here two openings, each about eight feet deep, have been made, on a coarse-grained granite vein six feet wide, cutting grayish garnetiferous gneiss. This vein consists essentially of quartz, white to dark-brown in colour, with white orthoclase, biotite and muscovite, the largest crystals of the latter being four inches in diameter. Apatite, tourmaline and garnet occur in smaller amount. One small crystal of pale-green beryl was also observed. The apatite is found in small crystals, but not in sufficient abundance to enable the vein to be profitably worked, and the hopes entertained that the quantity of the mineral would increase on going down on the vein were not realized. The black tourmaline has all through the district been mistaken for coal, and the deposit is commonly referred to as a "coal mine." Apatite.

Mica.—

Lac Ouareau.

Mica in large sheets is found at a number of places in the parish of St. Donat about Lake Ouareau. At the time of my visit, in 1887, it had Mica.

not been found in place, but was turned up in considerable quantities by the farmers when ploughing in certain fields. Specimens obtained from one of these localities, where the road running down the west shore of Lac Ouareau crosses the 11th range of the township of Chilton, when examined proved to be phlogopi.e.

Kildare, Range VII., Lot 12.

Phlogopite occurs on this lot, scattered through a pyroxene rock containing quartz, felspar, and a little tourmaline. Sheets six by eight inches in size have been obtained. An opening has been made in the deposit and a small amount of mica shipped.

Infusorial Earth.—

Infusorial earth.

A small deposit is mentioned by Mr. Giroux as occurring near a small lake a few miles north of Chertsey, where the farmers use it for whitewashing their buildings.

Garnet Rock.—

Bands of highly garnetiferous gneiss are found at many localities within this area, associated with rusty-weathering gneiss, quartzite, and crystalline limestone. At two localities these are associated with bands of granular garnet rock, sufficiently thick to be of economic value.

Garnet rock.

The first of these localities is on the rear of lot 20 of range VII. of the township of Rawdon, where several beds of a rock composed very largely of a red garnet, occur interstratified with a fine-grained garnetiferous gneiss and white quartzite, the largest of the garnet beds being about two feet thick. Some portions of these beds consist of almost pure garnet, while in others this mineral is mixed with a little quartz, felspar and dark mica. A few blasts have been put in at this locality, but the deposit has not been worked as yet, although an abundance of garnet is to be obtained. The microscopic characters of the rock are described on page 84 J. A still purer variety of the garnet rock in beds of considerable thickness occurs on the adjacent lot, No. 21 of range VII. of Rawdon, but these have not been opened up as yet. The other locality is one mentioned many years ago by Sir William Logan (Report of Progress, 1853-56, p. 43), and referred to by him as follows :—

"On the west side of the crystalline limestone at St. Jérôme, beds of garnet-rock are interstratified among the quartzite of the locality.

They vary in their composition, and sometimes consist of a number of hyacinth-red garnets weathering pink, with yellowish-white prisms of diopside, among which are present small grains of greenish felspar weathering opaque white, a few minute scales of graphite and still fewer and more brilliant black grains supposed to be schorl. In some layers the garnets almost exclude the other minerals, but many variations occur in the proportions in which they are disseminated, in parallel undulating bands, in the thickness of the four or five feet composing the escarpment in which they are exposed, the bands being separated by thin divisions of quartzite and felspar. On the whole the garnets greatly prevail, and would appear to be in sufficient quantity for economic application."

Crystalline Limestone.—

The heavy bands of crystalline limestone which occur in many parts of the area and whose distribution has already been referred to, have a very considerable economic value as well as a high scientific interest. Although too coarse in grain to afford a good quality of marble, and the local demand for building stone being very limited, the limestone is in many places burned for lime, the local requirements being largely supplied in this way, especially in the remote districts in the rear of the area, which lie far from the Palæozoic limestones bordering the St. Lawrence. Crystalline limestone.

Near St. Sauveur, in the Augmentation of Mille Isles, the coarsely crystalline bluish-white limestone, which here appears in very large exposures, has been burnt at intervals for many years, the suitability of the rock for the production of lime having been pointed out to the farmers in that settlement by Sir William Logan in the early years of the Canadian Survey. St. Sauveur.

At Lake Ouareau, about the rear-line of the township of Chilton, as has been mentioned (p. 23 J), a heavy band of similar limestone was discovered forming the greater part of two islands situated about half way up the lake and near its west shore, and also exposed elsewhere in the vicinity. The settlement here was, before this discovery, very remote from all known sources of lime, the necessary supplies of this material being drawn from St. Jérôme, a distance of forty miles, over roads not always of the best. The inhabitants of the district will now build kilns and burn their own lime. To the west at St. Jovite, in the township of De Salaberry, crystalline limestone is also burned, and in course of time the band which has been mentioned as passing down Trembling Lake will probably be similarly utilized. Lake Ouareau. St. Jérôme.

Rawdon.

The limestones to the east of the Morin anorthosite area are also burned at a number of places. There are kilns on lot 28 of range X. of Rawdon, and also on lot 28 of range XI. of the same township, for which the very extensive limestone deposits of that locality are utilized. The lime produced is said to be rather dark in colour, but clean and very strong, hardening into a sort of cement. On the northern continuation of the same band in the township of Cathcart, the limestone is burned at several points in the vicinity of St. Come. One of the principal kilns is situated on lot 23 of range IX., and has a capacity of 100 bushels. To burn this charge, about six cords of wood is required, which is to be obtained for fifty cents a cord; firing being continued for three days and nights. The lime, which is pure, clean and strong, sells for $1.00 per barac (six bushels). Another kiln is situated on lot 27 of range XI. of the same township.

Burned for lime.

The limestones at many other points above referred to in describing their distribution, would also afford abundant supplies of excellent lime. It may be mentioned, however, that the lime yielded by these Laurentian limestones is not as a general rule so suitable for the finer plasters used in interior work as it is for mortar for brick and masonry, being usually darker in colour than that obtained from the Palæozoic limestones of the plains, and often somewhat "sandy," on account of impurities contained in the rock.

Marble.—

Marble.

In addition to the limestones above mentioned, which have been burnt for lime, two occurrences of limestone have been worked as marble.

The first of these is situated in the township of Cathcart, near the line between lots 8 and 9 of range VI., and was opened for marble in 1881 by Messrs. Guibault and Dupuis of Joliette and Mr. William Burns of Rawdon. An excavation about 30 feet by 40 feet was made, and work was then suspended. Some specimens of marble of a good quality and taking a good polish are said to have been obtained. An examination of the location, however, shows that the marble, which is medium to rather coarse in grain, is mixed up with bands and strings of a green serpentine and of a gray pyroxene rock, the latter seriously impairing its value as a marble. The quantity also appears to be limited. The pyroxene, which occurs in the form of a granular aggregate somewhat resembling marble in appearance, is a malacolite having a specific gravity of 3·228 and containing 52·48 per cent of silica, with a little alumina and traces of iron and manganese. The serpentine is derived from the alteration of this pyroxene, and can be seen to gradually pass into it in many places. It is sometimes light-green and sometimes deep-green in colour, and frequently runs through the pyroxene, dividing it up into rectangular areas separated by narrow serpentine seams, giving the rock a somewhat striking appearance. A little brown mica, tourmaline and iron-pyrites are seen in some specimens.

Another marble, quite different in character and age, occurs about a mile from St. Lin, on the road to New Glasgow. The rock belongs to the Chazy formation and is exposed where a small stream tributary to L'Achigan River cuts through the drift and lays bare the underlying rock. The marble is produced by the alteration of the Chazy limestone by an intercolated sheet of trap which occupies the bed of the stream. It is red in colour and forms a thin layer over the traps. The marble has been quarried to a limited extent, but work had been suspended at the time of my visit. The trap, which has a somewhat unusual composition, has already been referred to in describing the dykes of the area (p. 139 J).

Anorthosite.—

This rock, although it has been but little used for building purposes, might in many cases be employed with advantage for decorative construction. It may be obtained in unlimited amount in the Morin area, of any colour from deep violet to white. The opalescent varieties occur but sparingly in this district. To judge of its appearance when cut and polished, two large blocks, one of the violet and one of the white variety were collected, and six-inch cubes were prepared from them. These were exhibited in the Colonial and Indian Exhibition held in London in 1886. The violet variety was collected on the eastern side of range II. of the township of Morin, and when polished presented a handsome appearance, but was rather dark in colour. The white variety, which was taken from the large exposures at New Glasgow, took a high polish, and in this state was found to bear a striking resemblance to marble. It is more difficult to work than marble, but would be more durable and would retain its polish better, especially in exposed situations, and might well be employed for many purposes in construction. Anorthosite.

On account of its toughness and durability, this white anorthosite from New Glasgow has been extensively used for paving stones in the Paving stone city of Montreal, especially on streets where there is a heavy traffic. A number of small quarries have been opened in the vicinity of New Glasgow, while a larger one is operated about two miles to the north of the village. The stone is blasted out in large blocks and is then dressed to the required size by means of large hammers. The industry which has thus sprung up is somewhat extensive; up to the time of my last visit in August, 1881, 541,000 anorthosite paving blocks having been shipped to Montreal by rail.

SUMMARY OF ARCHÆAN GEOLOGY.

1. The Archæan rocks in this area are of Laurentian age, and are in part referable to the Grenville Series and in part to the Fundamental Gneiss.

2. The Grenville Series contains gneisses, as well as limestones and quartzites, which are of aqueous origin, having the chemical composition and the stratigraphical attitude of sedimentary rocks. With these are intimately associated, however, other gneisses which are of igneous origin.

3. The Fundamental Gneiss consists largely, if not exclusively, of igneous rocks in which a banding or foliation has been induced by movements caused by pressure.

4. Both series are penetrated by various igneous masses, of which the most important are great intrusions of anorthosite, a rock of the gabbro family, characterized by a great preponderance of plagioclase. This rock is in places perfectly massive, but generally exhibits the irregular structure which is so often observed in gabbros and which is brought about by a variation in the size of the grain or the relative proportion of the constituents from place to place. In addition to this original structure, the rock almost always shows a peculiar protoclastic, cataclastic or granulated structure which is especially well seen in the foliated varieties. This differs from the structure characteristic of dynamic metamorphism in the great mountainous districts of the world, having been produced by movements in the rock-mass while this was still deeply buried in the crust of the earth and probably very hot—perhaps near the melting point.

5. The same granulated structure is also seen in all those gneisses which have been formed from massive igneous rocks by dynamic movements.

6. The fine-grained aqueous rocks of the Laurentian, on the other hand, have been altered chiefly by a process of recrystallization.

7. The "Upper Laurentian" or "Anorthosite Group" of Sir William Logan does not exist as an independent geological series—the anorthosite, which was considered to be its principal constituent,

being an intrusive rock, and its remaining members belonging to the Grenville Series.

8. In all cases of supposed unconformable superposition of the anorthosite upon the Laurentian gneisses, which have been carefully investigated, the unconformability is found to be due to intrusion.

9. The anorthosites are probably of pre-Cambrian age, and seen to have been intruded about the close of the Laurentian.

10. The Canadian anorthosites are identical in character with the anorthosites associated with the Archæan rocks of the United States, Norway, Russia and Egypt. The Norwegian occurrences, however, are probably more recent in age than those of Canada.

APPENDIX I.

Literature Relating to the Anorthosites of Canada.

Adams, Frank D.: The Anorthosite Rocks of Canada. Proc. Brit. Ass. Adv. Sc., 1886.

— On the Presence of Zones of Certain Silicates about the Olivine occurring in the Anorthosite Rocks from the River Saguenay. Am. Naturalist, Nov., 1885.

— Preliminary Reports to Director of the Geological Survey of Canada on Anorthosite of Saguenay and Morin areas. Rep. of the Geol. Surv. of Canada, 1884, 1885, 1887.

— Ueber das Norian oder Ober-Laurentian von Canada. Neues Jahrbuch für Mineralogie, &c., Beilage Band VIII., 1893. Translated in Canadian Record of Science, Oct., 1894, Jan., 1895, July, 1895.

Baddeley: Geology of a portion of the Labrador Coast. Trans. Lit. and Hist. Soc. of Quebec, 1829.

— Geology of a portion of the Saguenay District. *Ibidem*, 1829.

Bailey and Matthew: Geology of New Brunswick. Rep. of the Geol. Surv. of Canada, 1870-71.

Bayfield: Notes on the Geology of the North Coast of the St. Lawrence. Trans. Geol. Soc. London, Vol. V., 1833.

Bell, Robert: Report on the Geology of Lake Huron. Rep. of the Geol. Surv. of Canada, 1876-77, p. 198.

— Observations on the Geology, Mineralogy, Zoology and Botany of the Labrador Coast, Hudson Bay and Strait. Rep. of the Geol. Surv. of Canada, 1882-84.

Bigsby, John: A List of Minerals and Organic Remains occurring in the Canadas. Am. Journ. Sci. (I), Vol. VIII., 1824.

Cayley, Ed.: Up the River Moisie. Trans. Lit. and Hist. Soc. of Quebec, Vol. V., 1862.

Cohen, E.: Das Labradorit-führende Gestein der Küste von Labrador. Neues Jahrb. für Mineralogie, 1885, I., p. 183.

Davies, W. H. A.: Notes on Esquimaux Bay and the surrounding Country. Trans. Lit. and Hist. Soc. of Quebec, Vol. IV., 1843.

Emmons, Eb.: Report on the Geology of the Second District of the State of New York. Albany, 1842.

Ferrier, W. F.: Notes on the Microscopic Character of some Rocks from the Counties of Quebec and Montmorency, collected by Mr. A. P. Low, 1889-91. Rep. of the Geol. Survey of Canada, 1890-91, L.

Hall, James: Notes on the Geological Position of the Serpentine Limestone of Northern New York, etc. Am. Journ. Sci. (III), Vol. XII., 1876.

Hawes, G. W.: On the Determination of Feldspar in thin sections of Rocks. Proc. National Museum, Washington, 1881.

Hind, H. Y.: Observations on Supposed Glacial Drift in the Labrador Peninsula, etc. Q. J. G. S. Jan. 1864.

— Explorations in the Interior of the Labrador Peninsula. London, 1863.

Hunt, T. Sterry: Examinations of some Felspathic Rocks. London, Edinb. and Dublin Phil. Mag., May, 1855.

— On Norite or Labradorite Rock. Am. Journ. Sci., 1870.

— The Geology of Port Henry, New York. Canadian Naturalist, March, 1883.

— Comparison of Canadian Anorthosites with Gabbros from Skye. Dublin Quart. Journ., July, 1863.

— Azoic Rocks. Part 1. Report of Geol. Survey of Pennsylvania. 1878.

Jannasch, P.: Uber die Löslichkeit des Labradors von der Paulsinsel in Salzsäure. Neues Jahrb. für Min. 1884, II. 42.

— Uber eine neue Methode zur Aufschilessung der Silicate. Ber Deutsch. Chem. Ges. Berlin, 1891, XXIV. 273.

Jukes, J. B.: A General Report on the Geological Survey of Newfoundland, 1839--40. London, 1843.

Kemp, J. F.: Crystalline Limestones, Ophicalcites and associated Schists of the Eastern Adirondacks. Bull. Geol. Soc. Am., Vol. VI. 1895.

— Gabbros of the Western Shore of Lake Champlain. Bull. Geol. Soc. Am., Vol. V. 1894.

— Illustrations of the Dynamic Metamorphism of Anorthosites and related Rocks in the Adirondacks. Bull. Geol. Soc. Am., Vol. VII. p. 488, 1896.

Laflamme: Anorthosite at Château Richer. Report of the Director of the Geol. Surv. of Canada, 1885.

— Report on Geological Observations in the Saguenay Region. Rep. of the Geol. Surv. of Canada, 1884.

Lawson, A. C.: The Anorthosytes of the Minnesota Coast of Lake Superior. Geol. and Nat. Hist. Surv. of Minnesota. Bull. No. 8, 1893.

— The Norian Rocks of Canada. Science, May 26th, 1893.

Leeds, Albert R.: Notes upon the Lithology of the Adirondacks. 13th Ann. Rep. of the New York State Museum of Nat. Hist., 1876; also American Chemist, March, 1877.

Lieber, O. M.: Die amerikanische astronomische Expedition nach Labrador im Juli, 1860. Peterm. Mitth., 1861.

Logan, W. E., and Hunt, T. S.: Reports of the Geol. Surv. of Canada 1852-58, 1863, 1869.

— On the Occurrence of Organic Remains in the Laurentian Rocks of Canada. Q.J.G.S., Nov., 1864.

Low, A. P.: On the Mistassini Expedition. Rep. of the Geol. Surv. of Canada, 1885, D.

— Notes on Anorthosite of St. Urbain, Rat River, &c. Summary Rep. of the Geol. Surv. of Canada, 1890.

— The Recent Exploration of the Labrador Peninsula. Canadian Record of Science, Vol. VI., No. 3.

— Report on the Geology and Economic Minerals of the Southern Part of Portneuf, Quebec and Montmorency Counties, P.Q. Rep. of the Geol. Surv. of Canada, 1890-91, L.

McConnell, R. G.: Notes on the Anorthosite of the Township of Brandon. Summary Rep. of the Geol. Surv. of Canada, 1879-80.

Obalski, J.: Notes on the Occurrence of Anorthosite on the River Saguenay. Report of the Commissioner of Crown Lands for the Province of Quebec, 1883.

Packard, A. S.: The Labrador Coast. London, 1861.

— Observations on the Glacial Phenomenon of Labrador and Maine, &c. Mem. Boston Soc. Nat. Hist., Vol. I., 1865.

— Observations on the Drift Phenomenon of Labrador. Canadian Naturalist, New Series, Vol. II.

Puyjalon, H. de: Notes on Occurrence of Anorthosite on Gulf of St. Lawrence. Report of the Commissioner of Crown Lands, Province of Quebec, 1883-84.

Reichel, L. J.: Labrador, Bemerkungen über Land und Leute. Peterm. Mitth., 1863.

Richardson, J.: The Geology of the vicinity of Lake St. John. Rep. of the Geol. Surv. of Canada, 1857.

— The Geology of the Lower St. Lawrence. Rep. of the Geol. Surv. of Canada, 1866-69.

Rosenbusch, H.: Mikroskopische Physiographe der massigen Gesteine, 1886, p. 151.

Roth, J.: Allgemeine und chemische Geolegie, Bd. II., p. 195.

— Uber das Vorkommen von Labrador. Sitz. Berlin. Akad. XXVIII., p. 697, 1883.

Selwyn, A. R. C.: Report on the Quebec Group and the Older Crystalline Rocks of Canada. Rep. of the Geol. Surv. of Canada, 1877-78.

— Summary reports of the Geol. Surv. of Canada, 1879-80. 1889.

Selwyn, A. R. C., and Dawson, G. M.: Descriptive Sketch of the Dominion of Canada. Published by Geol. Surv. of Canada, 1882.

Smyth, C. H., Jr.: On Gabbros in the South-western Adirondack Region. Am. Journ. Sci., July, 1894.

— Crystalline Limestones and Associated Rocks of North-western Adirondack Region. Bull. Geol. Soc. Am., Vol. VI. 1895.

Steinhauer, M.: Note relative to the Geology of the Coast of Labrador. Trans. Geol. Soc. London, Vol. II. 1814.

Van Hise, C. R.: Correlation Papers, Archæan and Algonkian. Bull. U. S. Geol. Survey, No. 86, 398.

Vennor, H. G.: Notes on the Occurrence of Anorthosite. Summary Rep. of the Geol. Surv. of Canada, 1879-80; also Rep. of the Geol. Surv. of Canada, 1876-77, pp. 256-268.

Vogelsang, H.: Sur le Labradorite Coloré de la Côte du Labrador. Archives Néerlandaises, T. III. 1868.

Van Werveke, L.: Eigenthümliche Zwillingsbildungen am Feldspath und Diallag. Neues Jahrb. für Min. 1883, II. p. 97.

Wichmann, A.: Uber Gesteine von Labrador. Zeits. d. d. Geol. Ges. 1884.

Wilkins, D. J.: Notes on the Geology of the Labrador Coast. Canadian Naturalist, 1878.

APPENDIX II.

The Smelting of Titaniferous Iron Ores.

As the anorthosites in different parts of the Laurentian frequently contain great bodies of iron ore which are invariably rich in titanium, the question of the possibility of smelting such ores is one of great practical importance in the Dominion.

Several attempts to smelt these ores having proved unsuccessful the deposits in question have been looked upon as of but little value. Some recent investigations into the conditions under which titaniferous iron ores may be profitably smelted, by Mr. A. J. Rossi, have however an important bearing on the subject, and Mr. Rossi's paper presenting the results of his investigation, which appeared in "The Iron Age" for February 6th and 20th, 1896, is accordingly here presented in a slightly abridged form. It is possible that some of the less highly titaniferous of these Canadian anorthosite iron ores might be worked if the practice recommended by Mr. Rossi were followed.

THE SMELTING OF TITANIFEROUS IRON ORES.

BY A. J. ROSSI, NEW YORK.

General Considerations.

In a paper read at the Montreal meeting of the American Institute of Mining Engineers in February, 1893,* we have had occasion to treat a subject which has been the cause of much controversy—viz., the smelting of titaniferous ores. In this paper, to which we will refer in what follows, we have placed ourselves as the champion of these much abused ores, and it was our good fortune in the discussion, short as it was, to see our efforts to rehabilitate these ores sustained by persons who occupy a prominent place in the metallurgical and scientific world. At that time we called attention to the fact that these ores had been smelted successfully in England in 1868, for a few years, at Norton-on-Tyne, by Dr. Forbes, quoting the able paper of Wm. M. Bowron,† then the chemist in charge of the works. In it he explains in detail the metallurgical treatment, giving the composition of all the materials charged in the furnace (16 feet diameter at boshes and 50 feet high),

*Vol. XXI., p. 832.

†A.I.M.E., Vol. XI., p. 159.

and that of the resulting slag. He says: "The uncertainty of the importation of the ores"—which came from Norway—"their leanness" (35 to 36 per cent of iron), "and the enormous quantity of titanic acid they contained" (38 to 40 per cent), "having militated seriously against the commercial economy of the process after a few years' working;" but, as he adds, "the process, regarded as a process, was a perfect success."

It was brought out in the discussion of our paper that: "Titaniferous ores from Taberg (Sweden) had been readily smelted for years;" "that these ores are of special value, being usually entirely free from phosphorus;" "that ores containing 5 to 6 per cent of titanium (8·33 to 10 per cent TiO_2) have been regularly used for a long time in a large establishment in Pennsylvania with very great advantage;" "that there were furnaces using titaniferous ores, without being aware of it, with beneficial results."* These ores occur in large deposits in this country, "some of these deposits having been placed providentially where they would prove the most inviting." Dr. Forbes has stated emphatically that whenever the amount of titanium did not exceed about 8 per cent (13 to 14 per cent TiO_2) "no difficulty was found in working the ores cleanly and profitably."

In the same discussion Dr. W. B. Phillips of Birmingham, Ala., summarized very clearly and tersely our own views on the subject when he said: "How long will American metallurgists cling to their opinion that these ores cannot be profitably treated?" "That the verdict recorded against them was unjust, based entirely on insufficient grounds and far from creditable to the progressive spirit of American metallurgy;" "that he, for one, believes that in the smelting of titaniferous ores there is abundant promise of success."

As to the special qualities of the metal obtained from them, to whatever cause it might be attributed, the absence of phosphorus or some specific action, there seems to be a sort of *consensus omnium*, and the results of our own experiments on a large scale on the resistance, properties of chill, &c., of mixtures in which entered the pig metal, afford another contribution to the truth of this assertion. "These ores yielded in England a forge iron which has brought double the market price of common iron. For use as a mixture to impart the properties of cold toughness to other irons, for making an iron to be mixed with other irons that are not quite up to the mark for boiler plates, sheets of cold stamping and the like, and for extra good iron generally these ores are most valuable."†

* A.I.M.E.—H. B. Netze, paper, Baltimore Meeting, Feb. 9.

† W. M. Bowron, paper.

We have had occasion to mention the continuous smelting for years in this country, some 40 or 50 years ago, of similar ores that occur in large deposits in the Adirondacks.* We have given even the plans of a furnace of some 15 tons capacity which is standing there yet, and was erected after the successful running of two smaller stacks. Lack of railroad communications, the death of the principal interested parties and the civil war caused alone the abandonment of the enterprise at the time, but in this case also the extra qualities of the product were attested by many official government tests. The fact that specimens of iron and steel made from the pig metal obtained from these ores received the "reward of a prize medal"† at the World's Fair in London, in 1851, affords another evidence of this superiority, References could be multiplied.

Briefly, we find :—

1. That these ores have been certainly smelted in Sweden for years without any difficulty.

2. That their metallurgical treatment for a certain number of years in England by Dr. Forbes, in a large furnace, has proved a perfect success.

3. That furnaces were run for years in the Adirondacks with these ores with excellent results.

4. That the metal they yield, either as pig metal, iron or steel, possesses special valuable qualities.

5. That these ores, which occur in large masses in many States of the Union, are almost invariably "Bessemer ores," and as such it is asserted have been used in Pennsylvania furnaces with great advantage.

6. That when containing very large percentages of titanic acid (as much as 38 to 40 per cent and even 48·60 per cent, like the ilmenite of Canada), and consequently a very small amount of iron (32 to 35 per cent, or less), their treatment though perfectly successful, metallurgically speaking, has not proved economical as to fuel.

Obvious as this last observation may appear and applicable as it may be to any kind of non-titaniferous ores, it has been put forward for a long time as a serious objection against the smelting of these ores on the score of economy! But, as was ably brought out in the discussion of our paper by Prof. B. J. Harrington of Montreal, "there are titan-

* A.I.M.E.—Montreal Meeting, '93.

† *Ibidem.*

iferous ores and titaniferous ores, and when speaking of smelting them we should keep the distinction in mind. There is a great deal of difference between an ore containing 40 per cent of titanic acid and one containing 10 or even 20 per cent." It would be more proper indeed to call an ore like the St. Urbain ore (Canada), which was smelted in Canada and which contains 48·60 per cent of titanic acid, corresponding to 29·10 per cent titanium and only 28·49 per cent iron, a titanium ore than to call it an iron ore.

Such was the state of the question when we took it up in 1893. Confident, from the work of others, that titaniferous iron ores had been and could be worked successfully, what we have done in the matter is to propose a new process of smelting them, suggested to us by a protracted study of the compounds of titanium, which we believe to be more economical than those followed previously. We experimented with it in 1892 in a very small blast furnace, an apparatus hardly worth the name, but at least reproducing the conditions of working and of reduction of a blast furnace as to the charging of materials, ore, stone and fuel, in lumps and in layers and blowing hot air under pressure through the mass, with the ordinary and distinct outlets for slags and pig metal. Successful as this experiment was, as we obtained several hundred pounds of very good metal, there could not be any attempt to secure or demonstrate economy under these circumstances. Since then we have operated on a much larger scale, in a furnace of a practical capacity, with results which will be described in this article. But before proceeding further, and in order to enable one to judge of the possible economy, it may be necessary to recall briefly certain properties of the titanium compounds and to explain what the different methods of treatment to be compared consist of.

Different Methods of Treatment of Titaniferous Ores.

Dr. Forbes's treatment, to all appearances, anticipated by those who smelted these ores before him, in Sweden or in this country, consists in adding to the titaniferous ores, as fluxes, limestone and quartz or silica bearing materials in such quantities as to form, with the titanic acid, compounds reproducing approximately a natural mineral of titanium, known to be fusible at a moderate temperature (3 of the scale of Dana), the sphene or titanite, a silicotitanate of lime containing about 35 per cent of TiO_2, 25 to 33 per cent of lime and 28 to 35 per cent of silica. The silica being generally deficient in titaniferous ores, often not exceeding 1 to 2 per cent and rarely going above 5 or 6 per cent, a large amount of quartz or silica bearing material has to be added besides the limestone in order to supply the desired and supposedly indispensable percentage of silica in the slag. This taxed the furnace as to productive capacity, actual amount and cost of fluxes required and consequently greater consumption of fuel for melting the excess of slag.

Our experiments have shown us that entirely satisfactory results can be secured without this addition of silica, and that titano-silicates, so to speak—that is, compounds in which in a general manner the titanic acid is predominant or constitutes an essential acid element for the slag, sometimes to the extent of making the substance practically a titanite—are fusible and quite fluid, at the temperature obtainable in a blast furnace in which even the blast is but very moderately heated, when the basic elements of the compound are alumina, lime and magnesia. Those slags are the more fusible in which the ratio of the oxygen of the acid to the oxygen of the bases does not reach over 4 : 3 approximately (1 : 0·75). The fusibility increases *cœteris paribus*, as the acid element predominates until certain limits are attained. It diminishes (if not the fluidity) as the basic element increases above this ratio, although the compound may prove perfectly admissible still as a slag in a blast furnace. In this respect titano-silicates, or even titanites, behave like silicates, but the difference lies in the fact that titanites decidedly more basic than those corresponding to the oxygen ratio 4 : 3 are apparently less fusible than the corresponding silicates; or, more strictly speaking, the diminution in the fusibility seems to increase more rapidly for the titanates than for the silicates with the same increase in the basic element. This is directly in favour of titanic acid as far as blast furnace practice is concerned, since its presence in a certain quantity in an ore will require the addition of less fluxes than the same quantity of silica would demand in order to obtain an equally fusible compound, if not one of the same oxygen ratio. On these experiments we have based our proposed method of treatment of titaniferous ores, which consists in introducing magnesia to a good amount into the slag by using a magnesian limestone, a dolomite. The alumina from the stone and ash of fuel and that very generally present as principal basic constituent of these ores furnished all the amount which is required to form the tribasic compound with the magnesia and lime of the stone and the titanic acid of the ore. In the same manner as magnesia introduced in certain proportions into an alumina lime silicate renders the latter more fluid and fusible, the addition of magnesia to a titano-silicate of lime and alumina considerably increases its fusibility and especially its fluidity. This observation is of importance inasmuch as it has been claimed sometimes that when minerals contain both magnesia and titanic acid they are rendered more refractory. True as this may be in a general manner as regards the compounds of titanic acid and magnesia, the presence of magnesia in a titaniferous ore would prove an advantage when properly fluxed with alumina and lime. Silica, which is a factor not necessary or depended upon to insure the fusibility in a titano-silicate, is to be found in the latter in such variable quantities as the silica of the ores, stone and ash of fuel will make it in each case, without extra addition of quartz or the like to bring it to a definite percentage considered indispensable.

In the very small furnace referred to above, with a blast at a temperature not over 250 or 300 degrees F. at the most, we ran without any difficulty slags of the following composition: SiO_2, 14·63; TiO_2, 34·66; CaO, 26·03; Al_2O_3, 7·36; MgO, 10·27; FeO, 7·12. Oxygen ratio, 4 : 3 practically; actually, 4 : 3·1.

The ore smelted in this small furnace contained only 1·50 to 2 per cent silica and 20 per cent titanic acid, and still the amount of silica derived only from fuel, fluxes and ores reached about 15 per cent of the total.

Let us apply now the two methods just described to ores, fuel and fluxes of the same composition as those used by Dr. Forbes in England in his large furnace, the only difference being that in our case the stone will be a dolomite, in his a calcite with an extra flux of quartz or silica-bearing materials. Mr. Bowron in his paper gives the following analysis of all the materials actually used in the furnace:—

Ore.		Coke, 5 per cent ash.		Calcite.		Old bricks.	
SiO_2	5·70	SiO_2	2·50	SiO_2	0·90	SiO_2	59·60
TiO_2	39·20	Al_2O_3	2·25	CaO	54·60	Al_2O_3	24·30
Al_2O_3	2·89			Al_2O_3	0·40	CaO	2·33
MgO	0·80			MgO	0·43		
MnO	0·60						

As will be observed, the amount of silica present could not in this case, in any manner, form with the bases, omitting the titanic acid, a slag of a composition admissible in a blast furnace. It would correspond to a percentage of SiO_2, 21·14; CaO, 42·74; Al_2O_3, 16·00, and MgO, 20·00, with an oxygen ratio of 4: 9·80. The most extreme slags we have seen recorded exceptionally reached an oxygen ratio of 4: 6 (or 2: 3) of oxygen of acid to oxygen of bases. The use of a dolomite containing 7 or 8 per cent silica would alone raise the SiO_2 in the slag to about 13 per cent, diminishing the titanic acid proportionally. We give the above merely as an illustration of the possibilities, as we would not certainly smelt such poor ores when an abundance of titaniferous ores can be found containing at least 55 per cent of iron and up to 64 per cent and more, with only 14 to 10 per cent or less of titanic acid.

Such as it is, we have found the preceding compound perfectly fusible. It melted in a crucible, placed in charcoal, through which we blew cold air at a pressure of 3 or 4 ounces. It was distinctly crystallized in bluish black needles. We may remark here in passing that such a small amount of silica could hardly be expected in a blast furnace. With ores containing 20 per cent of titanic acid and 50 to 53 per cent of iron, such as were smelted in our larger furnaces last summer, the slag still contained about 15 per cent of silica and only 35 per cent of titanic acid. With richer ores, of an average of 60 per cent of iron and 10 per cent of titanic acid, not less than 18 per cent silica could be expected in the slag, with about 32 to 34 per cent of titanic acid. If the presence of silica were to be considered as an important element for the fusibility, these two latter slags ought to be still more fusible.

Properties of Titanic Compounds.

The results of the experiments which we have published in 1893, made either in crucibles or in our very small furnace, have been confirmed by the subsequent ones and by the protracted test we have made this summer in a blast furnace of a practical capacity.

Titano-silicates of lime, magnesia and alumina of an oxygen ratio of acid to basic element of 4 : 3, or still more acid, or slightly more basic, melt readily and prove more fluid at the temperature reached in a blast furnace working under unfavourable conditions as to heat. We will quote the following examples :—

SiO_2	11·94	14·82	16·00	15·60	18·00
TiO_2	38·20	32·99	28·48	40·50	34·50
CaO	23·40	21·02	26·00	24·00	27·60
MgO	6·50	9·50	10·00	8·00	10.00
Al_2O_3	15·00	10·45	10·00	10·00	12·70
FeO	5·00	4·50	6·50	2·00	.....
Oxygen ratio	4 : 3·10	4 : 3	4 : 2·3	4 : 2·5	4 : 3

That the fusibility of a titanic compound does not necessarily depend upon the smaller amount of silica and the high percentage of titanic acid, but bears a more direct relation to the oxygen ratio, was proved by the following experiments :—

1. By proper mixture of titanic acid (rutile) and bases we formed the following compound: SiO_2, 0·61; TiO_2, 44·05; CaO, 25·24; Al_2O_3, 14·40; MgO, 10·50, and FeO, 5·30, with an oxygen ratio of 4: 4·78. It melted in the crucible. The fusibility, however, was decidedly affected; the appearance was stony and lumpy. We repeated the experiment with practically the same results, the only difference being that there was increased fluidity and the fusibility was better when the temperature in the crucible could reach a good white heat.

2. We mixed together in a graphite crucible impure titanic acid, common rutile containing about 10 per cent of ferric oxide and 0·90 of silica, with lime, alumina and magnesia in such proportions as to form a decidedly acid titanate. Heated in charcoal, under a blast of 3 or 4 ounces of cold air, the mass (500 grams) melted completely. The compound was beautifully crystallized throughout in fine bluish black needles. We repeated this experiment several times, and have obtained several pounds of this curious substance, of which we have given specimens to the School of Mines of Paris and New York (Columbia College). Its composition, on an average, was: SiO_2, 0·72; TiO_2, 65·53; Al_2O_3, 10·92; CaO, 14·60; MgO, 7·30, and FeO, 0·90. What is characteristic and of great importance is that practically all the iron of the oxide of iron of the rutile separated cleanly at the bottom in the shape of a metallic button, a very small percentage of the iron only finding its way into the slag. The button was decidedly gray iron, No. 3, if not higher yet, in grade. There were no signs of the formation of cyano-nitride of titanium where the button touched at the bottom the graphite of the crucible. The oxygen ratio in this case was practically 4: 2 (exactly 4: 1·86).

In another experiment we tried to reproduce the mineral orthoclase, on a titanic base, by mixing together proper proportions of rutile, freed from iron as much as possible, and alumina and potash. Orthoclase has a composition of SiO_2, 64·6; Al_2O_3, 18·5; K_2O, 16·9. It melts at 6 (Dana) and has been found occasionally in crystals in some furnace scoriæ in Germany. Its oxygen ratio is 4: 1·33 (3: 1). By replacing the 64·6 of silica by such an amount of titanic acid as would contain as much oxygen (86·4 TiO_2) we have obtained a compound of the following composition: TiO_2, 67 to 70; Al_2O_3, 14·30, and K_2O, 17·00. It melted and crystallized, but not as perfectly as the preceding compound. Its fusibility was certainly less. Magnesia, alumina and lime appear to form with titanic acid compounds more fusible than others containing, with alumina, even such a percentage of potash as 17 per cent.

Briefly, the presence of titanic acid, even in large excess and without silica, in a substance, is far from being a cause of infusibility *a priori* if it is judiciously combined with the proper bases in suitable proportions.

Within the limit which we have briefly indicated there are, of course, many intermediary mixtures which, according to circumstances and the materials available, could form the basis of very fusible and fluid slags.

In our blast furnace experiments of last summer the temperature of the blast was not over 400 degrees F., and its pressure not more than 1 to 1¼ pounds, and still we had no trouble whatever to run from ordinary ores non-titaniferous slags of a ratio of oxygen of silica to oxygen of bases of 4 : 6 (2 : 3)—that is, of such a type as corresponds to the hottest working with blast at 1400 degrees F. under a pressure of 8 to 10 pounds, and to the darkest grades of iron most charged with silicon and graphitic carbon. The iron was white, and contained but a few tenths of 1 per cent of silicon. Though high enough to melt the more refractory silicates admissible in a blast furnace, the temperature was not sufficient to reduce the silica. This has a direct bearing on the smelting of titaniferous ores as corroborating the observations of Dr. Forbes in his practice and showing that such conditions can be made to prevail in a furnace as will melt the most refractory slags admissible and reduce the oxides of iron, and still they will not be such as to reduce the silica, and still less the titanic acid. Under these circumstances the furnace cannot be troubled with "titanium deposits," as it has been claimed.

These deposits consist of cyano-nitride of titanium, which supposes for its formation not only the reduction in the furnace of titanic acid to titanium, but the highest temperatures and other conditions. We have experimented considerably on this particular point, and inasmuch as under certain conditions, of which we may have to speak at some future time, and which were intended to secure the formation of this cyano-nitride which we wanted to produce, we failed to obtain it, we have reasons which justify us in taking exception to the too sweeping assertion in regard to the formation of these deposits. Some of the slags run in our furnace last summer contained as much as 32 to 35 per cent of TiO_2 and 16 to 14 per cent of silica, with alumina, lime and magnesia as bases; their oxygen ratio was 4 : 3. We made a number of analyses of such slags and in all cases we found them to dissolve completely, without any residue, in hydrochloric acid in the cold if very finely pulverized or under a gentle heat. The silica and titanic acid separated in a gelatinous state as the substance was heated. Had the titanic acid been merely carried mechanically, even partially, by the slag as so much infusible sand, it would have separated as an insoluble residue. This was never observed, and certainly furnishes the best proof that we had to deal with a definite compound, a titano-silicate. It explains why compounds containing a large amount of a substance infusible *per se*, the titanic acid, may prove quite fusible when this titanic acid can be carried into a definite combination with the proper bases, and also explains the tendency of these compounds to crystallize.

It may be argued that circumstances may so occur in the running of a blast furnace smelting any kind of non-titaniferous ores that they would lead to an obstruction whose removal would require forcing the heat and the pressure of the blast, and that these circumstances in the special case of titaniferous ores would be favourable to the formation of titanium deposits by the reduction of the titanic acid. The tendency of our days is to have in charge of the furnace competent persons capable of judiciously proportioning their charges from analyses made from day to day of the materials used, and such accidents have become certainly much more rare.

At all events this objection has been anticipated by Dr. Forbes, and, in the paper of Mr. Bowron referred to, a ready mode of relief is indicated. He says: "Throw off the titanic ore, and using non-titaniferous ore for a while, raise the heat and pressure of the blast and run the furnace on easily fusible slags until obstruction is removed; then resume the use of titaniferous ores."

The charges of the furnace were as follows: Coke, 2240 lbs.; ore, 2240 lbs.; calcite, 1200 lbs.; old bricks, 500. Making the proper calculations, he finds that from ores, coke and fluxes there could be expected a total amount of cinder-making materials of 2347·66 lbs. for every ton of ore used in the charges, 2·75 tons of ore being required per ton of pig metal with an ore carrying 36 per cent of iron. Assuming for convenience sake, and which is practically sufficient, that all the iron goes into the pig metal, this gives per ton of pig 6456 lbs. of slag, and a consumption of 4675 lbs. of fluxes. The resulting slag, as run from the furnace, had a composition from analysis by Mr. Bowron of: SiO_2, 27·83; TiO_2, 36·18; CaO, 24·36; Al_2O_3, 9·18; MgO, 0·60. As will be seen, the amount of silica present, 27·83, is still high enough to form with the 9·18 alumina and 24·36 of lime (independently of any titanic acid as an acid element) a perfectly fusible slag. It would correspond, reduced to a percentage and omitting the titanic acid, to a composition of: SiO_2, 44·88; CaO, 39·29; Al_2O_3, 14·80; MgO, 1·00, with an oxygen ratio of 4 : 3·10, nearly. This is a very fusible blast furnace slag, not very basic, not even corresponding to the darkest grades of iron.

Let us apply exactly the same mode of calculation in our case, assuming the same ore and fuel and the same quantities of each in the charges, but using a magnesian limestone not any more siliceous than Forbes's calcite, for fairness of comparison. The dolomite chosen has a composition similar to that of the ore we have used this summer in our larger furnace (except for amount of silica). It contained SiO_2, 0·90; CaO, 39·00; MgO, 12·00, and Al_2O_3, 2 to 3. It is easy to calculate that for every ton of ore and fuel in the charges 1000 lbs. of such dolomite stone would be sufficient to obtain a slag of the composition SiO_2, 10·78; TiO_2, 49·08; Al_2O_3, 8·10; CaO, 21·80, and MgO, 10·21. The total amount of slag from the materials of the charges per ton of ore would be found to be 1788·78 lbs. Per ton of pig metal we would have 4919·34 lbs. slag, as against 6456 lbs. as before, a saving of 23·80 per cent on the amount of cinder to melt, and consequent saving of fuel, and 2750 lbs. of magnesian stone, as against 4675 lbs. of fluxes, calcite and bricks, a saving of 41·30 per cent on the amount of fluxes added, although we have assumed the same quantity of coke to be required in both cases.

Of course it is not in our province, within the limits of this article, to discuss all that could be done in such cases. It would certainly depend on the circumstances which would have been likely to cause the obstruction, and others which could be only judged on the spot, and which might occur with any kind of ores. The cause may be the use of an excess of limestone. It is a recorded fact that furnaces smelting non-titaniferous ores have been thus choked up by such an excess of lime in the slag, so that it was too pasty to tap, and infusible blocks weighing thirty tons were formed, the removal of which required blasting. But the throwing off of the titaniferous ores for a while and the use of ordinary ores in their stead would at once create the ordinary conditions of practice. Furthermore, in the special case considered we could suggest several means which could prove efficacious.

Blast Furnace Tests.

When we had to make a practical test of these titaniferous ores last summer, conditions of economy imposed upon us the necessity of adopting a smaller scale than we would have desired. We decided on building a furnace of about three tons daily capacity, a size sufficiently large already to judge practically of the advantages of a certain treatment and to furnish valuable information, convinced that, if we were successful in these conditions as to running of slags, reduction of the ores, &c., we would be certain to obtain much more satisfactory and especially more economical results in a larger furnace provided with modern improvements.

For the same reasons we did not judge it necessary to complicate the construction by using a cup and cone, and for simplicity and economy sake we built our furnace open top. We could not in such circumstances expect to obtain a very high temperature of blast; in short, we placed ourselves in conditions of running rather unfavourable. But as it was important also to determine as much as possible the relative economy, if any, of the melting of titaniferous and non-titaniferous ores, we decided to run the furnace for a certain time first on ordinary ores, such as Lake Superior hæmatites, in order to study its working and ascertain what we could expect from it as to production, quality of pig-metal and amount of fuel required per ton of pig-metal before we should begin to use the titaniferous ores. By so doing we secured, we believe, a reasonable basis for a useful comparison of the economy of smelting the two classes of ores, or of the different treatment of the same ores, whatever might be the size of the furnace, since in both cases we were placing ourselves in exactly the same conditions as to apparatus used, temperature, pressure and volume of blast.

We give below the composition of the materials which entered the furnace from actual analyses made by the chemist in charge, supplementing them by such others as we have had made by different analysts in New York, or which have been furnished to us by outside parties.

Non-titaniferous Ores.—Lake Superior Hæmatites.

	Chemist in charge.		From parties furnishing the ore.	
SiO_2	4·58	5·24	5·60	4·66
Al_2O_3	9·16	7·19	.....	.....
CaO	0·29	.....	.....	.....
MgO	0·42	1·82	.....	.....
S	0·03	0·04	0·02	0·04
P	0·08	0·10	0·07	0·116
Fe	64·20	64·76	57·50	62·00

Calcite (fossiliferous).

	Chemist in charge.
SiO_2	2·89
CaO	52·00
Al_2O_3	0·59
MgO	Little.

Connellsville Coke.

(7·38 per cent ash.)

	Chemist in charge.
S	0·78
SiO_2	3·99
Al_2O_3	1·82
Fe_2O_3	1·50
CaO	0·07
MgO	....

Hackettstown, N. J., Dolomite.

—	I. E. S. Moffat.	II. Philadelphia Iron Works.	III. Lafayette College.	IV. Average analysis by the writer at Boonton, N. J.
SiO_2	8·06	9·44	9·27	8·75
CaO	29·09	28·18	29·29	28·60
Al_2O_3	} 1·12	4·97	3·37 {	3·00
Fe_2O_3				0·76
MgO	18·57	15·35	17·30	16·90
				0·18 S.
				0·15 P_2O_5.

Titaniferous Ores of the Adirondacks (Essex County).

—	"Mill Pond."			"Sanford."				"Cheney."	
	Rich ore. Habershaw.	Chemist in charge.		Habershaw. Rich.	Middling good ore.			Rich. Wilbur.	Chemist in charge. Poor ore.
		Average rich.	Middling good.		Rickett's Bank.	Chemist in charge.	Ledoux & Co.		
SiO_2	1·09	3·67	1·53	0·87	2·46	1·39	1·34	......	9·79
TiO_2	10·73	13·38	19·74	10·91	20·03	19·52	18·70	8·25	15·77
Al_2O_3	0·44	1·50	3·50	0·53	3·50	4·00	....	....	7·12
CaO	traces.	little.	little.	......	....	....	....	......	8·89
MgO	traces.	0·50	1·60	......	....	....	....	......	3·00
Mn_3O_4	0·13	....	....	......	....	....	....	......	......
Fe_3O_4	87·20	82·37	73·62	87·60	70·73	70·80	71·03	86·53	55·64
P	none.	0·017	0·037	none.	....	0·022	....	0·74	1·00
S.	none.	0·068	0·08	none.	....	0·028	....	0·30	......
Fe	63·45	59·56	53·62	62·65	51·22	51·30	51·44	62·15	40·33

The Cheney ore was also used, but sparingly, one-fifth to one-sixth only being added to the charge, and none but the poorer ore, this last ore, which occurs in the gneissoid gabbro in decidedly stratified rocks, differing in this respect from the preceding. It has almost identically the same composition as certain ores from Split Rock and Lake Champlain, distant some 50 miles from each other and analysed by Professor Maynard some years ago. They occur in the same formation, if we quote rightly Professor Kemp, Professor of Geology at Columbia College, who, we understand, intends to publish at an early date the results of his investigations on the genesis of the titaniferous ores of this district.

The furnace as built stands 20 feet from the bottom of the hearth to the charging platform, the diameter of crucible is 2 feet 6 inches, its height 2 feet 3 inches, boshes 3 feet high, diameter 4 feet 6 inches at top. The stack is 14 feet 9 inches high, with a diameter of 4 feet 6 inches at its junction with the boshes, and 2 feet 10 inches to 3 feet at top, the inside capacity of the furnace being then very nearly 200 cubic feet. The lining proper was made of B. furnace fire-bricks 9 inches long, with a back lining of bricks 4½ inches, making the total thickness nearly 14 inches. The stack rests on six cast iron pillars bearing at the bottom on a cast iron ring resting on the masonry of the foundations, and which bears the upper ring supporting the stack. The circle pipe is 6 inches in diameter, taking the blast from a system of two parallel rows of 6-inch diameter iron siphon-pipes arranged in an oven heated by a coke fire on a grate at one end. With this arrangement we have not been able to obtain practically more than 400° F. as temperature of blast measured at the tuyere's nozzle. The tuyeres, three in number, take the blast from the circle pipe through 3-inch diameter drop pipes having a diameter of 2 inches at the nozzle, which could be reduced by means of proper bushings, if found advisable, to all dimensions from 2 inches to 1 inch.

The tuyeres are provided with iron coils fitting them loosely, and where this coil passes through the back lining the latter was replaced by a special cast iron hollow box taking the circular shape of the furnace, and allowing the coil bearing the tuyeres to pass freely through a circular opening in the box, this opening and the space between the coil and tuyere being rammed in with fire-clay during the run. An independent circulation of water through the coils and boxes insured the cooling. In order to protect the boshes we resorted to a simple special device which proved very satisfactory. I used thick sheet iron plates made to fit snugly the curve and slant of the boshes between the pillars. These plates were upset at the bottom so as to form a shallow collector for water, closed at both ends. The water, supplied by a circular pipe around the furnace, sprayed through pin-hole openings provided for the purpose on the inside of this feed pipe and trickled down in fine streams on the inclined surface of the plates to the collector at the bottom, to be there wasted

The blast was supplied by a positive rotary blower capable of delivering at a normal speed at least 1000 feet per minute; more or less could be obtained according to the speed of the small steam engine driving it. The delivery pipe was 6 inches in diameter. Where it entered the hot blast oven it was provided with a release gate valve to control the volume and pressure of air admitted in the furnace. In no case was the volume above 500 cubic feet per minute; generally from 350 to 400 cubic feet under a pressure of 16 to 20 ounces (1 to $1\frac{1}{4}$ pounds). In order to meet possible contingencies a by-pass with special arrangement of valves connected the admission pipe and delivery pipe of cold and hot air, so that in case of accidents happening to the oven we would have been able to blow in with cold air during the repairs; but we did not have occasion to use it.

It was soon found that by driving the furnace fast the best results were obtained. The slags, to our surprise, considering the small height of the furnace, did not contain much iron, no matter whether the ores used were Lake Superior hæmatites or titaniferous ores. By driving slowly the percentage of iron in the slag could be kept below 2 per cent (2·66 per cent FeO at most), a very small amount indeed. The slags of the large Dowlais furnaces, as stated by Percy, carried, in his time, 2·50 FeO, and not unfrequently 4·50, 5·50 per cent FeO, and even 7 and 8 per cent in running as white iron. At the Ebbw Vale and Blaena Iron Works, says the same writer, the regular amount of iron carried by the slag reaches 5 per cent or more, or 6·50 to 7 per cent FeO; it was exceptionally that we had more than this, and we may say that practically, in our condition of running, the reduction of the oxides of iron was quite satisfactory.

As could be expected, the furnace was extremely sensitive to any sudden changes in the burden, as well as to disturbances or irregularities in the amount or pressure of blast. On the other hand, it answered quickly to any such changes, and some 15 hours after the charges had been modified, sometimes less, the expected slag was tapped. Numerous analyses proved this to be the case. This feature of the apparatus was very advantageous for our purpose, as it allowed us to experiment on almost any composition of slag desired and ascertain rapidly the effect on the running of the furnace.

It could be easily observed also that, though the heat in the furnace were sufficient for a satisfactory reduction of the oxides of iron and the melting of almost any slag, it was not high enough to reduce the silica and cause the metal to charge itself with silica and graphite carbon. The iron obtained from both kinds of ores, titaniferous or not, was invariably white, and still during our run with Lake Superior hæmatites, not containing any titanic acid, we so proportioned our charges purposely to obtain slags so basic and so aluminous that some of them would have appeared, *a priori*, to be only admissible in furnaces in which the greatest heat prevails. Their composition corresponded to that of slags accompanying the darkest grades of iron, most charged with silicon and graphite, obtained in furnaces in which the temperature of the blast reaches as high as 1400 degrees F. and its pressure 8 to 10 pounds. Under these conditions of working, no titanic acid could be reduced. We made a great many analyses of slags during this run, No. 1, with non-titaniferous hæmatites, their average oxygen ratio being over 4 : 4 (1 : 1), and we ran slags extra basic of a ratio of 4 : 6 (1 : 1½), and still the iron was white. We quote as types the following:

SiO_2	30·10	33·40	36 to 37
Al_2O_3	22·98	22·70	22·50
CaO	36·87	30·80	28 to 27
MgO	4·38	4·70	4·5 to 5·0
FeO	3·80	6·60	2·80 to 5
Oxygen ratio	4 : 6	4 : 5	4 : 4·40 to 4·44

In this run we used as limestone the calcite of which the analysis has been given above, adding generally a little dolomite, of which we had a large stock.

The greatest run made in 24 hours with these ores, which contained an average of 62 per cent of iron, was 4600 pounds. These hæmatites were not reduced as fast in the furnace as we expected they would be; driving fast increased the production but not to the extent looked for. The blast was kept at a pressure of an average of 16 to 18 ounces, its volume fluctuated between 350 and 450 cubic feet.

When we had ascertained what we could expect from our furnace with ordinary ores, we began to add the titaniferous ores mentioned above in the proportion of four-fifths to five-sixths of Mill Pond or Sanford, and one-fifth to one-sixth of Cheney. It had not been the intention to use this Cheney ore at all at first, but owing to some mistake at the mines we had to dispose of some 40 or 45 tons of it. We proceeded by gradual increases of one-eighth titaniferous ores in the charges, keeping the furnace a certain time on each new mixture, until the burden of ore was all in titaniferous ores.

During this run, No. 2, the mixture averaged 55 to 56 per cent of iron. Our best run in 24 hours was 5035 pounds. As will be noticed, as soon as we began to charge the titaniferous ores the yield of the furnace increased to a decided extent. It appeared as if these ores were more readily reduced than the hæmatites, made iron faster, at least under the conditions under which we were working. Large lumps not being admissible with a tunnel head 2 feet 10 inches to 3 feet in diameter, we broke all our stock, ores and flukes, from beginning to the end of the tests, to pieces of the size of the fist or a very large egg. The pressure of this blast during this run—No. 2—was about the same, 17 ounces on an average, and its volume varied, as before, between 350 and 400 cubic feet.

During this run we changed our stone from a calcite to a dolomite, or rather a dolomite to which we added enough calcite to bring the percentage of magnesia in the mixture of stones to about 12 to 14 per cent. We give below the principal analyses of the slags run as types :

	At beginning.	Middle of run.	Toward end of run.
SiO_2	34·10	29·50	27·29
TiO_2	4·90	9·96	17·48
Al_2O_3	22·00	18·26	14·43
CaO	23·63	24·12	22·71
MgO	10·00	9·72	11·55
FeO	3·82	6·40	4·30
Oxygen ratio	4:4·40	4:4·10	4:3·50

When the furnace was fully on titaniferous ores, the ore mixture averaged about 52 per cent of iron. It was soon noticed that the furnace could be driven fast with great advantage. A charge would reach the bottom in less than 15 hours; 12 to 15 hours was the rule. The yield increased considerably. We had runs of 4800, 4900 and 5600 pounds in 24 hours, and our best run in any single day reached as high as 6735 pounds, fully 3 gross tons. The blast was kept at very nearly 18 ounces throughout; it did not vary to any extent, and the only changes observed were independent of our control. They were due to the irregularities in the blowing apparatus, which, owing to the exigencies of the works where these experiments were made, had to be located at a considerable distance from the hot blast oven. The economy of running the furnace fast was clearly apparent and confirmed our views in this respect, views corroborated by A. Pourcel, late technical director of the steel works at Bilbao, Terre Noire, France, and Port Clarence, England, in a letter, from which we extract the following:

"Mr. Rossi's ideas concerning the treatment of titaniferous ores in the blast furnaces have struck me from the start, as you are aware, as eminently logical. Furthermore, they seem to me to be sufficiently justified by the trial, on a small scale (in 1893), which Mr. Rossi has described in detail. * * * The easy reduction of the titaniferous ores justifies the expectation that with a blast furnace of 300 ccm. (10,500 cubic feet) capacity, for instance, it will be possible to reach easily a production of 100 tons of pig iron in 24 hours with ores containing 52 to 56 per cent metallic iron. * * * In conclusion I will say that the formula of slag and of moderate temperature of blast (300 to 400 degrees C.) recommended—with proof to sustain his opinion—by Mr. Rossi, ought to ensure the success of the treatment of titaniferous ores from the start, but there is nothing to exclude, *a priori*, the hypothesis that, with a rapid driving, by forcing somewhat the production, it may be possible to produce the same forge iron or pig iron for open hearth steel (Siemens-Martin furnace) with a temperature of blast higher—that is, in the conditions of running economical as to fuel. * * *"

In order to judge of the relative economy of these three runs, under as nearly as possible similar conditions, we will compare the amounts of fuel and stone required per unit of pig metal when the furnace gave the greatest production in each case. This supposes indeed, for the kind of ores or mixtures of ores considered, the most favourable conditions of running for each. By making precisely the same ample allowance of time in each case for stone and coke before each maximum cast of 24 hours as chargeable to that cast, we found the figures given below.

We feel justified in doing so by the fact that with titaniferous ores we had two successive casts of 12 hours each of 3325 and 3410 pounds (in all 6735 pounds in 24 hours) followed by a cast of 3200 pounds, and in other runs a cast of 2400 pounds in 12 hours followed by one of 2635 pounds (in all 5035 pounds in 24 hours), for the mixture of titaniferous ores and hæmatites, and a cast of 2200 pounds followed by one of 2400 pounds (in 12 hours), in all 4600 pounds in 24 hours, for the non-titaniferous hæmatites smelted alone.

Run No. 1.—Non-titaniferous hæmatites from Lake Superior:

Pig iron..........	1·00	
Stone............................	1·15	
Coke	2·15	Ores 62 per cent iron.

Run No. 2.—Mixture of hæmatites and titaniferous ores:

Pig iron	1·00	
Stone	1·19	
Coke	2·20	Ores 56 per cent iron.

Run No. 3.—Titaniferous ores from the Adirondacks:

Pig iron	1·00	
Stone	0·95	
Coke	1·99	Ores 52 per cent iron, 20 per cent titanic acid.

Hence, to say the least, the titaniferous ores, under the same conditions of furnace running, did not require any more fuel per unit of pig metal than excellent non-titaniferous ores; really, they require decidedly less, and the production of the furnace was increased considerably. We should remark here that run No. 1 was made with ores containing 62 per cent of iron, while in run No. 3 the amount of iron was not over 52 per cent.

We purposely chose the titaniferous ores not too rich and high in titanic acid. Had we used ores such as are found in very large quantities in that same district, averaging 60 to 62 per cent of iron and reaching even 64 per cent, with only 13 to 10 per cent of titanic acid, the saving on both fuel and stone, especially the latter, would have been much more in favour of titaniferous ores. If we make the calculation for such richer titaniferous ores containing 60 to 64 per cent of iron, of which we have given the analysis above, it is easy to see that, even in assuming 100 coke to 100 ore, in this case some 0·50 to 0·60 ton only of dolomitic stone would have been required per ton of pig metal to obtain a slag containing some 22 per cent of silica and 30 per cent of titanic acid, with lime 24 per cent, alumina 14 per cent and magnesia 10 per cent as bases. With such a reduction in the amount of resulting slag to melt and of fluxes to add the economy as to fuel by rapid driving would have appeared of considerable importance.

We should remark also that if 2 tons of coke for 1 ton of pig metal would certainly be considered excessive in a modern furnace, we must not lose sight of the fact that the furnace was small and had an open top; that the temperature of the blast was not over 400 degrees F., and that we were wasting the gases which if utilized could have raised the temperature of the air easily to 800 or 900 degrees F. We would have desired to obtain the latter figure, and even 1400 degrees F. We have seen open top furnaces 65 to 70 feet high, of a capacity of 35 to 40 tons per day, not making a better showing as to amount of fuel per ton of iron, with ores richer yet than our titaniferous ores were. At any rate, we required even more than 2 tons of coke for 1 ton of pig metal with non-titaniferous ores, under the same conditions of furnace work.

We kept the furnace running until we exhausted our supply of ore, and we were able to empty it to within 1 foot of the tuyeres. When we opened it we found, as usual, in the crucible a small salamander, but no traces of cyano-nitride of titanium were visible either in the crucible, the boshes or any part of the furnace. This could be expected. The conditions of running of our furnace were not such as to reduce the silica, and still less the titanic acid. Though much inferior as to heat to those which could be adopted (a temperature of 800 degrees F. being perfectly admissible with these ores), they were reproducing in a general manner those which, with these ores, have given very satisfactory results. The iron contained but 0·1 to 0·2 per cent of silicon and only traces, practically, of titanium. Far from building, the ores had cut the lining several inches, and the latter was covered with a good protecting glazing material. We made a great number of analyses of the slags during this last run; others have been made since in New York. We give below the most characteristic ones as types:

SiO_2	20·59	15·32	14·82	15·90
TiO_2	26·81	31·26	31·97	34·38
Al_2O_3	10·17	14·50	12·43	11·23
CaO	23·60	20·56	24·00	22·10
MgO	10·24	9·09	9·97	9·70
FeO	6·90	6·02	4·50	6·40

An examination of these figures shows that the only varying elements of the analyses are the proportions of SiO_2 to TiO_2. In the last slags run the general composition was, in round numbers, 15 per cent SiO_2, 35 per cent of TiO_2, 10 to 12 per cent of alumina, 20 to 25 per cent of lime, and some 10 per cent of magnesia. In all the titanic acid is predominant.

These furnace tests, on a practical scale, have demonstrated, we believe, that under the conditions in which they were conducted:—

1. In a furnace only 20 feet high, with blast at only 400 degrees F., under average pressure of 16 to 18 ounces, titaniferous ores containing 20 per cent of titanic acid and 52 to 53 per cent iron can be perfectly reduced, making iron faster and with a consumption of fuel (coke) not any greater, or even less, per ton of pig metal than other ores free from titanium, with an economy as to quantity of fluxes used.

2. The titaniferous ores did not build. The lines of the furnace were found cut just as much as is the case with any other ores, non-titaniferous, after a limited run. No titaniferous deposits were observed.

3. Slags very high in titanic acid, containing 30 to 35 per cent of TiO_2 and but 15 per cent of silica, with alumina, lime and magnesia as bases, were found perfectly fusible under these conditions of low heat. They were fluid, running liquid 40 feet from the furnace on a snake-like course. Chemically, they were soluble without residue in hydrochloric acid; physically, they crystallized in a distinct manner.

4. With richer ores containing less titanic acid, with a greater temperature of the blast, at least 800 degrees F., as it has been done, much more economical results might be legitimately expected.

5. It is possible to form fluid and fusible compounds with titanic acid by the addition of the proper quantities and nature of fluxes, such as a dolomitic stone introducing magnesia. The latter, combined with alumina and lime, will contribute to render the titano-silicate or titanate much more fluid and fusible: contrarily to what has been asserted as to the difficulty or impossibility of tapping slags containing a few per cent of titanic acid (1 to 2 per cent).

6. There is nothing in the premises which could lead to suppose that a furnace could not be kept running under these conditions for an indefinite period.

Properties of the Iron Obtained from Titaniferous Ores.

Whatever may have been the opinion of many metallurgists as to the advantages, or even the possibility, of smelting these ores, the refractory character of slags containing titanic acid, there is one point on which they seem all to agree, the excellent qualities of the iron and steel obtained from titanic pig metal and the special value of the latter. We refer the reader for more details on this subject to the authority quoted in our Montreal paper and a preceding one read before the American Chemical Society in 1890.*

Speaking of the iron made at Norton-on-Tyne, J. Deby, late foreign secretary of the J. I. and S. Inst., says:† "It went to the armour plates of Sheffield on account of the toughness which this iron not only possesses but imparts to others in admixture." Mr. Bowron, alluding to the same iron, states that "it commanded double the price of ordinary iron." ‡ Such expressions as "wonderfully good" are found in the scientific press in England, relating to this titanic iron. It is

* Titanium in B. Furnace, Vol. xii. No. 4.

† Journal I. & S. Inst., 2, p. 19, 1877.

‡ Bowron paper.

not our intention in this article to examine the causes of this superiority. In a general manner we may say that if it is due to the presence of titanium in the pig metal, very small quantities of this substance are then sufficient to secure such results. In our blast-furnace tests we have not been able to obtain more than a few hundredths to one tenth of one per cent of titanium. It is met in quantities varying from 0·2 to 1 per cent in many pigs here and in England, to which it seems to impart a "greater tenacity."* The higher the grade of the iron the more titanium it is likely to contain. On the other hand, titanic pig made from ores from St. Urbain, Canada, containing as much as 41 to 48 per cent of titanic acid, smelted by the Forbes treatment under low temperature and pressure of blast, contained only traces—0·03 to 0·05, exceptionally 0·26 titanium—and still the qualities of the pig metal and iron were "exceptionally good" (analyses made at the Paris School of Mines).

But, if but comparatively very small amounts of titanium and silicon are found in the pig metal from a cold furnace, the percentage of carbon, mostly in the combined state, is often very high. Analysis of the metal from our small coke furnace of 1893 gave :—

Silicon	0·36	traces to 0·16
Titanium	None	0·07
Comb. carbon	2·835	2·99
Graphitic carbon	0·253	0·24

Even the salamander contained only Si, 1·05 ; Ti, 0·054. The metal, though "white," has not the ordinary characters of white iron. Its grain is generally very close and fine, its fracture more steel-like in colour and appearance and it is remarkably tough and hard. Under special conditions we have obtained pig metal containing :—

Silicon	0·29	0·62	and even 0·84
Titanium	0·85	0·78	1·94
Manganese	0·34	....	....
Carbon	4·56	4·12	...

It was so hard that it could hardly be broken on an anvil with a sledge hammer. It blunted the hardest drills and we had difficulty in obtaining samples for analysis.

Having been called upon by a large manufacturing firm to make tests on the chill, strength and resistance of mixtures of cast iron into which entered small percentages of different metallic elements, we had occasion to test, on the machine, our white cast iron obtained from titaniferous ores. Square bars of 1 inch section and 12 inches long between supports, broke under a load at the centre of 2700 to 2900

* Rivat Decimasié, p. 156.

pounds, which corresponds to a modulus of rupture, in cross breaking, of 48,600 to 52,200 pounds per square inch.

Cast in chilled molds, this iron offered a remarkable depth of chill on the test blocks. It had become so hard that drills or chisels of the hardest steel would not touch it. Its resistance to attrition was exceptional. For many obvious applications these properties would open a very extensive use for this iron as pig metal. Pieces of machinery requiring special hardness were cast from this material and were subjected to particularly hard and trying conditions of wear. They have been found, after a year's service, in good order yet.

By mixing with irons showing a breaking load of 3350 pounds per square inch and a chill on the test pieces of 1·125 inches small percentages of this titanic pig metal, we increased the resistance to breaking to 3900 pounds and more, corresponding to a modulus of 70,000 pounds per square inch. The depth of the chill was increased to 1·375 inches. It compared favourably for resistance with other mixtures into which entered certain metallic elements, mixtures much more costly, and with which the chill dropped to 0·81 inch, and in some cases to 0·062 inch, making them unfit for the purposes for which they were intended, strong though they were. Hence the simple addition of this titanic pig metal, not more expensive, practically, than any other cast iron, to ordinary mixtures used for specific purposes, though increasing the hardness and the chill of the product in a remarkable manner, considerably increased also its resistance to cross breaking, bringing it to equal the strength obtained by much more expensive mixtures of which the cost would industrially exclude the use, and which, to all purposes, destroys the chill, an essential factor in the case considered. Industrial products were manufactured from these titanic metal mixtures to be submitted to the regular tests for strength, which they stood with very satisfactory results. The experiments were repeated many times and under different conditions. They dealt with a number of different mixtures, but they are of a more private character, and what we have quoted from them is sufficent, we believe, for the purpose of this present article.

Referring again to the two papers mentioned above for qualities of the iron and steel obtained from this pig metal, we see that either as such, or as a transformed product, the metal obtained from titaniferous ores could command numerous and important applications owing to its special qualities.

Conclusion.

In conclusion we may repeat what Wm. B. Phillips said in the discussion of our Montreal paper: "The verdict against titaniferous ores has been based on insufficient ground."

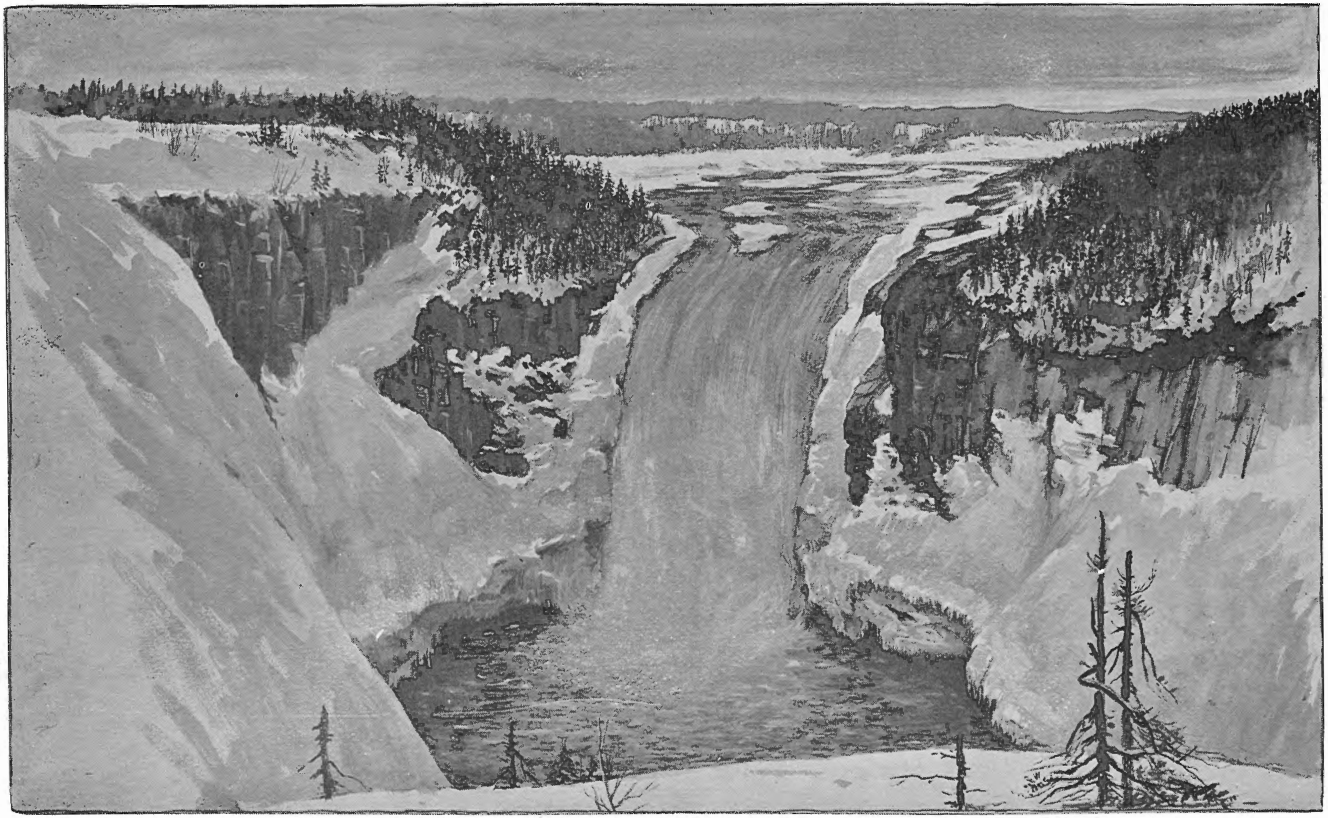
1. As anybody who may desire to make the experiment can verify, titanic acid can form definite compounds, perfectly fusible, if properly fluxed, containing as much as 35 to 40 to 50 per cent of titanic acid, with alumina, lime and magnesia as bases, and admissible as slags in blast furnace work. Larger percentages still, such as 65 per cent can enter into a compound, and it remains fusible. The objections to the smelting of titaniferous ores on account of the refractory character of the slags are not sustained by our practice, or that of others, or by direct experiments on the properties of these compounds.

2. In running a furnace under special conditions cf temperature and pressure of blast, no trouble has been experienced from titanium deposits. We never observed any in our blast furnace tests, and none are mentioned by Dr. Forbes in his practice in England and Norway.

3. If these special conditions of the lower heat, considered more favourable in smelting these ores, are held to imply against them a waste of fuel, it is a question whether this is not offset by the smaller amount of cinder to melt, the lesser quantity of fluxes necessary and their indirect effect on the productive capacity of the furnace, as well as the greater value of the pig metal obtained for specific and numerous applications. This is without taking into account the possibility of not submitting to it by a rapid driving and forcing the production, conditions which, to judge from our tests, could be easily realized with these ores.

The most economical results are obtained by the introduction of magnesia to an important extent into the composition of the slag, with alumina and lime. Many objections raised against the use of these ores have proved, when practically examined, of as little value as those brought forward against the use of magnesia in a blast furnace.

We have tried in the above to present the facts as we have observed them, and to state, as near as possible, the conditions in which we have conducted our experiments. We hope that enough has been accomplished to induce others to help us in our efforts to rehabilitate a class of ore, Bessemer in character, which could furnish to the metallurgists materials of excellent quality, and available in many districts where others prove costly.



Reproduced from Photo. by A. P. Low, 1894.

GRAND OR McLEAN FALLS, HAMILTON RIVER.

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON EXPLORATIONS IN THE

LABRADOR PENINSULA

ALONG THE

EAST MAIN, KOKSOAK, HAMILTON, MANICUAGAN

AND

PORTIONS OF OTHER RIVERS

IN

1892-93-94-95

BY

A. P. LOW, B. AP. SC.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1896

To

George M. Dawson, C.M.G., LL.D., F.R.S.,
Director Geological Survey of Canada.

Sir,—I have the honour to submit herewith a report of my work in the Labrador Peninsula during the seasons 1892, 1893, 1894 and 1895.

I have the honour to be,

Sir,

Your obedient servant,

A. P. LOW.

NOTE.—All bearings mentioned in this Report refer to the true North. The magnetic variation at the mouth of the East Main River is 17° west and increases as the river is ascended till at Lake Nichicun it is nearly 30° west. From Nichicun to Fort Chimo the variation increases gradually to 45° west at the latter place. At the mouth of the Hamilton River the variation is 38° west, and along the river it ranges between 30° and 38° west, while along the Romaine River it is about 30° west, and at Lake Mistassini about 20° west.

REPORT

ON

EXPLORATIONS IN THE LABRADOR PENINSULA

ALONG THE

EAST MAIN, KOKSOAK, HAMILTON, MANICUAGAN AND PORTIONS OF OTHER RIVERS.

INTRODUCTORY.

The present report is based mainly upon the observations made along the routes of exploration followed during the seasons of 1892, 1893, 1894 and 1895. The knowledge so gained has been supplemented by information obtained from officers and servants of the Hudson's Bay Company, Indians, and other persons acquainted with the Labrador Peninsula. Free use has also been made, in regard to certain subjects, of the information to be found in the writings of Mr. Lucius M. Turner,* Dr. A. S. Packard,† and Mr. W. A. Stearns,‡ who have all spent some time on the southern and eastern coasts and there collected much valuable information relating to the history, physical geography and natural history of those regions. Observations on the natural resources of the peninsula made by officers of the Geological Survey in former explorations, have also, when necessary, been incorporated in the text; a list of these explorations is given at the end of the historical notes.

Sources of information.

Acknowledgments are due to Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, and to Mr. Peter McKenzie, for circular letters to the various officers in charge of posts along the routes travelled, and to the following gentlemen in charge of these posts: Messrs. J. Broughton, D. Mathewson, Wm. Scott, C. Sinclair, J. A. Wilson, A. Nicholson, H. M. S. Cotter, John Ford, J. Fraser, J. Gordon, W. Miller, J. Iserhoff and J. Corson, for their generous hospitality, valuable information and efficient aid, to which the success of the explorations has been largely due.

Acknowledgment of assistance.

* List of birds of Ungava, Proc. U. S. Nat. Museum, VIII., 1885.
Ethnology of Ungava, Annual Report U. S. Bureau of Ethnology, 1889-90.
† The Labrador Coast, New York, 1891.
‡ Labrador, Boston, 1884.

Work of assistants.

During the season of 1892, Mr. A. H. D. Ross, M.A., acted as my assistant and besides carrying out other varied duties, made a large collection of plants, which added greatly to the botanical knowledge of the eastern watershed. The names of these plants have been included in the list given in an appendix. In 1893, 1894, and 1895, Mr. D. I. V. Eaton, C.E., acted as assistant and topographer, and it is entirely to his careful work that the exact surveys of these years are due. Mr. Eaton, since his return to Ottawa, has also compiled the map which accompanies this report.

Previous reports.

Itineraries of the various journeys made in the course of these explorations have been printed in the Summary Reports of the Geological Survey Department for 1892, 1894, and 1895, and only a brief outline of the routes followed need in consequence be given here.

Route followed in 1892.

In 1892, the routes traversed were from Lake St. John, up the Chamouchouan River to its head, thence north-east through three large lakes to Lake Mistassini. From that lake the east channel of the Rupert River was descended some fifty miles, to a portage-route crossing through small lakes to the East Main River fifty miles northward. This stream was carefully surveyed downward for three hundred miles to its mouth on the east side of James Bay. James Bay was crossed to Moose River, and that stream ascended to its head, where the Canadian Pacific Railway was reached, making in all a canoe trip of over thirteen hundred miles.

Route followed in 1893 and 1894.

In 1893 and 1894, the party remained in the field during the winter. A start was again made from Lake St. John, and the chief branch of the Chamouchouan River was ascended to its head near Lake Mistassini. The same route as that followed the previous year, was taken to the East Main River, where the survey was commenced at the end of that year's work, and carried upward to the head of the river, where a crossing was made to the upper waters of the Big River, and that stream was descended to Lake Nichicun. A portage-route was then followed to Lake Kaniapiskau, and the Koksoak River, which flows out of it, was descended to its mouth at Ungava Bay. In this manner a canoe trip through the centre of the Labrador Peninsula from south to north was accomplished. From Fort Chimo, the Hudson's Bay Company's steamship "Eric" was taken to Rigolet on Hamilton Inlet. From Rigolet, canoes were taken to Northwest River, at the head of the inlet, where the early winter was passed. From the 19th January to the middle of May, the whole time was employed in hauling the outfit, canoes and provisions on sleds up the Hamilton River as far as the Grand Falls, some two hundred and fifty miles above the mouth of the river. The months of June and July were occupied in the exploration of the Ashuanipi branch of the Hamilton River to within a hundred miles of Lake Kaniapiskau, and with the exploration of Lake Michikamau. In August a start was made for the coast by ascending the Attikonak branch of the Hamilton River to its head, and thence crossing to the Romaine River. This stream was descended to within one hundred miles of the coast, whence a portage-route was followed to the St. John River, and by way of this river the Gulf of St. Lawrence was reached. The total mileage of travel for 1893-94 was 5460 miles, made up as follows:—In canoe, 2960 miles; on vessel, 1000 miles; with dog-teams, 500 miles; and on foot, 1000 miles.

Route followed in 1895.

The summer of 1895 was spent in exploring the Manicuagan River, flowing southward into the Gulf of St. Lawrence, which it enters about 240 miles below Quebec. This stream was geologically explored to the head of Mouchalagan Lake, where the surveys previously made by the Crown Lands Department of Quebec ended. Above this lake the main stream was surveyed, by micrometer, to its head in Summit Lake in latitude 53° N., and track-surveys were carried over portage-routes on various branches of this river and the head-waters of the Outardes River and of the Big River of Hudson Bay. In so doing a good idea was obtained of the country about the central watershed of the peninsula, as well as considerable additional information in regard to the geology and natural history of the region.

Arrangement of matter.

The subject matter of this report is separated into two parts.—The first contains a general summary of the observations made, and the conclusions reached from these. It is consequently more concise and readable than the other part, which consists of detailed descriptions of the routes, the rocks noted, and other observations for the use of future explorers in the regions traversed. In the part relating to the geology, a summary of the chief observations and deductions is given in connection with each formation, before the detailed observations are entered upon.

Appendices.

In the Appendices will be found lists and short notes on the mammals, birds, fishes and insects known to exist in the interior of the peninsula; also a complete list of plants of Labrador, compiled by Mr. J. M. Macoun, from the various collections made by members of the staff of the Geological Survey and others. A meteorological record for 1893-94 is also given in Appendix VII.

Previous Discoveries and Explorations.

Biarne.

The first European authentically known to have visited the eastern shores of America was Biarne, the Norseman, who, in 990, sailed south-east from Greenland, and skirting the shores of Labrador and Newfoundland, proceeded southward probably as far as Nova Scotia.

Leif.

In 1000, Leif, the son of Eric the Red, the first settler in Greenland, followed Biarne's track and landed on the coast of Labrador, which, from its desolate rocky coast, he called Helluland, "Strong Land."

Latest Norse voyages.

Following Lief came several expeditions of these hardy Norse navigators, who passed southward to "Vineland the good." The latest Norse voyage was in 1347, after which date knowledge of the American continent was lost for nearly one hundred and fifty years.

Szkolney.

According to Humboldt, Szkolney, a Pole, is said to have made a voyage to Greenland and Labrador in 1476.

Basque fishermen.

About this time, or shortly afterwards, the Basque fishermen, in search of whales, crossed the Atlantic to the shores of Labrador and Newfoundland, and appear to have been met there by the Cabots and Cortereal.

John Cabot.

In 1497, John Cabot from Bristol, in search of a western passage to Cathay, sighted the coast of Labrador or Newfoundland. In the following year, his son, Sebastien Cabot, sailed from England and skirted the whole Labrador coast to beyond Cape Chidley, where he turned southward past Newfoundland, Nova Scotia and New England in hope of finding a passage to the eastward.

Cortereal.

Cortereal, who sailed from Lisbon in 1500, reached Newfoundland, proceeded thence northward, and probably re-discovered Greenland.

Brest.

In 1504, the town of Brest was founded by the French on Bradore Bay, near the Strait of Belle Isle. In 1517, fifty vessels called here, and in the height of its prosperity, about 1600, Brest contained two hundred houses and a population of about 1000 persons.

St. Lawrence.

Denis, of Honfleur, and Aubert, of Dieppe, are said to have explored the St. Lawrence as far as the Saguenay in 1506 and 1508.

Labrador.

A Portuguese map of 1520, has the name "Lavrador" applied to Greenland, while the unseparated coasts of Labrador and Newfoundland are called "Bacalhaos" or codfish in the Basque tongue. The name Labrador is derived from the Portuguese word for labourer, and was given to the coast because Cortereal brought home a cargo of natives as slaves.

Jacques Cartier.

In 1535, Jacques Cartier explored the Gulf and River St. Lawrence as far as Hochelaga, and wintered at Quebec. The Saguenay River was examined by Roberval in 1543.

Mercator's map of 1569, shows the coast of Labrador and Ungava Bay, or Hudson Bay; and as his information was obtained from Portuguese sources, it is evident that the fishermen of that country had previously penetrated Hudson Strait. Mercator's map.

In 1577, Martin Frobisher sighted the northern coast of Labrador, in about latitude 58°, and thence sailed northward a short distance into Hudson Strait. Martin Frobisher.

The cod fishery of Labrador and Newfoundland had grown so rapidly that in 1578, 150 French, besides 200 vessels of other nations, were engaged in this industry, together with thirty Biscayan whalers. Fisheries.

In 1586, John Davis passed along the Labrador coast and discovered two openings, Davis Inlet, in latitude 56° N. and Ivutoke (Hamilton) Inlet in latitude 54° 30′ N. John Davis.

Hudson Strait was penetrated to Ungava Bay, or Hope's Advance, by Weymouth in 1602. Weymouth.

In 1603, Champlain established the first permanent settlement on the St. Lawrence, at Quebec, a small trading post having been built in 1600 at Tadoussac. Champlain.

Henry Hudson, in 1610, passed through the straits and wintered in the southern part of the bay which bears his name. The following spring he was cast adrift, off the east coast, by his mutinous crew. Henry Hudson.

In the following year, a ship was sent to his rescue under command of Sir Thomas Button, who entered Hudson Strait by a narrow channel south of Cape Chidley, crossed the bay, and wintered at the mouth of the Nelson River. Sir Thomas Button.

About the year 1630, the town of Brest and four leagues of coast on each side was granted to a noble named Courtemanche, who had married a daughter of Henry IV.; and the Eskimo, who had given the French much trouble, were expelled from the Gulf shores about the same time. Eskimo expelled from the Gulf of St. Lawrence.

The quest of the north-west passage brought out James and Fox, in 1631, to Hudson Bay, where James wintered on Charleton Island. James and Fox.

In 1641, the missionary, Jean de Quen, ascended the Saguenay and discovered Lake St. John.

The Sovereign Council of Quebec, in 1656, authorized Jean Bourdon to make discoveries in Hudson Bay. He proceeded there, took possession in the name of the French King, and made treaties of alliance with the Indians. Jean Bourdon.

In 1658, a lease of exclusive trading, hunting and fishing privileges was given by the King of France to Sieur Demaure. This lease Le Traïté de Tadoussac.

was called "Le Traité de Tadoussac," and the territory to which it applied was called the King's Domain. It extended along the St. Lawrence from Isle aux Coudres to a point two leagues below Seven Islands, and included the country northward to the heads of the rivers draining into the St. Lawrence. The trading stations established in this territory were called "Postes du Roi," or King's Posts. The lease passed to the "Compagnie des Postes du Roi," and was renewed every twenty-one years. After the cession of Canada, the lease was continued in the same manner by the English government. When it was renewed by the Hudson's Bay Company, in June, 1842, for another term of twenty-one years, the Crown reserved the right to subdivide the country into townships for purposes of settlement. The Hudson's Bay Company's lease was ended by limitation in 1859.

Père Dablon.

In 1661, Père Dablon, a Jesuit, and Sieur de Vallière were ordered by d'Argenson, at that time Governor of Canada, to proceed to the country about Hudson Bay. They went there apparently by way of the Saguenay and Rupert rivers. Subsequently, the French company, in their dispute with the Hudson's Bay Company, claimed that they had at that time erected a small post at the mouth of the Rupert River for trade with the Indians, who had asked at Quebec that a missionary and traders be sent among them.

Sieur de la Couture.

In 1663, the Indians from about Hudson Bay again returned to Quebec to renew their former request for traders, and Sieur de la Couture, with five men, proceeded overland to the bay, took possession in the King's name, noted the latitude, planted a cross and deposited His Majesty's arms, engraved on copper, at the foot of a large tree. In the same year, Sieur Duquet and Jean L'Anglois also visited the bay, and set up the King's arms by orders of d'Argenson.

Radisson and Chouart.

In 1667, Radisson and Chouart *dit* Groseilliers ascended to Lake Superior, and thence crossed to Hudson Bay. They returned to Quebec, and proposed to the merchants to conduct ships to Hudson Bay, but, their proposal being rejected, they went to Paris, where they met with no better success. From Paris they were sent by the British ambassador to London, where their proposal was well received by certain merchants. In 1668, a small vessel was fitted out under command of Zachray Gilham, who, accompanied by the two Frenchmen, sailed to the southern part of the bay, and wintered in a small building called Fort Charles, at the mouth of the Nemiskaw, or Rupert River.

Hudson's Bay Company.

In 1669, on the return of Gilham to London, Prince Rupert and others applied to King Charles II. for a charter, which was granted them under the title of the "Governor and Company of Adventurers Trading from England to Hudson's Bay."

In the following year, the company sent out Chas. Bayly to establish a post at Rupert River. He was accompanied by Chouart and Radisson, and remained in the country, thus inaugurating the first permanent English settlement on Hudson Bay.

First settlement on Hudson Bay.

In 1674, Charles Albanel, a Jesuit missionary, arrived at the English settlement with letters from the Governor of Quebec, who had despatched him in 1672, overland from Quebec, to see what the English were doing on the bay. The route followed by Albanel was up the Saguenay River to Lake St. John, thence by the Chamouchouan River to the height-of-land and Lake Mistassini, and down the Rupert River to its mouth. An account of his trip is given in the Relations of the Jesuits, and is the first description of this portion of the country.

Père Albanel.

In 1675, outposts were established at Moose and Albany, and a depot on Charleton Island, where the ship from England discharged her cargo and took on board the furs from the various posts, brought there in sloops.

Establishment of Moose and Albany.

By 1685, the company had forts at Albany, Moose, Rupert, Nelson and Severn; also a small post on the East Main, or "Ison-glass River," where a mica mine was worked, but was soon abandoned as unprofitable.

In March, 1686, the directors of the French Company, on representation of the harm done to their trade by the English on the bay, obtained from M. de Denonville a body of Canadian and regular troops, under the command of M. de Troye. They were sent overland, reaching Hudson Bay in June, and captured Forts Rupert, Moose and Albany. This was the beginning of a desultory warfare, carried on with varying success, between the French and English for a number of years, until the Treaty of Ryswick in 1697. The seventh clause of the treaty restored to each belligerent the possessions held previous to this war. The eighth clause appointed commissioners to examine and determine the rights of either of the kings to places in Hudson Bay; "but the possession of those places which were taken by the French during the peace that preceded the present one, shall be left to the French by virtue of the foregoing article." In consequence, the only post left to the Hudson's Bay Company was the fort at Albany.

Warfare between French and English at Hudson Bay.

In 1700, the Hudson's Bay Company addressed a communication to the Lords of Trade in reference to their boundaries. They proposed the Albany River, or the 53rd parallel of north latitude, as the boundary on the west coast of the bay, and the Rupert River as the boundary on the east coast. The French were ready to accept the

Boundary claimed by Hudson's Bay Company.

55th parallel of north latitude, but this the company refused to agree to. In answer to the Lords of Trade, in 1701, the company made the further offer as to the limits between themselves and the French :— "2. That the French be limited not to trade by wood-runners or otherwise, nor build any house, factory or fort, to the northward of Hudson's River, on the east main or coast."

Treaty of Utrecht.

Matters remained unsettled until the Treaty of Utrecht in 1713, when the French ceded all their rights to Hudson Bay to the English.

Boundary claimed by Hudson's Bay Company.

In 1712, the company in a memorial to the Lords of Trade, and later in 1714, proposed for a settlement of the boundary between their territory and the French, "That the said limits begin from the island called Grimmington's Island or Cape Perdrix (Cape Mugford) in the latitude of $58\frac{1}{2}$ degrees north, which they desire may be the boundary between the English and the French on the coast of Labrador, towards Rupert's Land on the east main, and Nova Britannia on the French side."—"That a line supposed to pass to the south-westward of the said island of Grimmington or Cape Perdrix to the great Lake Miskosinke at Mistoveny, dividing the same into two parts as in the map now delivered"—"and from the said lake to run southward unto 49 degrees north latitude."

Delisle's map.

The map made by Delisle in 1703, shows the knowledge possessed by the French at the time of the Treaty of Utrecht of the interior of the Labrador Peninsula. On it is marked Lake Mistassini, discharging into James Bay, and also into Lake St. John. Pletipi, Manicuagan and Nichicun lakes are in their respective places, but the last is made to drain through Lake Pletipi into the Outardes River. At the head of the Peribonka River, there is a large lake named Outakouami, which discharges also into the East Main River, and a large stream flowing northward with the following note:—"R. que les sauvages disent tomber dans la mer du nord après 60 lieues de cours;" and the bay is shown in part near latitude 55°, with a break between it and "Bay du Sud" (Ungava), which extends southward between latitudes 61° and 57°. Hamilton Inlet is marked by a long narrow bay, without any large rivers at its head. The country northward of the East Main River and the eastern part of the southern watershed appear to have been unknown. Indefinite and rough as the topography of this map is, still it is greatly in advance of the English maps published about this time, which show only Lake Mistassini and the Rupert and East Main rivers in the interior of the Labrador Peninsula.

From the Treaty of Utrecht until after the cession of Canada, the Hudson's Bay Company appears to have confined its trade and investigations on the east side of the bay wholly to the coast. In 1732, a small post was re-established at the mouth of the East Main River, which was shortly afterwards made the headquarters of the east coast, and continued as such until after 1820, when two districts were established on this side of the bay, with headquarters at Rupert and Great Whale rivers. About the time of the re-establishment of East Main, a post was opened on Richmond Gulf for trade with the Eskimo, but was soon abandoned, after two massacres by the natives.

Hudson's Bay Company.

An ordinance respecting the limits of the King's Domain, issued at Quebec in 1733, makes mention of the posts of Tadoussac, Chekoutimy, Lac St. Jean, Nikaubau, Mistassinoe, Papinachois, Naskapis, River Moisie and Seven Islands, showing that the lessees were well established throughout that territory. No records are obtainable of the other districts, seigniories, and fur leases granted at Quebec, but the above may be taken as an example of the manner in which the French traders had penetrated and established posts throughout the interior of the Indian country, many years previous to the English occupation of Canada. The traders and "coureurs des bois" must have travelled far into the interior of the Labrador Peninsula, where they lived the greater part of the time with and like the Indians, only returning to Quebec for a short time every two or three years. Much of the information obtained by these men was never recorded and is consequently lost, while the little that was written is very difficult of access.

Trading posts in the King's Domain.

In 1732, Joseph Normandin was sent by the governor to explore and survey the region about Lake St. John. He ascended the Chamouchouan River to Lake Nikaubau, and mentions Peltier post as well as one on Ashouapmouchouan Lake, which was first established in 1690.

Joseph Normandin.

Shortly after the conquest of Canada, the North-west Company was formed, and appears to have acquired, among others, the lease of the "King's Domain." Under its vigorous management, the fur trade in the North-west and Canada rapidly increased, and this company soon became antagonistic to the Hudson's Bay Company, which now began the establishment of inland posts. The first of these, inland on the east side of Hudson Bay, probably dates from this period; it was situated on the East Main River, about three hundred miles above its mouth, at Birch Point, where a portage-route leads southward to Lake

North-west Company.

Post inland on the East Main River.

Mistassini. Subsequently, and before the amalgamation of the Hudson's Bay and North-west companies, this post was removed to the outlet of Lake Mistassini, and again to its present position on the south-west bay, where the North-west Company also had a post on a long narrow point, a few miles to the southward. This appears to have been the only inland post of the Hudson's Bay Company established in Labrador prior to the amalgamation of the companies in 1821.

Labrador Company.

Shortly after the conquest of Canada, the town of Brest, and one hundred and fifty miles of the north shore of the Gulf of St. Lawrence to the westward of that place, was granted to the Labrador Company of Quebec, with exclusive rights to the fisheries and fur trade. In this manner the entire north shore of the gulf was closed to private enterprise, and long remained so, as the coast to the westward of the Labrador Company's concessions was held by the seigniors of Mingan, whose grant extended to the eastern limit of the King's Domain.

Labrador Coast under jurisdiction of Newfoundland.

In 1763, the southern and eastern coasts of Labrador were placed under the jurisdiction of the Governor of Newfoundland; and the eastern and northern boundaries of the province of Canada were defined by the St. John River to its head, and from there by a line drawn through Lake St. John to Lake Nipissing.

Moravian Missionaries.

In 1770, the Moravian missionaries first settled among the Eskimo on the Atlantic coast.

Major Cartwright.

About the same time Major Cartwright made settlements at Cape Charles and Sandwich Bay, bringing with him a number of people from Dartmouth, for the salmon fisheries and trade with the Eskimo and Indians.

Labrador Coast.

In 1773, the coast of Labrador was restored to the jurisdiction of the Governor of Canada, on account of disputes between Newfoundland and the Labrador Company.

Hamilton Inlet.

In 1777, the first English entered Hamilton Inlet for purposes of trade with the natives, and found there the remains of posts erected by the French prior to the secession. The first posts were established on the inlet, by a Quebec Company, in 1785.

André Michaud.

André Michaud the celebrated French botanist, in 1782 passed through Lake St, John and reached Lake Mistassini. He had intended to descend the Rupert River to James Bay, but was obliged to return from Lake Mistassini, on account of the lateness of the season.

Labrador again attached to Newfoundland.

In 1809, the eastern coast of Labrador was again attached to the Government of Newfoundland, but the area of coast was reduced, and extended only from Anse Sablon northward to Hudson Strait.

In 1811, the Moravian missionaries Kollmeister and Kmoch, explored the northern Atlantic Coast and Ungava Bay, and reported favourably on the climate and soil of the latter place. Kollmeister and Kmoch.

The Labrador Company was dissolved in 1820, and that part of the Gulf shore previously under its control was thrown open to settlement and private fisheries. Labrador Company.

After the amalgamation of the Hudson's Bay and North-west companies in 1821, the policy of the former appears to have changed; and the country to the east of Hudson Bay was shortly after explored, posts being established throughout the interior of the peninsula. Explorations East of Hudson Bay.

In 1814, the Rev. Mr. Steinhaur published in the Transactions of the Geological Society a short description of the Atlantic coast, together with notes on the various rocks found about the Moravian mission stations. Rev. Mr. Steinhaur.

Between 1821 and 1824, James Clouston was employed in exploring the country east of Hudson Bay. There are no available notes or records of his travels, and all that remains is a map on a small scale, showing the routes that he followed. These embrace the East Main River to the Tichagami Branch, a few miles beyond the old post of Birch Point, two portage-routes between the East Main and Rupert rivers, the Rupert River and Lake Mistassini, and the routes to Waswanipi on the Nottaway River. The original map is at Great Whale River post, where a tracing of it was made in 1888, which is now in the Geological Survey office. James Clouston's explorations.

In 1824, a party was fitted out at Moose Factory to proceed overland to Ungava Bay and there establish a post; but it was not until three years later that this was accomplished by Dr. Mendry, who coasted along the east shore to Richmond Gulf, and then passed inland to Clearwater and Seal lakes, thus reaching the head-waters of the Larch Branch of the Koksoak River, which was descended to near its mouth, and Fort Chimo there first established. This trip is the basis of Ballantyne's "Ungava" a popular story for boys. A map made of the route by Dr. Mendry, is at present at Moose Factory, and a tracing of it is in the Geological Survey office; the part between Clearwater Lake and the forks of the Larch River has been used, in the compilation of the map accompanying this report. Establishment of Fort Chimo.

In 1824, the Governor of Newfoundland was empowered to institute a court of civil jurisdiction along the coast of Labrador.

Between 1827 and 1829, Admiral Bayfield made charts of the Atlantic and St. Lawrence coasts for the British Admiralty. Admiral Bayfield.

In 1827, the first survey of Lake St. John was made for the Quebec Government by Larue.

John McLean. In January and February of 1838, John McLean, then in charge at Fort Chimo, crossed overland to Hamilton Inlet, where the Hudson's Bay Company had established posts in 1837, passing on the way through Lake Michikamau. He retraced the route and reached Fort Chimo again on the 20th April. The same year a post was established at Erlandson's Lake, which appears to have been situated on the headwaters of the Whale River. Another outpost was also established on the George River.

Discovery of the Grand Falls, Hamilton River. In 1839, McLean again started across to Hamilton Inlet with canoes, but reached only the Grand Falls of the Hamilton River, and thus had the honour of being the first white man to view this mighty cataract. Not having a knowledge of the portage-route past the falls, he was obliged to return without reaching his destination. In the following summer he was more successful, and reached Hamilton Inlet with canoes, as he also did in the two following years. An interesting account of McLean's trips and also much information concerning the country, is given by him in his book entitled "Twenty-five years in the Hudson's Bay Territory."

Fort Nascaupee. In 1840, Fort Nascaupee was established on Lake Petitsikapau, drawing its supplies from Hamilton Inlet, and the post of Erlandson's Lake was then abandoned. This was followed in 1853 by the temporary withdrawal of the Hudson's Bay Company from Fort Chimo and other posts belonging to it.

Map of the interior of Labrador Peninsula. In 1842, John Beads and John Spenser, at Nichicun and Lake Kaniapiskau, compiled a map of the region surrounding these place giving the various branches and lakes of the rivers draining southward, westward and northward, from the central portion of the peninsula. This map was found at Nichicun in 1893, and is now in the Geological Survey office. It has been used largely in the compilation of the unsurveyed parts of the map accompanying this report.

List of trading posts. In his evidence before the select committee of the House of Commons on the Hudson Bay's Company, 1857, Sir George Simpson made a return of the various posts and number of Indians attached to each, throughout the territories of the company. The following list shows the posts then situated in the Labrador Peninsula:—Chicoutimi, Tadoussac, Isle Jeremie, Godbout, Seven Islands, Mingan, Musquarro, Natasquan, Northwest River, Rigolet, Kibokok, Great Whale River, Little Whale River, Fort George and Rupert House, all located on the coast, and Mistassini, Temiskami, Waswanipi, Mechiskan, Pike

Lake, Lake St. John, Nichicun, Kaniapiskau and Fort Nascaupee in the interior.

A. F. Blaiklock.

Surveys by Quebec Crown Lands Department.

In 1860, A. F. Blaiklock surveyed the Mistassini and Chamouchouan rivers flowing into Lake St. John. Since that date, under the direction of the Quebec Department of Crown Lands, all the principal rivers of the southern watershed have been carefully surveyed to near their sources; and but little work remains to be done to complete the map of the rivers of this slope.

United States Coast Survey Eclipse Station.

The same year an expedition was sent by the United States Government, and a station was established on the Atlantic coast in latitude 59° 54′, to observe a solar eclipse. In the report of the United States Coast Survey, 1860, a short account of the voyage, with notes on the climate, together with a chart of Eclipse Harbour is given by Commander Alexander Murray; and notes on the geology of the northern coast of Labrador by Oscar M. Leiber.

Henry Yule Hind.

In 1862, Henry Yule Hind ascended the Moisie River about 150 miles; and wrote two volumes on his experiences and information gathered from Indians and other sources relating to the interior of Labrador. This book is still quoted as the standard authority on the Labrador Peninsula.

A. S. Packard.

In 1860 and 1864, Dr. A. S. Packard visited the Atlantic coast, and besides various earlier papers on the fauna and flora, published in 1891, a work entitled "On the Labrador Coast," which deals very fully with the history and natural resources of the Atlantic coast, and is a valuable addition to the bibliography of Labrador.

Fort Chimo re-established.

In 1866, the Hudson's Bay Company again established Fort Chimo, and shortly afterwards opened posts at George and Whale rivers, where extensive salmon and porpoise fisheries are still carried on, besides trade with the natives.

Père Babel.

Between 1866 and 1870, Père Babel, O.M.I., travelled inland from Mingan, and lived with the Indians, exploring with them both branches of the Hamilton River, and the headwaters of many of the streams of the southern slope. A map made during his wanderings, is kept at the mission station of Betsiamites, and when consideration is taken of his imperfect instruments and other disadvantages, its accuracy is wonderful.

Roman Catholic missionaries.

About 1875, the Roman Catholic missionaries visited and established a mission for the Indians at Northwest River; and during the two following summers, Père Lacasse crossed overland from that place to Fort Chimo, returning in the Hudson's Bay Company's vessel.

Moravian missionaries.

In 1873, the Moravian missionaries published two maps of the Atlantic coast; the northern sheet extending northward from latitude 57°, the southern sheet embracing the coast from Hopedale to Sandwich Bay.

Abandonment of interior trading posts.

With the establishment of posts on Ungava Bay, the Hudson's Bay Company abandoned their interior posts on the Hamilton River, and at Lake Michikamau. Fort Nascaupee and Michikamau were closed in 1873, and the post at the head of Lake Winokapau in 1874. The closing of these posts now leaves only Nichicun, Mistassini and Waswanipi in the interior of the peninsula.

Jurisdiction of Newfoundland.

In 1876, the extent of the jurisdiction of the Government of Newfoundland in Labrador, was defined in Letters Patent constituting the office of Governor and Commander-in-Chief of the Island of Newfoundland. "All the coast of Labrador, from the entrance of Hudson Straits to a line to be drawn due north and south from Anse Sablon on the said coast to the fifty-second degree of north latitude, and all the islands adjacent to that part of the said coast of Labrador."

Hudson Strait exploration.

In 1884 and 1885, the Dominion Government sent a vessel to Hudson Strait, to establish observation stations on both sides, in order to obtain reliable information concerning the amount and movements of the ice.

Rev. Mr. Peck.

In 1885, the Rev. Mr. Peck, of the Church Mission Society, crossed from Richmond Gulf to Ungava Bay, following the route previously taken by Dr. Mendry.

Lucien M. Turner.

During 1885 and 1886 Mr. L. M. Turner was engaged collecting birds and mammals, and doing other scientific work in the vicinity of Fort Chimo for the Smithsonian Institution at Washington.

R. F. Holmes.

In 1887, Mr. R. F. Holmes attempted to reach the Grand Falls of the Hamilton River from its mouth, but, being handicapped with a heavy boat and a poor crew, reached only Lake Winokapau. He made an excellent map of the river to that point, and wrote an account of his trip, which appeared in the Transactions of the Royal Geographical Society.

Expeditions up Hamilton River.

In 1891, two separate expeditions from the United States ascended the Hamilton River, and visited the Grand Falls within a few days of each other. Messrs. Austin Cary and D. M. Cole * who were the first to reach the falls, had the misfortune to burn their boat and outfit, and were obliged to tramp to the mouth of the river, two hundred and

* Bulletin American Geog. Soc., vol. xxiv., p. 1.

fifty miles distant from where the mishap took place. This they very pluckily accomplished, passing unseen Messrs. Henry G. Bryant * and C. A. Kenaston, who were on their way up the river at the time.

Explorations by the staff of the Geological Survey.

The following is a list of the reports relating to the Labrador Peninsula published by the Geological Survey of Canada, from explorations made by members of the staff:—

Report, 1853-56.—On the Island of Anticosti, and the Mingan Islands.—J. Richardson.

Report, 1857.—On part of the Gaspé Peninsula from Magdalen River to Gaspé Bay, and on Lake St. John.—J. Richardson.

—On the Fauna of portions of the Lower St. Lawrence, the Saguenay, Lake St. John, etc.—R. Bell.

Report, 1866-69.—On the north shore of the Lower St. Lawrence.—J. Richardson.

Report, 1870-71.—On the geology of the country north of Lake St. John.—J. Richardson.

Report, 1871-72.—On exploration of Country between Lake St. John and Lake Mistassini.—W. McOuatt.

Report, 1877-78.—Report on an Exploration of the East Coast of Hudson Bay.—R. Bell.

Report, 1879-80.—Report on Hudson Bay and some of the Lakes and Rivers lying to the west of it.—R. Bell.

Report, 1882-83-84.—Observations on the Coast of Labrador and on Hudson Strait and Bay.—R. Bell.

Report, 1885.—Report of the Mistassini Expedition.—A. P. Low.

" —Observations on the Geology, Zoology and Botany of Hudson Strait and Bay.—R. Bell.

Report, 1887-88.—Report on Explorations in James Bay and the Country east of Hudson Bay, drained by the Big, Great Whale and Clearwater Rivers.—A. P. Low.

Physical Geography.

Boundaries of the Labrador Peninsula.

The eastern coast of the Labrador Peninsula extends north-north-west, from the Strait of Belle Isle to Cape Chidley, a distance of about seven hundred miles, or from latitude 52° to latitude 60° 30′, fronting the North Atlantic. The northern boundary from Cape Chidley to Cape Wolstenholme, at the entrance of Hudson Bay, in a straight line, is nearly five hundred miles long, and runs about west-north-west in direction, forming the southern shore of Hudson Strait including Ungava Bay. A line drawn from Cape Wolstenholme to the bottom of James Bay, runs nearly north-and-south for eight hundred miles, and corresponds closely to the eastern shore-line of the peninsula. The southern boundary is arbitrary but has been taken as a straight line extending in a direction nearly east from the south end of James Bay near latitude 51°, to the Gulf of St. Lawrence near Seven Islands in latitude 50°. This line is nearly six hundred miles long, and passes close to the south end of Lake Mistassini. From where the line reaches the Gulf coast, in the neighbourhood of Seven Islands, the shore-line forms the southern boundary to the Strait of Belle Isle, with a length of somewhat over five hundred miles.

* A Journey to the Grand Falls of Labrador, Geog. Club, Philadelphia.

Extent.

The total area embraced within these boundaries is approximately 511,000 square miles, of which, previous to the present explorations, 289,000 square miles were practically unknown. There still remains about 120,000 square miles of the northern portion of the peninsula, between Hudson and Ungava bays, totally unknown to anyone except the wandering bands of Eskimo who occasionally penetrate inland from the coast.

Atlantic Coast.

The Atlantic coast is exceedingly irregular, being deeply cut by many long narrow bays, or fiords, so that the coast-line exceeds many times the direct distance from Belle Isle to Cape Chidley. Hamilton Inlet is the largest and longest of these inlets, extending inland over one hundred and fifty miles from its mouth. Among others, Sandwich, Kaipokok, Saglek and Nachvak bays are from thirty to fifty miles deep. These narrow fiords are surrounded by rocky hills that rise abruptly from the water to heights ranging from 1000 feet to 4000 feet. The water of the inlets is generally deep and varies from ten to one hundred fathoms. A fringe of small rocky islands extends almost continuously along the coast, with a breadth of from five to twenty-five miles. Outside the islands, the inner banks extend seaward for an average distance of about fifteen miles, and on them the water is rarely over forty fathoms deep. From this it will be seen that the fiords, as a rule, have greater depths than the banks outside the island fringe.

Formation of fiords.

To account for such an apparent anomaly, it is necessary to consider the formation of both the fiords and banks. The fiords appear to be valleys of denudation of very ancient origin, eroded, at least in part, when the elevation of the peninsula was considerably greater (at least 600 feet) than at present. Their remote antiquity is established by the deposition in their lower levels of undisturbed sandstones of Cambrian age. The banks are likely of comparatively recent formation, and appear to be made from material carried off the higher lands by glaciers and deposited by them as a terminal moraine among and outside the fringe of islands, to be subsequently flattened out by floating ice and currents, thus filling up the deep channels at the mouths of the fiords.

Northern coasts.

The coast adjacent to Hudson Strait and Ungava Bay has not been examined closely, but enough is known for us to state that it is generally bold, with highlands rising immediately from it. Small rocky islands form a narrow fringe in many places, especially about Ungava Bay, and the coast is indented with small bays, but not to such an extent as the Atlantic coast.

Hope's Advance is a western extension of Ungava Bay, as yet unexplored. The navigation of Ungava Bay and Hudson Strait is rendered dangerous to sailing craft by the strong currents and exceedingly high tides, the latter having a mean rise in Ungava Bay of nearly forty feet, and at exceptional spring-tides they have been known to rise sixty feet.

Dangerous currents.

From Cape Wolstenholme to near Cape Jones, at the entrance to James Bay, the eastern coast-line of Hudson Bay is high and rocky. The coast between the entrance to Hudson Strait and Cape Dufferin, a distance of nearly three hundred miles, has not yet been continuously explored. Mosquito Bay is situated along this part of the coast, and was formerly supposed to connect with Hope's Advance. Such has since proved not to be the case, and Mosquito Bay has been found to extend inland not more than seventy-five miles. Between this bay and Cape Dufferin, there is a fringe of islands stretching out from ten to twenty miles from the mainland. To the southward of Cape Dufferin, the coast-line remains high, and an almost continuous line of high islands of Cambrian rocks forms a safe channel for small boats, as far south as Great Whale River. This channel varies from two to eight miles in width. South of Great Whale River, to within a short distance of Cape Jones, the coast is unprotected and bold.

Coast of Hudson Bay.

The eastern shore-line of James Bay is generally low, and the waters of the bay are very shallow and dotted far out with rocky islands and bouldery reefs, between which there is a perfect labyrinth of channels, navigable with small craft, but dangerous to approach with large vessels.

The north shore of the Gulf of St. Lawrence, in many places, has a more or less wide interval of low land, between the shore and the rocky plateau behind. From Seven Islands to Natashquan Point, the shore is comparatively regular and the islands few in number. To the eastward of Natashquan, as far as the Strait of Belle Isle, the coast is greatly indented by small bays and coves, and islands are numerous, especially between Cape Whittle and Blanc Sablon.

Gulf of St. Lawrence coast.

The peninsula of Labrador is a high, rolling plateau, which rises somewhat abruptly, within a few miles of the coast-line, to heights between 1500 and 2500 feet, the latter elevation being somewhat greater than the watershed of the interior. The interior country is undulating, and is traversed by ridges of low rounded hills, that seldom rise more than 500 feet above the general surrounding level. From the barometer readings, taken during the season of 1894, in conjunction with stationary barometers at Hamilton Inlet and Anticosti, the general level of the interior plateau, about the Upper Hamilton

General elevation and contour.

River and Lake Michikamau, near the central watershed, varies from 1600 feet to 1800 feet, and this may be taken as the general height of much of the interior of the peninsula. The highest part of the main interior mass is near the high granite area between the head-waters of the Peribonka, Manicuagan and Outardes rivers, flowing into the St. Lawrence, the East Main and Big rivers, flowing into Hudson Bay, and the Koksoak River flowing into Ungava Bay. The general elevation of this area exceeds 2000 feet.

Gradual slope towards James Bay.

The only portion in which the general level is attained by a gradual slope, is the part facing James Bay, where the land along the coast is low, and the rise eastward towards the interior is so light that one hundred miles inland it is only about 700 feet above sea-level.

Highlands of the St. Lawrence.

Beyond this the land continues to rise gradually, so that Lake Mistassini is only 1300 feet above sea-level. As before stated, the rise from the coast in other places is quite rapid; and along the St. Lawrence coast there is a range of high ground extending from the neighbourhood of Quebec to below the St. John River. The larger streams have cut deep valleys through this range. Along the Saguenay, at Cape Eternity, the hills rise almost shear 1500 feet above the river; while behind, in the Lake St. John region, few elevations exceed 1000 feet. On the Bersimis River, the high range begins about forty-five miles inland and continues to about the one hundredth mile, beyond which the country is comparatively level, and somewhat lower. On the Romaine and St. John rivers, the high lands formed from a great mass of irruptive rocks, begin about twenty-five miles from the coast, and are about fifty miles broad. The general level of this belt is nearly 2000 feet and many of the summits are more than 2500 feet above sea-level, while the general level of the country immediately behind them is not much over 1600 feet. H. Y. Hind* mentions similar high lands on the Moisie River, where the general level is above 1500 feet, and some of the mountain ranges are 3000 feet above sea-level.

Atlantic highlands.

Along the Atlantic coast, the land rises abruptly inland, almost everywhere, to altitudes varying from 1000 feet to 1500 feet, from the Strait of Belle Isle to the vicinity of Nain. To the northward of Nain the coast range is much higher, and, in the neighbourhood of Nachvak Bay, ranges of sharp, unglaciated mountains rise abruptly from the sea to heights varying from 2500 feet to 4000 feet; while farther north they are reported to culminate in peaks of 6000 feet, a few miles inland. With a slight decrease in height, this range con-

*Explorations in Labrador, vol. 1, chap. ix.

tinues northward to the barren islands at Cape Chidley. This mountain range appears to be confined to the coast region and probably is under fifty miles in width, the country on the western side sloping rapidly down to the level of the interior plateau. About Ungava Bay, the general level of the plateau is probably somewhat under 1000 feet, and the land rises gradually towards the interior. Little or nothing is known definitely of the great northern area between Ungava and Hudson bays, but, from observations by Dr. R. Bell, made along the coasts, the land appears to rise rapidly for 1000 feet, and then more gradually to elevations between 1500 and 2000 feet. From information obtained from the Eskimo at Ungava, there would seem to be a low tract of country extending westward from Hope's Advance towards Mosquito Bay on the Hudson Bay coast, and also another area of comparatively low country westward of the Leaf Lakes and of the Koksoak River valley.

The land fronting the Hudson Bay coast, as far south as Cape Jones, reaches the 1000 feet level within a short distance from the sea, and then rises quickly to a general level between 1500 and 2000 feet, the latter being the maximum of elevation in this region, as determined by the few explorations in this portion of the peninsula. The gradual rise from the seaboard of the country to the east and south-east of James Bay, has already been mentioned. *Elevation of land fronting Hudson Bay.*

To sum up the foregoing statements of levels,—the interior of the peninsula is almost flat, so that in an area of 200,000 square miles, there is not a difference of general level of more than 300 or 400 feet, and the highest general level of the interior is under 2500 feet. A belt of land somewhat higher than the general interior follows the St. Lawrence coast, a short distance inland. The northern half of the Atlantic coast rises in a chain of mountains, considerably higher than any other portion of the peninsula. Along the northern and western coasts there is no evidence yet obtained to show the existence of a coastal ridge, but rather a probability that the general elevation increases towards the interior. *Summary of elevation.*

Like the other portions of northern Canada underlain by glaciated Archæan rocks, the interior of the Labrador Peninsula is covered with myriads of lakes, that occupy, at a moderate estimate, at least one-fourth of the total area. In size, these vary from small narrow ponds, to lakes with surfaces hundreds of square miles in extent. Great Mistassini and Michikamau lakes have areas considerably exceeding 500 square miles. Among those of which the area is between 200 and 500 square miles, may be mentioned Manouan Lake, on a tribu- *Lakes.*

tary of the Peribonka River, Pletipi Lake, at the head of the Outardes River, the Manicuagan lakes, on the headwaters of the river of the same name ; all sending their waters into the St. Lawrence. Discharging into the Atlantic are Winokapau, Petitsikapau, Ashuanipi and Attikonak lakes on the Hamilton River, and Grand Lake on the Northwest River, which also drains Lake Michikamau. On the rivers discharging northward, Lake Kaniapiskau is the only one yet partly explored, but reference to the map will show a number of large lakes on the various tributaries of the Koksoak and George rivers, which have been located from information derived from Hudson's Bay Company employees and Indians.

Western watershed

On the western watershed, Clearwater Lake is one of several large lakes lying in an area between the sources of the Stillwater branch of the Koksoak River, and the Nastapoka, Clearwater, Little and Great Whale rivers flowing into Hudson Bay; all of which rise and flow through a number of large unexplored lakes.

Lake Nichicun is near the headwaters of the Big River and is drained by that stream. The Mistassini lakes discharge into the Rupert River, while the Nottoway River, which discharges into the southern part of James Bay, drains, among others, lakes Waswanipi and Chibougamoo.

Lakeless area.

Besides the lakes mentioned, there are hundreds having a surface area between 20 square miles and 100 square miles, while smaller lakes are numberless. The only portion of Labrador not thickly covered with lakes, is the low country extending inland for about 100 miles from the east coast of James Bay. This area has been covered with a deep mantle of marine sands and clays, which has filled up the inequalities of the surface, and prevented the formation of lakes; it is covered instead by a net-work of small streams, with deep channels cut out of the stratified drift.

Formation of lakes.

The lakes, except the largest, are usually confined in the shallow valleys between low rocky ridges, by barriers of drift, and in consequence their depth is not great, seldom exceeding fifty feet, while many of them are under twenty feet deep. Mistassini and Michikamau lakes, occupying ancient basins, in which Cambrian rocks were deposited, are among the exceptions, the former having a depth of over 400 feet, while that of the latter is said, by the Indians to exceed 250 feet. Lake Winokapau, in the valley of the Hamilton River, and Lake Mouchalagan on the Manicuagan River, are other exceptions, the former being over 400 feet deep, and the latter 650 feet deep, but, as will be explained further on, these and Grand Lake, on the Northwest River, differ from the ordinary lakes in their manner of formation.

It follows, from the great number of lakes, that the country must be covered with a perfect network of streams discharging them. The discharges and lakes interlock so closely that, with a knowledge of the country, it is possible to travel with canoes in any direction, the longest portages never exceeding two or three miles. Great depths in lakes.

There are four principal watersheds to the peninsula: of these the southern is the smallest, its rivers rarely exceeding 300 miles in length; the most important are the Saguenay and its branches, Bersimis, Outardes, Manicuagan, Moisie, Romaine, Natashquan and St. Augustine. The eastern watershed drains chiefly into Hamilton Inlet, three large rivers flowing into its head. Of these the Hamilton River is much the largest, taking its rise near the middle of the peninsula and draining an area extending from latitude 52° to latitude 54° covering seven degrees of longitude. Its longest branch rises nearly 600 miles from its mouth. The other rivers of Hamilton Inlet are the Northwest and Kenamou, the former draining a large area to the north of the Hamilton River, the latter flowing in from the south-west. Apart from these three large streams, no other rivers of importance are found along the Atlantic coast, on account of the high lands of the coast cutting off the drainage of the interior and forcing it to flow northward into Ungava Bay. Rivers.

The Koksoak River is the largest stream flowing northward, and is probably the largest river of Labrador. Besides the main stream, there are a half dozen tributaries, each of which drains an important basin. The longest branch flows out of the northern end of Summit Lake, on the 53rd parallel of latitude, while a branch of the Manicuagan River flows out of the southern end of the same lake, thus connecting by water the Gulf of St. Lawrence with Ungava Bay. The total area drained by this river and its tributaries is about 60,000 square miles. The George River, is another great stream which rises in large lakes close to Lake Petitsikapau on the Hamilton River, and drains a wide area westward of the Atlantic coast range. The Whale River is a smaller stream lying between the George and Koksoak rivers. Koksoak River.

The western drainage basin is the greatest in Labrador and is emptied by large rivers, that rise far inland, close to the head-waters of the Koksoak and Saguenay rivers. Proceeding from the northward, the larger rivers flowing into Hudson Bay are:—The Nastapoka which flows out of several large lakes to the eastward of Clearwater Lake and near the head of the Stillwater branch of the Koksoak River; the Little and Great Whale rivers, that rise close to the western branches of the Koksoak; the Big River which rises in the mountainous area south Western rivers.

and east of the head of the East Main River, in about latitude 52°, and close to the sources of the Peribonka, Manicuagan and Outardes rivers tributaries of the St. Lawrence. From its source the Big River flows northward nearly one hundred and fifty miles, passing through Lake Nichicun, and then turns westward four hundred miles, emptying into James Bay, near latitude 54°

The East Main River takes its rise in a number of lakes close to Lake Nichicun and flows nearly west, discharging into James Bay a short distance north of latitude 52°. The Rupert River forms the discharge of the Mistassini lakes, and, having such large reservoirs at its head, is not subject to the same fluctuations of volume, as the other rivers. It empties into Rupert Bay close to the mouth of the Nottoway River, which drains a wide area to the south-east of Hudson Bay, and rises in a number of large lakes close to the height-of-land dividing it from the St. Maurice River, which joins the St. Lawrence at Three Rivers.

Ancient river channels.

The channels of most of the rivers of Labrador are of very ancient origin, apparently dating back to a period before the deposition of the Cambrian rocks. These valleys are cut deep into the general level of the plateau, their depth and length apparently depending on the volume of water carried, and thus showing that they have been mainly formed by normal denudation.

The larger rivers flowing southward, have deep valleys cut through the highlands of the coast region, and the streams are often from 500 feet to 1000 feet below the general level of the surrounding country. The heads of these valleys are from one hundred to three hundred miles from their mouths; and at their upper ends the rivers descend from the level of the interior in a succession of heavy falls, through narrow gorges where processes of erosion are at present extending and deepening the valleys. This erosion is, however, so exceedingly slow, that the change in the heads of the valleys, since glacial times, has been practically nothing, owing no doubt to the hardness and resistance to weathering of the Archæan rocks in which they are cut. The gorge of the Saguenay, with its almost vertical walls rising 1500 feet above the surface of the water, and its great depth of more than 800 feet in places, is an excellent example of one of these ancient river-valleys. That of the Hamilton River, which is cut back from the head of Hamilton Inlet for nearly three hundred miles, and of which the depth is from 700 feet to 1200 feet below the general level of the surrounding country, is another fine example of river erosion. The rivers occupying smaller valleys, are all of the same type. The East Main and Rupert rivers, flowing as they do on the gradual slope towards James

Bay, where the marine deposits of sand and clay are found inland about one hundred miles, have not the marked valleys found elsewhere, but descend in a number of steps, where they have either cut narrow gorges out of soft Huronian schists, or fall directly over granitic ledges. The ancient valleys of these streams appear to have been filled up during the deposition of these marine beds, and the present river-courses are of post-glacial origin.

New channels.

Before entering the ancient valleys above described, all the rivers in central Labrador flow almost on the surface of the country, and are broken into chains of lakes often formed by dams of glacial drift, which in other places form low ridges that divide the streams into different channels. These channels wander about on the lower levels of the interior country in a most bewildering manner, and render travel without a guide excessively difficult.

Climate.

Climate along the coasts.

The climate of Labrador ranges from cold temperate, on the southern coasts, to arctic on Hudson Strait and the high lands of the northern interior, and is generally so rigorous that it is very doubtful if the country will ever be fit for agriculture north of latitude 51°, except on the low grounds near the coast. Along the east coast of James Bay, good crops of potatoes and other roots are grown as far north as Fort George—about latitude 54°—while on the Atlantic coast of the peninsula, about the head of Hamilton Inlet, similar crops are easily cultivated. On the outer coast the climate is more rigorous, and appears to be much affected by the northern current, with its numerous floating icebergs, which lowers the mean temperature and renders the growth of root crops slow and uncertain at Rigolet in latitude 54°. Garden vegetables are, however, grown at Nain in latitude 56° 30′; but extra precautions are taken with them, such as the building of walls to protect them from the east wind, and covers put over them when in danger from summer frost. At Fort Chimo, near the mouth of the Koksoak River in latitude 58°, with care small patches of turnips, lettuce and radishes are grown.

Climate of the interior.

In the interior, at the Hudson Bay's post of Mistassini, in latitude 50° 30′, a crop of potatoes is raised annually, but, owing to the shortness of the season and the prevalence of summer frosts, they rarely mature without the tops being frozen. No other vegetables are cultivated here at present. At Nichicun attempts are made to grow potatoes, but they have always proved more or less failures, owing to frosts in July and August. It will thus be seen that the prospects of the settlement of the central portion of Labrador, for purposes of agriculture, are by no means bright; and, if settlements are made for other purposes, the inhabitants will have to depend largely on more southern localities for their vegetable food. Owing to the absence of grass plains, and to the mantle of moss and lichens that covers the surface of the ground almost everywhere, there is little likelihood that it will ever be a grazing district. The high lands of the interior have only two seasons, winter and summer. The summer season begins almost simultaneously throughout the interior, and the jump from winter into summer occurs as a rule during the first two weeks of June, when the snow disappears, and the ice leaves the rivers and lakes, except the largest, where it often remains until July. With the disappearance of the snow and ice, the temperature during the day rapidly increases, and the leaves are almost immediately put forth by trees and bushes. During 1894, frosts were of almost nightly occurrence until June 28th, when a thin sheet of ice was formed in the vessels about camp, and slight flurries of snow fell in the morning. After this date no frost was noted, but, thermometers having unfortunately been broken, the exact temperature could not be taken. To the north of latitude 52°, snow falls and ice begins to form in the small lakes about the middle of September. From early in October the snow remains permanently, and all the smaller lakes are solidly frozen, so that, for the greater part of the interior plateau, there is at most only three months of summer. The temperature during the winter season is often very low on the interior high lands, away from the influence of the sea. The coldest months are December, January and February, and the following readings of thermometers taken at Mistassini* in 1885, will give an idea of the temperature of that region, which appears to be somewhat higher than about Nichicun and the upper Hamilton River.

Absence of grass.

Summer season.

Winter season.

Temperatures at Lake Mistassini.

——	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
Mean temperature	-18·5	-00·1	01·9	25·3	42·3	53·1	59·9	56·7
Highest temperature	16	39	35	54	85	79	76	81
Lowest temperature	-56	-46	-47	-19	08	30	39	31

Great thickness of ice.

According to reports of the Indians, the ice in Lake Michikamau is 7 feet 6 inches thick on an average, and the amount of continuous frost to form such a thickness must be very great. The ice in Lake Winokapau, in the deep valley of the Hamilton River, was from actual

*Annual Report, Geological Survey of Canada, vol. I. (N.S.), 1885, p. 16 D.

measurement found to be 4 feet 9 inches. From the journal kept at the post on this lake, between 1866 and 1874, the first snow generally fell about September 20th and continued until June, the latest record being June 10th. The lowest temperature recorded was 55° below zero. Geese and summer birds arrived on or about May 10th. From the journals at Northwest River post, the lowest temperature recorded from 1867 to 1893, was 53° below zero. There are several observations of 45° below zero, which appears to be the minimum winter temperature of most years. At Rigolet, where the temperature is moderated by the open sea, the thermometer rarely registers 40° below zero. At Fort Chimo, where the open sea is not far distant, 45° below zero is said to be the lowest temperature registered. The summer temperature of the Atlantic coast region is considerably lower than inland or along the western coast. As a rule the thermometer in the interior—north of Mistassini—rarely rises above 80° during the middle of the day on more than a few days during the summer season.

Lake Winokapau.

Hamilton Inlet.

Fort Chimo.

The temperature depends greatly on the direction of the winds. During the summer, south and south-west winds prevail in the interior, and are accompanied by higher temperature and often overcast sky, with drizzling rain. The west and north-west winds bring clear weather with lowering temperature, especially during the winter season. North and north-east winds are usually accompanied by heavy storms of rain and snow, with cold moist atmosphere. East and south-east winds, as a rule, blow with clear pleasant weather.

Winds.

The precipitation of moisture over the interior area is not great. During the winter the snowfall varies from three to six feet, and the greater part of it descends during the periods of north or north-east wind, which are not common; the north-west wind, blowing at least three-quarters of the time during the winter season, is accompanied by a bright clear atmosphere. During the summer season the precipitation, if not great, is constant, as a day rarely passes without drizzle, or thunder showers, which lower the temperature.

Rain.

At Northwest River, the head of Hamilton Inlet freezes completely over between the 1st and 15th of December, and opens again between May 15th and June 15th. Snow falls early in October, and from that date to about the first week in May, the latest record being July 2nd. At Rigolet, the outer part of Hamilton Inlet rarely or never freezes solid before the middle of January, and in some winters does not close at all. This is due to the strong currents in this part of the inlet. Sandwich Bay, nearly one hundred miles farther south, generally freezes over in the end of December, and the same time may be taken as that of the closing of most of the larger fiords of the

Bays on Atlantic coast freeze over.

Snow.

Atlantic coast. About Fort Chimo, the lower grounds are permanently covered with snow by the 1st of December, this covering remaining until the 10th of June. The higher hills retain snow until the last of August, and by the middle of September snow again covers the tops of the distant high hills.*

Soil.

Character of soil on the Archæan area.

The soil of the greater part of the peninsula is derived from the underlying Archæan rocks, and is mostly in the form of glacial till, mixed with boulders of various sizes. The till is a mixture of sand and clay in which the former greatly predominates. In many large areas which have been traversed by fire, much of the vegetable matter of the surface has been destroyed, and the remaining soil supports only a scant growth of small trees. Along the sides of the river-valleys the drift has been re-arranged and mixed with sediments. Here the soil, though generally light and sandy, is richer than the unmodified till; and the size and variety of trees growing on it are consequently greater. Within the limits of the marine deposits, about the margins of the peninsula, the stratified sands are underlain by bedded clays, and as the coast is approached, the overlying sands thin out, leaving the clays near the surface, thus producing a light soil with a heavy subsoil, on which the vegetation is much better than anywhere else, except on the lower banks and islands in the rivers near the coast, where the sands and clays are topped with deposits of alluvium. The soil covering the areas of Cambrian rocks, being made up of the débris of limestone, shale, and other rocks of this formation, is of a heavier nature than that formed from the Archæan rocks; and the change from one to the other is marked by the better growth of trees on the former.

Marine deposits.

Cambrian débris.

Trees and Other Plants.

Various trees.

The southern half of the Labrador Peninsula is included in the sub-arctic forest belt, as described by Prof. Macoun.† Nine species of trees may be said to constitute the whole arborescent flora of this region. These species are :—*Betula papyrifera*, Michx., *Populus tremuloides*, Michx., *Populus balsamifera*, Linn., *Thuya occidentalis*,

---

* Annual Report U. S. Bureau of Ethnology, 1889 90.—Ethnology of the Ungava District. L. M. Turner, p. 172.

† The Forest Trees of Canada. John Macoun.—Trans. Royal Soc. Canada, Sec. iv., 1894, pp. 5-7.

Linn., *Pinus Banksiana*, Lam., *Picea alba*, Link., *Picea nigra*, Link., *Abies balsamea*, Marsh, and *Larix Americana*, Michx.

Distribution.

The distribution of the forest areas and the range of the various trees depend on several factors, among which may be mentioned, position as regards latitude, height above sea-level, distance from sea-coast, and character of the soil, all of which are important.

Forest areas.

The forest is continuous over the southern part of the peninsula to between latitudes 52° and 54°, the only exceptions being the summits of rocky hills and the outer islands of the Atlantic coast. To the northward of latitude 53°, the higher hills are treeless and the size and number of the barren areas rapidly increase. In latitude 55°, more than half the surface of the country is treeless, woods being only found about the margins of small lakes and in the valleys of the rivers. Trees also decrease in size until, on the southern shores of Ungava Bay, they disappear altogether. The Leaf River, which empties into the bay a few miles north of the mouth of the Koksoak River, is the northern limit of forest trees on the west side of Ungava Bay.

Barren grounds.

Along the east coast of Hudson Bay, Dr. Bell found trees growing a few miles beyond the north end of Richmond Gulf.*

In the neighbourhood of Clearwater Lake, the writer found many clumps of black spruce and larch, and, according to Indian reports, small patches extend to the Nastapoka River in latitude 57°. So that a line drawn a little south of west, from the mouth of the Leaf River to the mouth of the Nastapoka River on Hudson Bay, would give a close approximation to the northern tree limit of western Labrador.

Northern tree limit.

The tree-line skirts the southern shore of Ungava Bay and comes close to the mouth of the George River, from which it turns south-south-east, skirting the western foot-hills of the Atlantic coast range, which is quite treeless, southward to the neighbourhood of Hebron, in latitude 58°, where trees are again found in protected valleys at the heads of the inner bays of the coast. At Davis Inlet, in latitude 56°, trees grow on the coast and high up on the hills, the barren grounds being confined to the islands and headlands, which remain treeless to the southward of the mouth of Hamilton Inlet. These barren islands and bare headlands of the outer coast, along with the small size of the trees on the lowlands, have caused a false impression to be held regarding much of the Atlantic coast, which from Hamilton Inlet southward is well timbered about the heads of the larger bays and on the lowlands of the small river-valleys.

Atlantic coast.

*Report of Progress, Geol. Surv. Can., 1877-78, p. 256.

The distribution of each of the several species of trees depends on conditions similar to those affecting the forest areas in general.

Distribution of white birch.

Betula papyrifera, Michx. (White, Paper, or Canoe Birch) is found everywhere throughout the southern portion of the peninsula. Except in the district to the south-west of Lake Mistassini, drained by the Nottoway River, and on the southern watershed, the trees do not grow sufficiently large or straight to afford bark for canoe building, and the Indians of the more northern portions have to depend upon bark imported by the Hudson's Bay Company for their canoes. About Lake Nichicun and on the upper waters of the Hamilton River, the largest trees rarely exceed eight inches in diameter. The trees are found in thickets of second-growth, on the hillsides which have been traversed by fire; they also grow sparingly in unburnt portions. Northward of Nichicun, the white birch becomes rapidly smaller and along the upper Koksoak River does not average three inches in diameter. At Cambrian Lake, where the limestones are encountered and the river-valley is deep and protracted, the size of the trees improves, and birches six inches in diameter are not uncommon. Below the junction of the Swampy-bay River, the trees again become small, and finally die out on the Koksoak River a few miles above Fort Chimo. On the Hudson Bay side, the northern limit of white birch is near the mouth of the Great Whale River, while inland it is found, in small straggling clumps, at the head-waters of the south branch of that river. About Hamilton Inlet, birch is common, and, at the head of the inlet, trees up to ten inches in diameter are not uncommon.

Northern limits.

Distribution of aspen.

Populus tremuloides, Mich. (Aspen). The range of this tree depends, to a great extent, on the nature of the soil. In the southern portion of the peninsula, it is found as a second growth along with the white birch, and also in clumps in the original forest. It appears to be most plentiful on the western half of the peninsula, where it grows most abundantly on the unmodified glacial till of the drift ridges. At Lake Mistassini, this tree is abundant and is often ten or twelve inches in diameter about the southern portion of the lake. Along the upper East Main River, only small clumps of bent and twisted trees are seen, while about Nichicun it is exceedingly rare. To the northward of Nichicun, this tree was not seen along the route followed to Ungava Bay. On the Hudson Bay coast, the neighbourhood of Cape Jones is the northern limit of the aspen; while inland it is found on the portage-route, between the lower and upper parts of the Big River, in latitude 54°. About the head of Hamilton Inlet, and along the river below the Grand Falls, clumps of aspen are frequently met with. But above the Grand Falls this tree was not seen anywhere on the waters of the Hamilton River, its first occurrence on the route southward being near the portage-route leading to the Romaine River from Lake Attikonak. Along the Romaine River, it soon becomes common as the stream is descended. On the Manicuagan River aspen is found in the deep river-valley to beyond latitude 52°, but does not grow on the surrounding table-land.

Populus balsamifera, Linn. (Balsam Poplar) is met with farther north than the aspen; but it appears to confine itself to the heavy clay soil of the river-valleys, or to the modified drift of the Cambrian areas. It is met with along the Big and East Main rivers, flowing into Hudson Bay, and its northern limit on this side of the peninsula is the Bishop Roggan River, the next stream north of the Big River. Along the rivers of this coast, balsam poplar was only met with for about one hundred miles inland from the coast, where its limit was that of the stratified marine clays of the river-valleys. On the upper East Main River, it was nowhere seen, and it does not appear to grow northward of Lake Mistassini in the western interior. After passing through an area of several hundred miles from Mistassini to Eaton Cañon, on the Koksoak River, balsam poplar is again found growing in the valley of that river and continues to be found at intervals, to within twenty-five miles of Fort Chimo. At the head of Cambrian Lake, large clumps of trees of this species, ten inches in diameter, were observed growing on the low terraces, but elsewhere they were small and straggling. On the lower Hamilton River, balsam poplar is common. Above the Grand Falls it is not found along the river, for upwards of a hundred miles, until the Cambrian area about Birch Lake is reached, when small trees of this species become common, and continue along the Ashuanipi Branch to the end of survey. On the Attikonak Branch, a few small trees were noted between Sandy Lake and the height-of-land to the southward.

Distribution of balsam poplar.

Northern limit.

Thuya occidentalis, Linn. (Cedar) hardly enters the southern limits of the peninsula. It occurs just south of the mouth of the Rupert River, at the foot of James Bay, and does not cross that stream in the eastern course of its northern limit. It is only found about the south-western bays of Mistassini Lake, from which it extends south-east, crossing the St. Lawrence to the westward of Seven Islands. No cedar trees were seen along the Manicuagan River from its mouth upward.

Distribution of cedar.

Pinus Banksiana, Lam. (Banksian Pine, Jack Pine, Cypress) is limited in its extension by an eastern as well as a northern boundary.

Distribution of Banksian pine.

It grows freely over the western half of the peninsula, and appears to prefer the dry, sandy drift ridges and rocky hills, where it is often found along with black spruce, as a second growth, covering areas devastated by fire. Its northern limit is the south branch of the Great Whale River, south of which it occurs abundantly to the shores of the St. Lawrence, but does not come quite to the coast on Hudson or James Bay, probably on account of the shore being generally low and swampy. Inland, it is met with abundantly, along the East Main River, to the Long Portage Creek, near its head, in about longitude 71° W. Here a line running nearly north and south terminates the eastern extension of the Banksian pine. About Nichicun only a few small clumps are found to the westward of the lake, and it is unknown to the Indians to the eastward. In the southern extension of its eastern limit, the line runs somewhat east of south and reaches the St. Lawrence in the neighbourhood of the mouth of the Moisie River, being everywhere common along the main branch of the Manicuagan River.

Northern limit.

Eastern limit.

Distribution of white spruce.

Picea alba, Link. (White Spruce) is found throughout the wooded area of the peninsula, but it is not everywhere common, and there are several areas where it is rarely found. Its distribution is but little affected by climate or by height above sea level; it appears to depend altogether on the soil. North of the southern watershed, it is confined to the areas of re-arranged drift of the river-valleys and marine deposits along the coast, or to the heavier drift of the Cambrian areas of the interior. Along the western coast, the interior limit of this tree, on the East Main and other rivers flowing into Hudson Bay, coincides closely with the margin of the marine deposits, and consequently does not extend one hundred and fifty miles eastward from that coast. From Lake Mistassini, along the route to Nichicun, no trees of this species were met with, but it is said to grow sparingly about the latter place. A few small trees were observed on terraces between Nichicun and Lake Kaniapiskau. Along the upper Koksoak River, small trees were seen occasionally on its terraced banks to Eaton Cañon. Below this place, the number of trees and their size increased rapidly in the river-valley, and from here to the forks of the Stillwater many of them exceeded eighteen inches in diameter three feet from the ground and were over fifty feet in height. Below the Stillwater, their size rapidly decreased, and the trees died out near the mouth of the Koksoak River, along with the black spruce and larch, of which the northern limit is about co-terminous with that of the white spruce. About Hamilton Inlet, white spruce is abundant on the lowlands, and at the mouths of the Kenamou and Hamilton

Northern limit.

rivers many large sticks have been taken out for spars and masts for schooners. Here, and along the Hamilton River valley, where unburnt, this tree often exceeds eighteen inches in diameter, and grows sufficiently tall to allow of three good twelve-foot logs being cut out of a single tree. Above the Grand Falls, white spruce is found along the river banks, but is generally small and scattered until the Cambrian area of the upper waters is reached, when it becomes more abundant and grows well up the hillsides. Many of the trees of this region are very stout at their bases, but being short and branching would make poor lumber. To the southward of the Cambrian area, on the Attikonak Branch and the upper Romaine River, very few trees of this species are seen until the latter stream enters its ancient valley, when they become more abundant. They are found everywhere in the valley to the St. Lawrence. In the valley of the Manicuagan River, trees of this species attain a large size and are very abundant to Lake Mouchalagan, above which they gradually become fewer and smaller, and die out near the mouth of the Attikopi River. Good timber.

Picea nigra, Link. (Black Spruce) is the most abundant tree of Labrador and probably constitutes over ninety per cent of the forest. It grows freely on the sandy soil which covers the great Archæan areas, and thrives as well on the dry hills as in the wet swampy country between the ridges. On the southern watershed the growth is very thick everywhere; so much so that the trees rarely reach a large size. To the northward, about the edge of the semi-barrens, the growth on the uplands is less rank, the trees there being in open glades, where they spread out with large branches resembling the white spruce. The northern limit of the black spruce is that of the forest belt; it and larch being the last trees met with before entering the barrens. Distribution of black spruce.

Abies balsamea, Miller. (Balsam Fir, or Spruce,) is another species that grows only on suitable soil. It is found nearly to the edge of the barren grounds. Throughout the wooded regions it grows more or less plentifully about the margins of the larger streams and lakes, apparently preferring soil containing considerable moisture and alluvium. Northward of the southern watershed, it is rarely found away from the edges of rivers and large lakes, and is wanting along the portage-routes connecting the larger streams. On the Hudson Bay coast, its northern limit is near the Great Whale River. On the Koksoak River a few trees were seen below the junction of the Stillwater. Along the Hamilton River it grows everywhere and was also found growing about the shores of Lake Michikamau. Distribution of balsam fir. Northern limit.

Distribution of larch.

Larix Americana, Michx. (Larch, Tamarack, 'Juniper'), is probably the hardiest tree of the sub-arctic forest belt; it grows everywhere throughout the Labrador Peninsula, and is probably next in abundance to the black spruce. Throughout the interior it is found growing in all the cold swamps, and is always the largest tree in the vicinity. Along the northern margin of the forest, the larch continues as a tree to the very edge, where the black spruce is dwarfed to a mere shrub. The larch of the southern region has been almost totally destroyed by the ravages of the imported, European larch saw-fly *(Nematus Erichsonii).* The present range of this pest extends northward from Lake St. John to beyond Lake Mistassini, and appears to be yearly spreading northward and eastward, but has not yet reached the St. John or Romaine rivers flowing into the Gulf of St. Lawrence.

Destruction by saw-fly.

Forest areas of commercial value.

Areas of forest of sufficient size, with trees large enough for commercial purposes, are confined to the southern watershed and to the lower courses of the streams flowing into the Atlantic or Hudson Bay. It is very doubtful if such areas occur along these coasts to the north of latitude 54°. Much of the timber of the more southern regions is not of the best and would afford only spruce deals, while the greater part could hardly be profitably worked in competition with the western pine; but the time will probably come when the trees of the more favourable portions of Labrador will be profitably worked into lumber, especially if the smaller growths are cut at the same time for the manufacture of paper pulp.

Forest fires.

At least one half of the forest area of the interior has been totally destroyed by fire within the past twenty-five or thirty years. These fires are of annual occurrence and often burn throughout the entire summer, destroying thousands of square miles of valuable timber, to the south of the central watershed. The regions thus devastated remain barren for many years, especially towards the northern limits, and the second growth of black spruce, Banksian pine, aspen and white birch is never as good or as large as the original forest. These fires are due to various causes, but the majority of them can be traced to the Indians, who start them either through carelessness or intentionally. The Nascaupee Indians of the semi-barrens signal one another by smoke made by burning the white lichens that cover most of the ground in the interior, and these signals cause many of the fires. The southern Indians signal in a similar manner, but do not practice it to such an extent as their northern brethern, having found that they are rapidly destroying their hunting grounds. Careless camp fires in dry seasons are another common cause of these forest fires, and many of those ascribed to lightning, if closely traced

Causes of fires.

would be found to have been set by wandering Indians, who are only careful on their own hunting grounds. From what is seen on the explored routes of the southern watershed, it would appear that at least one half of the forest has been removed by this cause.

Great fire of 1870-71.

The greatest fire of modern times occurred in 1870 or 1871, and swept the country south of the height-of-land, from the St. Maurice to beyond the Romaine River. The second growth is just beginning to cover up the traces of this great conflagration, which ruined the pioneers of Lake St. John, and it will be years before the country is generally again well wooded. The upper Romaine river-valley has been totally burnt over within the last ten years, and the margin of this great burnt area has been extended southward during the summers of 1893 and 1894, so that now practically no green woods exist along the course of this river from the St. Lawrence to its source. The country surrounding the Hamilton River is in a similar state; except patches of original forest, along the lower part of the river-valley and about Hamilton Inlet, only blackened stumps or a small second growth are seen along its course, with an occasional oasis of large green wood to break the monotony. In this region great fires occur annually; that of 1893 covered hundreds of square miles of the table-land between the Hamilton and Northwest rivers. Similar remarks apply to the forests of the western watershed, more than half of which have been burnt.

Romaine River.

Hamilton River.

Willows.

Throughout the forest belt, the lowlands fringing the streams and lakes are covered with thickets of willows and alders. As the semi-barrens are approached, the areas covered by these shrubs become more extensive, and they not only form wide margins along the rivers and shores of the lakes, but with dwarf birches occupy much of the open glades. The willows and birches grow on the sides of the hills, above the tree line, where they form low thickets exceedingly difficult to pass through. Beyond the limits of the true forest, similar thickets of Arctic willows and birches are found on the low grounds, but on the more elevated lands they only grow a few inches above the surface. In the southern region, the undergrowth in the wooded areas is chiefly Labrador tea *(Ledum latifolium)* and "laurel" *(Kalmia glauca)*, which grow in tangled masses, from two to four feet high, and are very difficult to travel through. In the semi-barrens this undergrowth dies out, and travel across country is much easier in consequence. In the southern regions the ground is usually covered to a considerable depth with sphagnum, which northward of 51° is gradually replaced by the white lichens or reindeer mosses *(Cladonia)*, which grow freely everywhere throughout the semi-barren and barren regions.

Small fruits. The distribution of small fruits and berries is of some importance and may be recorded here, although they are included in the plant list of Appendix VI.

Cherry. *Prunus Pennsylvanica*, Linn. (Wild cherry) is found in burnt areas northward throughout the interior to about latitude 55°, where it grows in small bushes, rarely more than four feet high.

Bake-apple. *Rubus chamæmorus*, Linn. (Cloudberry, Bake-apple, Yellow-berry) is found in the swamps everywhere throughout Labrador to beyond the tree limit, and forms an important article of food for the Indians.

Arctic raspberry. *Rubus arcticus*, Linn. (Arctic raspberry, Dewberry, Eye-berry) grows in the opens, along the banks of northern streams, and is especially abundant on the islands along the east coast of Hudson Bay. It is a much larger fruit, and has a more delicate wine-flavour than the next species.

Dewberry. *Rubus triflorus*, Richards (Dewberry, Eye-berry) is found along the banks of streams and on the edge of woods northward from the St. Lawrence to about latitude 54°, where it occurs rarely on the banks of the upper Hamilton River and about Lake Nichicun.

Raspberry. *Rubus strigosus*, Michx. (Red raspberry) is limited to about the same range as the last species, being found in burnt woods as far north as latitude 54°.

Strawberry. *Fragaria Virginiana*, Duchesne (Wild strawberry) is not abundant in the interior, owing to the absence of grassy glades, or opens; it is only found on grassy banks, at the ends of well-used portages, or in the clearings about the Hudson's Bay Company's forts, as at Mistassini, Nichicun and the abandoned Fort Nascaupee, on the Hamilton River. Along the coast of Hudson Bay, it is found abundantly on the islands, to beyond Fort George, in latitude 54°.

Indian pear. *Amelanchier Canadensis*, Torr. and Gray (June-berry, Indian pear). Of this species both the *oblongifolia* and *oligocarpa* varieties are found, northward, to the Big and Hamilton rivers. The latter variety is most common, and is much inferior in fruit to the rarer variety. It grows in glades, generally in swampy ground. The first variety is confined to the burnt areas and hillsides.

Blueberries. Several species of *Vaccinium* are found abundantly throughout the peninsula, growing on the burnt districts of the south, and in the open country of the semi-barren and barren lands.

Vaccinium Pennsylvanicum, Gray (Blueberry), is very abundant throughout the southern region, where it grows profusely on the extensive burnt lands, as far north as the East Main and Hamilton rivers, and is abundant at Nichicun, where the fruit is often destroyed by summer frosts. It was found abundantly along the Koksoak River, nearly to the Stillwater Branch. On the Atlantic coast, it has been found northward to the vicinity of Nain, while on the Hudson Bay coast, it reaches nearly to the Great Whale River. Its fruit is used largely by the Indians, who during the later summer months subsist largely upon it. It is eaten both raw and in the form of jam, and, mixed with a small proportion of flour, it is made into bread or cake.

Vaccinium uliginosum, Linn. (Duck-berry) is a more northern form, which, on the edge of the semi-barrens, largely replaces the last mentioned species. In the southern portions of the peninsula, it is only occasionally found on the banks and islands of the rivers. In the vicinity of the Hamilton and Big rivers, and northward, it is found growing profusely in the open spaces, along with *V. Pennsylvanicum*, and continues northward into the barren grounds, where it occurs as a small spreading shrub, growing only two or three inches high. The fruit of this species is more acid and firmer than the southern blueberry, and is not as pleasant to the taste, especially when cooked, having then a disagreeable flavour. It is also an important article of food to the Indians and Eskimo. Duck-berry.

Vaccinium cæspitosum, Michx., is a more northern variety than the last, being found on the summits of the higher hills about the headwaters of the Hamilton River. It continues abundant to beyond the mouth of the Koksoak River.

Vaccinium Vitis-Idæa, Linn. (Cranberry, Pomme de terre) is the most important berry of the northern half of Labrador. South of latitude 51°, it is found only on the summits of barren rocky hills, or on barren islands in the larger lakes; but to the northward, as the open barren spaces increase, it soon becomes abundant, and about the Hamilton and Big rivers is very plentiful everywhere, growing on the low ridges of drift as well as on the rocky hills. It continues to be abundant to the northward of the Koksoak River. Owing to the lasting qualities of the fruit and its improvement by frost, large quantities are gathered annually by the inhabitants, before the ground is covered with snow, for use during the long winter, throughout which the berries keep perfectly, and counteract the ill effects of the constant meat diet of the Indians and other inhabitants. The fruit is found in perfection, immediately after the disappearance of the snow in the spring, and continues good for several weeks, until the juices are dried up by the sun. Cranberry.

Crow-berry.

Empetrum nigrum, Linn. (Crowberry) is abundant throughout the semi-barren and barren regions of the peninsula, growing freely on the coast and inland. Where the various species of *Vaccinium* are absent, its fruit is eaten by the natives; but, as it is watery and not well flavoured, it is not esteemed as highly as the other berries. It is a favourite food of the curlew, and is eaten by geese in the early spring.

List of plants.

The lists of plants contained in Appendix VI. show the distribution of the flora of the Labrador Peninsula, including different areas of the interior where collections have been made, and also the Atlantic and Hudson Bay coasts.

Population.

Inhabitants.

With the exception of the white settlements along the north shore of the Gulf of St. Lawrence and on the Atlantic coast, and the few whites employed by the Hudson's Bay Company in the interior and on Hudson Bay, the inhabitants of the Labrador Peninsula are either Indians or Eskimo.

Difficulty in making a census.

It is very difficult to arrive at more than a rough approximation of the numbers of Indians inhabiting the interior, owing to their habits of roving from one Company's post to another; and the consequent liability to counting the same family several times, if the returns are computed from the books of the various posts, which is the only available data for any exact enumeration.

Number of Indians.

From the returns given in the reports of the Department of Indian Affairs, the Indians of the Gulf of St. Lawrence, including those of Lake St. John, numbered 1919 in 1888, and 1725 in 1893. These figures exclude 2860, under the heading of the "Nascopies of the Lower St. Lawrence," which number is the same in both returns. According to the same source, the number of Indians of Eastern Rupert Land is 4016; that of the Labrador (Canadian Interior) 1000, and that of the Atlantic coast 4000. The last probably refers to the Eskimo, but is not so stated. These returns would give a total native population of more than 13,000 persons, if the Indians of Eastern Rupert Land are those of the east coast of Hudson Bay.

In Appendix II., page 336, of the report of the Committee on the Hudson's Bay Company (1857), a return of the native population is given, compiled by the Hudson's Bay Company and others. The total number of natives trading at, and belonging to, the various posts in the Labrador Peninsula is given as 3885 persons; and this estimate, although probably somewhat high, is still much nearer to the native

Indian population than that given above. The population of the St. Lawrence coast is given as 1800 persons, which agrees closely with the Department of Indian Affairs returns for the years 1888 and 1893.* Of the remainder, 400 belonged to posts on the Atlantic coast, where probably a number of Eskimo are included, 950 belonged to the posts of the east coast of Hudson Bay, and the balance, 735, were attached to the posts of the interior. Since this return was made, the food resources and other conditions have changed considerably, and with them the distribution of the Indians.

Changes in population.

In 1857, there were seven trading posts in the interior of the peninsula, and at present there are but three, Waswanipi, Mistassini and Nichicun. Fort Chimo, near the mouth of the Koksoak River was not then opened. The policy of the Hudson's Bay Company was then to keep the Indians away from the coast and contact with opposition traders; this has now been changed, and the great body of the natives travel annually to and from their hunting grounds in the interior, to the various coast posts. In consequence, instead of 735 persons belonging to inland posts, at present there are not above 300 attached to these posts. The number of Indians trading at Northwest River and Davis Inlet, on the Atlantic coast, is about 200 persons. At Fort Chimo the famine of 1892-93 reduced the number of Indians in that district from 350 to less than 200 persons. Connected with the posts at Great Whale River, Fort George and Rupert House, on Hudson Bay, the total number of Indians does not exceed 1000 persons, and probably falls considerably short of that number, so that at the highest estimate the Indian population of the Labrador Peninsula does not exceed 3500, and is more likely nearer 3000.

Number of Eskimo.

The Eskimo inhabit the coast of the peninsula from Hamilton Inlet northward along the Atlantic coast to Hudson Strait, the east shore of Hudson Bay as far south as Great Whale River, while a few families live on the islands of James Bay. From the meagre returns available, only an approximate statement of their numbers can be compiled. In the census of Newfoundland (1891), the Eskimo are not separated from the white population of the Labrador coast; but, as the number of resident whites is not above 100 persons north of Hamilton Inlet, and as the Eskimo form about one-half the population of that place, from a total of 1191 persons there, and along the coast north of Hamilton Inlet, between 900 and 1000 may be taken as Eskimo. The following estimate of the Eskimo population living on Hudson

*The census return for 1891 gives a total of 1387 Indians belonging to the posts along the north shore of the St. Lawrence, to the eastward, and exclusive of, the Saguenay.

Strait and the east coast of Hudson Bay was supplied by Mr. R. Gray, who was for upwards of ten years clerk at Fort Chimo, and is well acquainted with the Eskimo of Ungava Bay:—From Cape Chidley to Hope's Advance, 51 families; about Hope's Advance, 30 families; from Stupart Bay to Cape Wolstenholme, 80 families; from Cape Wolstenholme to Great Whale River, 80 families. The average Eskimo family is small and rarely exceeds five persons. Taking this as the average, the total population to the west of Cape Chidley would be 1200 persons. This estimate is probably excessive, and 1000 persons would be nearer the number, if not still above it. According to the Newfoundland census of 1891, the total population of the Labrador coast between Blanc Sablon and Cape Chidley is 4106, including the Eskimo already referred to. Subtracting the 1000 Eskimo would leave a resident white population of 3106 greatly increased during the summer months by fishermen from Newfoundland. In 1890, 10,430 men, 2076 women and 828 children from Newfoundland were so engaged, in 854 vessels.

Whites on Labrador coast.

According to the Canadian census (1891), there is a white population of 5728, scattered along the north shore of the Gulf of St. Lawrence, to the eastward, and exclusive of those living about the mouth of the Saguenay River, who number 2440.

Total population.

To sum up, taking 3500 Indians, 2000 Eskimo and 8800 whites, the total population of the Labrador Peninsula is 14,300, or, roughly, one person to every thirty-five square miles.

The white population along the gulf coast consists largely of French Canadians who obtain a livelihood chiefly from the fisheries, with slight help from fur hunting during the winter. On the Atlantic coast the whites, northward from the Strait of Belle Isle to Sandwich Bay, are largely English speaking, and are either immigrants from Newfoundland, or the descendants of English fishermen formerly engaged in the salmon fishery. Northward of Sandwich Bay, the white inhabitants are, for the most part, descended from Hudson's Bay Company servants, who married Eskimo women and remained on the coast after their services had expired. They are known along the coast as "planters," and gain a fairly comfortable living from the cod and salmon fishery in the summer, and by fur hunting during the winter. They are all deeply in debt to the Hudson's Bay Company and Newfoundland fishing firms for supplies advanced. Having no capital of their own, they are compelled every spring, in order to carry on their fishing, to obtain supplies and nets from the merchants. If the season is favourable, they may be able to pay off their

"Planters."

debts at its close; but, as a rule, of late years they have been going deeper and deeper into debt, owing to the scarcity of fish along the coast where they are accustomed to make their fisheries. The natives ascribe the failure of the fishery to the numerous trap-nets now used along the coast by fishermen employed by the Newfoundland merchants. The use of these nets is said to be contrary to the law of Newfoundland, but, as there is no strict government patrol of the Labrador coast, the law is practically inoperative.

Winter quarters.

At the close of the fishery, the greater number of the "planters" leave their small houses on the coast, and proceeding to the heads of the various bays, go into winter quarters in their small houses there. During the winter they are engaged hunting fur-bearing animals. These also are not so plentiful as formerly, owing probably, to the large areas burnt over, either from fires accidentally made, or set on purpose by the owners of schooners, who often fire the country along shore, so as to easily make dry firewood for future seasons.

Fur hunting.

Each "planter" has a "path," or line of traps, often extending fifty miles or more inland, and as these paths cannot be covered in one day, he has small "shacks," or log houses, at convenient intervals along them, where he can pass the night with some degree of comfort. Some of the paths are so long that they require a week to go over and attend to the traps on the way.

Seal hunting.

During the months of April and May the planters and Eskimo are engaged at the seal hunt. They kill these animals on the ice of the upper part of the inlets, by watching at their holes or cracks, and spearing them when they come to breathe or sun themselves. Formerly the takes were large, but of late years they have been so small that many are abandoning the hunt. As soon as the ice leaves the bays, seals are taken in nets set along shore. The seals are used principally for local consumption, although some skins and a small quantity of oil are exported. The skins are used for outer winter clothing and other domestic purposes, while the fat and meat are preserved for dog food; for, as each "planter" has a team of dogs, varying in number from two to six, and as the Hudson's Bay Company keep a large number of dogs, a great quantity of seal meat is required.

Notwithstanding the decrease in the fishery, furs and seals, the planters make a much better living than many of the poorer people in cities; and, if they were to exert themselves more, and were more thrifty, they might make a comfortable and independent living. As it is, with a reasonable amount of care, thought and labour, they can procure sufficient provisions to keep their families well fed, as in the

Food supply.

fall, after the close of the commercial fishery, they can obtain an abundance of brook trout, that swarm at the mouths of all the streams flowing into the sea. At this time, spruce partridges are very plentiful on their migration from the coast inland, while, later, ptarmigan and rabbits are generally abundant. The proceeds of their fishery would easily provide them with flour and provisions, while all living inland might raise a small crop of potatoes; then, the proceeds of their winter's hunt would, in most cases, be ample to supply clothes for a year, and leave a surplus. This is, unfortunately, not the case, and a number of families are often without sufficient food and clothing every year.

Missionaries.

For the spiritual benefit of the whites, the Methodist church of Newfoundland has a mission station opposite Rigolet, in charge of the Rev. Mr. Pollock, who resides there a part of the time; the rest of his time being taken up with house to house visitations to the planters. As his district extends to and includes Sandwich Bay, one hundred miles to the south, where there is a large settlement, the time devoted to each family is small. The Episcopal church has a mission school at Sandwich Bay, in charge of Mr. L. Dicks, who also travels from house to house, instructing the children.

Education.

In spite of lack of educational advantages, nearly everybody can read and write, and all are very religious. As alcoholic liquors are not openly sold on the Labrador coast, cases of intoxication are exceedingly rare, and many of the younger people do not know the taste of alcohol. On the whole, these people compare favourably with those of more civilized regions, being frugal, moral, willing, good tempered, and naturally intelligent; their only fault, want of thrift and providence, is largely due to their mode of living, absence from any market of competitive labour, and the system of credit and debt under which they live.

Tribes of Indians.

The Indians of the Labrador Peninsula belong to tribes of the Algonkin family. The principal tribes of Labrador are the Montagnais, the eastern and western Nascaupees, and the coastal Indians of Hudson Bay. The Montagnais inhabit the country extending south of a line drawn westward from Hamilton Inlet, to the headwaters of the St. Maurice River. The Nascaupees inhabit the interior country north of this line, or from the bottom of James Bay eastward to Hamilton Inlet. The northern limit of their territory is marked by the Koksoak River, from its mouth to the Stillwater Branch, and by this stream westward to its head on the neighbourhood of Clearwater Lake, and thence westward to Richmond Gulf on Hudson Bay. This line divides the Indian territory from that of the Eskimo, and the boundary is well observed, the latter keeping far to the north of it, when hunting deer inland, and the Indians rarely crossing it from the southward.

The coastal Indians of Hudson Bay are confined to a narrow margin extending from the bottom of James Bay to Little Whale River, along the east coast.

Close relation of different tribes.

The various tribes are closely related by intermarriage, and, although using different dialects, have many manners and customs in common. The northern Indians have apparently migrated to their present territory, from a south-west direction, as their language contains many words of the Sauteaux or Ojibway tongue; whereas the southern Indians speak purer Cree. The Nascaupees have traditions that their people originally dwelt far to the south, on the north side of a great river, with the sea to the eastward. They were driven northward by the Iroquois during the wars of the early French régime in Canada. Such was the terror inspired by the Iroquois, who followed them beyond the southern watershed to the shores of Hudson Bay, and eastward along the St. Lawrence to the Natashquan River, that at present they use their name to frighten the children. The writer had two Iroquois as canoemen on the Big and Great Whale rivers, and could only with great difficulty, induce the native Indians to accompany him inland along with their traditional foes and conquerors. There are several places between Hudson Bay and the Lower St. Lawrence, where great massacres of the natives were perpetrated by the Iroquois.

Fear of the Iroquois.

Montagnais.

The Montagnais are more or less of mixed blood, having intermarried with the old *coureurs des bois* and the French and English traders. This admixture of white blood is seen in the better physique of the tribe, the men being more muscular and broader than the pure Indian of the interior. As a rule, the men are of medium height, but a few are tall. The women are inclined to obesity as they advance in years, like their sisters of the northern tribes. The western Nascaupees are, as a rule, the tallest men in Labrador, many of them being six feet and over in height, straight and of light physique. The eastern Nascaupees are usually not above five feet six inches tall, slightly built and not at all muscular, being incapable of carrying half the loads of the Montagnais. They are also the dirtiest and most degraded Indians of Labrador. The coastal Indians have apparently a large admixture of white blood, as many of them have blue eyes and the men as a rule have strong beards. They bear in figure and face a certain resemblance to their northern neighbours the Eskimo, being heavily built and unlike the typical Indian. The admixture of white blood would account for this difference of physique, and it may also have

Nascaupees.

Coastal Indians.

been induced by their living along the sea coast. Their resemblance to the Eskimo is not likely due to a blood relationship, as the Indians and Eskimo never take wives from one another, nor have sexual intercourse together.

Very little is known definitely about the philology and ethnology of the Indians, and the present account is only from desultory information picked up among them by the writer.

Language.

The language, as before stated, is various dialects of Cree, or a mixture of Cree and Ojibway. The dialects are more numerous than those of the four tribes given above. The Montagnais of Lake St. John speak a somewhat different dialect from that of Bersimis, and it again differs from the dialects of Mingan or Northwest River. These differences of dialect in the same tribe are slight, and are mostly in the slang and interjections. The same differences apply to the dialects of the Nascaupee, Mistassini and Nichicun, differing from that of Fort Chimo, and all from that of Whale River and Rupert House. But these differences are all so small that the Montagnais canoemen conversed readily with the natives at Mistassini, Nichicun, Fort Chimo and Northwest River, and were only slightly puzzled on the coast of Hudson Bay, where the number of Ojibway words is greater. A large majority of the Indians of Labrador are Christians, the Montagnais of the St. Lawrence and Hamilton Inlet being Roman Catholics, while the Indians of the western watershed have been converted by the missionaries of the Church of England. Only the eastern Nascaupees are pagans, and most of them have a faint tinge of Christianity, imparted on hurried visits by the Roman Catholic missionaries, between Hamilton Inlet and Ungava Bay. The christianized Indians are devoutly religious, attending strictly to the offices of the church during the long periods of absence from the eye of the missionary. While in the woods, they keep track of the weeks, ticking the days off on a rough calendar. They do not work on Sunday, and observe the fast days. Notwithstanding their careful observance of the offices, their religion is to a considerable extent leavened with old pagan superstitions, and a sneaking regard is still held for the windago and other evil spirits of their forefathers. It is almost laughable to see the respect with which the most religious of them treat the well-known conjurors or medicine men of the pagan Nascaupees; and they all secretly believe that these persons can, if they wish, work harm by the aid of evil spirits. All the Christian Indians can read and write, those instructed by the English missionaries using a kind of syllabic shorthand, while those under the French missionaries make use of books printed in the ordinary way.

Religion.

Conjurors.

Education.

Dishonesty and theft are unknown to the interior Indians; provisions and outfit can be left anywhere inland with perfect safety for any length of time. Only in a case of absolute starvation will provisions be taken, and then only a small part, for which payment will be left by the person taking them. It is to be regretted that along the coasts, where the Indians are in close communication with the whites, their honesty suffers, and a good lookout must be kept, or property will be stolen. Honesty.

As a rule, the Indians have not a strict regard for the truth, and speak it only when convenient. The missionaries have improved the moral and sexual relations of the Indians, but there is still room for improvement in the latter respect. Marriages are made early, the men taking wives as soon as they can support them, and the women being given in marriage when they are fourteen or fifteen years old. Among the Christian Indians monogamy is practised, and the marriage ceremony is performed by the missionaries, or, in their absence, by the officers of the Hudson's Bay Company. Among the pagan Indians many of the men have two wives, and some three or four, according to the number they can support by their hunt. Continence is not usual. Widows are in great demand in marriage, and often a young boy is mated to a woman old enough to be his mother. As a widow inherits her dead husband's hunting grounds, a marriage with her provides the second husband with hunting grounds as well as a wife, and in consequence widows are taken by young men without lands. The respect shown by children to parents is great, and the will of the aged father is law, even with middle-aged sons, who will not enter into any serious undertaking without first consulting the head of the family. Children are never beaten, but soon learn to obey without punishment. As a rule, the number of children borne by the women is small, rarely exceeding five. The women become wrinkled and old before they are forty years of age; after which they often live for many years. The men show the effects of age much less than the women, and it is exceedingly difficult to tell their exact age between 50 and 70 years, as the hair rarely turns grey. The greatest mortality is due to pulmonary diseases, which are induced by exposure to cold and wet, with no covering on the feet but deerskin moccasins, which soak like blotting-paper. "Lame back" incapacitates a number of the men, and is probably due to disease of the kidneys. Complaints of the stomach are also the cause of many deaths, owing to the weakening of that organ by alternate periods of starvation and gormandizing. Scrofulous sores and ulcers are not uncommon, and appear to be inherited. Morals. Marriage. Children. Disease.

Burial.

The dead throughout Labrador are buried in the ground, and, only when death takes place during the winter, is the body placed in a tree until the frost is out of the ground. The clothing, gun and other articles belonging to the deceased are often buried with him, or placed on the grave, when the burial takes place in the woods, and no Indian would touch anything so left, or camp near one of these lonely graves. The dead are mourned for according to the position they occupied, and the grief displayed is deep and sincere. A curious custom was noted in the interior, on the arrival of the various families at the posts in the spring—instead of joyous greetings the women clasp one another and indulge in a period of silent weeping, after which they cheer up and exchange gossip.

Mode of living.

The annual routine of an Indian life is made up of two periods, the short period, from one to three months, spent during the summer at the coast, and the long period passed inland. Those who trade at the inland posts, are engaged throughout the summer transporting to Hudson Bay the fur hunt of the past winter and bringing back the supplies to form the next season's outfit. The amount of supplies is so great and the number of men at these posts is so small, that every one capable of working is enlisted, including half-grown boys and old men. As most of the women and children accompany the brigades of large canoes, in their small canoes, the journey practically amounts to a co-operative scheme of bringing in supplies, and differs only in this respect from the annual visit to the coast of the independent families. The only Indians who do not come in contact with the white traders during the summer, are some eighteen families who reside on the shores of a large lake about two hundred miles above the mouth of the George River. These Indians never visit the coast during the summer, and their only communication with the white traders is during the early spring, when the younger men tramp to Davis Inlet on the Atlantic coast, and there trade their furs for tea, tobacco and ammunition. They do not buy clothing or provisions, and haul their purchases home on long narrow toboggans over the crusted snow. This little tribe of Indians carries on a small trade in the above mentioned articles with the other neighbouring Indians of the interior. As they reside in a district plentifully supplied with caribou, they depend upon these animals both for food and clothing, and are thus practically independent of the traders.

Annual visit to the coast.

The majority of the Indians who go to the coast, congregate at convenient centres in bands of six or more families, and in company descend the rivers in their small bark canoes. The time of the spring gathering is shortly after the ice leaves the rivers, when the fur of the otter becomes "common." Each family carries with it the packs of furs obtained during the winter, together with most of their movable property. Those living farthest inland are often more than two weeks in descending to the post, owing to the long and difficult "roads" they have to follow. On arrival at the coast, the fur-packs are handed over to the trader with whom the Indian deals, and a valuation being set upon them, the Indian is allowed credit for the value computed in "skins" or "beavers," which are the units of value in the trade—the price of the different furs being reckoned in comparison with a medium sized beaver skin, and the traders' supplies are valued in the same manner. On the St. Lawrence coast this system of barter is falling into disuse, and cash is taking the place of the old beaver as a medium of exchange. The summer season at the posts is passed in visiting friends and in a round of gaiety. Very few of the Indians have been induced to cultivate land on their own account, although they sometimes work in the gardens of the traders and missionaries. The only work that they willingly undertake is in canoes, either attending fishing parties or transporting provisions inland. During the summer season a majority live in small cotton tents, but some of the most successful hunters own small log houses, in which they pass the summer. During the month of August, preparations are made for the journey to winter quarters, and by the end of that month most of the Indians leave the various posts.

Fur trade.

Summer life.

Owing to the extermination of the caribou in many parts of the country and to an insufficiency of other game, the greater number of the Indians are now obliged to purchase a considerable quantity of flour, and carry it inland to their hunting grounds.

So much provisions, along with other outfit, are now taken by the southern Indians that they have to make two or three trips with their canoes at starting, and often they are more than two months in reaching their winter quarters. In former years, the Hudson's Bay Company and other traders annually advanced the Indians sufficient provisions and outfit to carry on their winter's hunt, and recouped themselves in the following spring. At present, to a great extent, this system of advances has been abandoned, and the Indian only gets such outfit and provisions as he can pay for in cash or fur. The change is due largely to the losses entailed by close competition, and to the dishonest practices of many of the Indians, who instead of delivering their fur to the persons who advanced to them, take it to rival traders and exchange it for cash or other articles—leaving their debts unpaid. The change is consequently justifiable where there is competition in the fur trade, but bears heavily on the Indian, who is naturally improvident

Transport of supplies.

Change in system of trade.

Its relation to the Indian.

and spends the proceed of his annual hunt as soon as he gets it, without thought or care. In consequence, when the hunt is a failure, which is often the case through no fault of the hunter, the poor Indian has little or nothing to buy his outfit with, and departs to the woods improperly supplied. To this cause is due much of the hardship, starvation and death reported among the Indians of the Labrador Peninsula during the past few years. With the exception of the eastern Nascaupees, all the Indians now dress in clothing procured from the trading shops, and many of the southern Indians, having acquired a taste for luxuries of civilization unknown to their fathers, must make large hunts in order to gratify these tastes.

Hunting grounds.

Each family is supposed to own a portion of territory with the exclusive hunting rights to it. The territory is generally divided into three parts, each part being hunted over in successive years, and in this manner the fur-bearing animals are allowed to recuperate. In the southern country extensive fires, too close hunting, and other causes are rapidly exterminating the animals, and the families owning these grounds, in order to obtain a living, are obliged to encroach upon their northern neighbours. As the intruders care little or nothing about keeping up the stock on these lands, the result is most disastrous, and in a few years, if strict laws are not enacted, the fur-bearing animals of the province of Quebec will be practically exterminated, and the Indians, thus left without their only means of subsistence, will be reduced to beggary, or will die off from famine.

Extermination of fur-bearing animals.

Winter tent.

As soon as the hunting grounds are reached and the cold weather begins, the cotton tent is exchanged for the wigwam or "metswap," which is constructed by removing the snow from a circle ten or twelve feet in diameter, about the circumference of which poles six or eight inches apart are planted sloping inwards so as to form a skeleton cone. This cone is covered with cotton cloths, sheets of birch bark, or dressed deer skin, often in part by all three, and a space is left at the top about two feet in diameter for the escape of the smoke. The removal of a pole leaves the space for a door, which is generally closed with an old flour-sack split open, and bound to sticks at the ends to keep it spread out. The bottom of the tent is banked up with snow on the outside, while a thick bed of green boughs is laid over the floor. The fire is built on a few stones in the centre, raised slightly above the ground. Many of the southern Indians have small stoves made out of sheet-iron instead of open fires, and thus avoid the constant smoke which fills the interior, especially when the door is frequently opened.

Before the lakes and streams freeze up, hunting is largely carried on with the gun, the Indians shooting from their canoes beaver, otter, mink and muskrats, and in the burnt areas, where blueberries are plentiful, bears. The northern Indians at this time are engaged in their principal caribou hunt, killing great numbers by spearing them in the rivers, as they pass on their annual migrations. After the rivers are frozen, most of the fur hunt is made with traps; these are either steel traps or dead-falls of wood. The principal animals taken during the early winter are marten, fox and lynx. During the intense cold of December, January and February, the wild animals move about very little and hunting is unprofitable. During this period the Indians do not hunt unless compelled to do so by hunger. In the month of March, the martens are once more travelling, and continue to constitute the principal hunt until the small streams begin to break up, when attention is given to the beaver and otter and, later on, to the bear. In this manner the winter routine is carried out, with the intervals mostly filled in looking for food. Ptarmigan and Canada grouse are killed during the winter, along with rabbits, which are periodically plentiful, while fish, ducks and geese aid in stocking the larder in the spring and fall.

Autumn hun

Winter hunt.

Spring hunt.

When the St. Lawrence was first discovered, the Eskimo inhabited the north shore of the gulf as far west as Mingan. They maintained their position here until 1600, when the Indians, having procured firearms from the French, waged unequal war on their old enemies and drove them eastward to the Strait of Belle Isle, where the Eskimo maintained a fortified camp on an island near the western end of the strait until 1630. Since then, a gradual retreat has been made northward, and their present southern limit is Hamilton Inlet, which appears to have long been the head quarters of the southern Eskimo, and is named Eskimo Bay on all the older maps. From here these people are scattered along the northern coast to Hudson Strait. Several large settlements are found at the Moravian Mission stations of Hopedale, Zoar, Nain, Okak and Ramah on the Atlantic coast. There are very few families between Nachvak and George River in Ungava Bay, the coast being high, desolate and unfit to sustain a large population. The Eskimo are more numerous along the west coast of Ungava Bay and Hudson Strait, and are found along the east coast of Hudson Bay, and among the outer islands of that coast, as far south as Great Whale River. Of late years, some three or four families have hunted on the islands in James Bay.

Eskimo along the St. Lawrence.

Moravian Mission stations.

Turner* divides the Eskimo inhabiting the coasts of the Labrador Peninsula into three or four sub-divisions, on account of sub-tribal dis-

Tribes of Eskimo.

* Annual Report U. S. Bureau of Ethnology, 1889-90.—Ethnology of the Ungava District, Hudson Bay Territory, Lucien M. Turner.

tinctions maintained among themselves. The names given to these tribes, by Turner, are those used by the Eskimo of Ungava Bay. The first sub-division includes all those dwelling along the Atlantic coast and along the south shore of Hudson Strait to the mouth of the Leaf River, a few miles northward of the mouth of the Koksoak River. These people call themselves Suhinimyut, "those who dwell at or in the sun," or the dwellers in the east. The second sub-division embraces the Eskimo dwelling along the south shore of Hudson Strait, between Leaf River and Cape Wolstenholme, at the entrance to Hudson Bay. These people are called the Tahagmyut, "dwellers in the shade," or the western people. By the Hudson's Bay Company they are known as "Northerners." The third sub-division includes those living along the east coast of Hudson Bay, and they are designated the Itivimyut, or "the dwellers on the other side." A fourth division may be made of the Eskimo of the outer islands of Hudson Bay, who, according to the traders and missionaries, differ from their neighbours along the coast, both in language and customs. They are known as the Kigiktagmyut, or "Island people." Along the Atlantic coast, as far north as Hopedale, few or none of the Eskimo are pure blooded. To the northward the Moravian missionaries keep the natives from contact with the whites, and in consequence there are very few of mixed blood. In Ungava Bay and on Hudson Bay there are, around the Hudson's Bay posts, many half-breeds, the result of marriage between the employees and Eskimo women.

Improvement by missionaries.

The natives along the Atlantic coast, from Hopedale to Nachvak, have long been under the direct influence of the Moravian missionaries, and, in consequence, have abandoned many of their ancient customs. Polygamy is no longer tolerated among them; in many cases they conform with a fair standard of civilization, and are quite religious, although very superstitious.

On the coast of Hudson Bay, mainly through the endeavours of the Rev. Mr. Peck, of the Church Mission Society, most of the Eskimo have been converted to Christianity. On this coast the missionaries do not reside constantly among the natives, and in consequence these people are very liable to relapse, during their absence, into some of their former pagan habits. The Eskimo of Hudson Strait have not yet been brought under the influences of Christianity, and afford a better chance for the study of their native customs and traits.

Physique.

It is customary to think of the Eskimo as considerably below the stature of the average European. This is not the case with those inhabiting the coasts of Labrador. The males, as a rule, are quite as tall as the average white man, but owing to their broad, heavy build, they appear shorter than they really are; and this appearance is enhanced by their wide garments of hairy deer or seal skins. Where seen by the writer on Hudson Bay, and at Fort Chimo, George River, Nachvak, Davis Inlet and Hamilton Inlet, several of the men at each place were six feet and upwards in height, the average height being about five feet six inches. The women, as a rule, are short and stout, and look in their native dress of deer-skin coat, trousers and long seal boots, much shorter than they actually are.

Temperament. The temperament of the Eskimo differs much from that of the Indian, the former being jovial, good-natured and very industrious. They are good workers with tools, and on the Hudson Bay coast the blacksmiths confess that the natives, without the use of a forge, can work and temper iron better than they can. These people, living as they do on the coast, depend largely upon marine animals for food and clothing. (Food.) Their principal food is seal meat, together with porpoise, whale meat and fish. They also kill many caribou, to the north of the Koksoak River. For this purpose, they travel inland from the coast, but the pursuit of this animal is chiefly for its skin, used in clothing. The hunters quickly tire of the flesh, it being not fat enough to suit their taste. During the winter, they hunt fur, to purchase what supplies they may need from the traders. The principal furs taken by them are red, cross, black, white and blue foxes, white bears, wolves and wolverines, besides deer and seals. The Eskimo have not as many civilized wants as the Indians, the principal articles of trade taken in exchange for their furs being ammunition, tobacco, knives and iron, tea, sugar and needles. (Trade.) They do not buy much flour or biscuit, and very little European clothing.

Habitations. With the exception of the Atlantic coast Eskimo, who live about the mission stations in small log houses, the summer camp is made much like an Indian wigwam, save that it has a ridge-pole, and is covered with seal-skins. During the winter, small circular snow houses are used. For travel during the summer, two kinds of boats are used, the kaiak or men's boat is long and narrow, and formed of a wooden frame covered with seal-skins, leaving only a small circular opening large enough to admit the body of a man. The bow is long and pointed and projects above the water forward, the stern is fuller, and much lower and rounder. (Boats.) This craft is for one man, who propels it with a double-bladed paddle, and it is used for hunting. In these small boats the islanders of Hudson Bay frequently cross some fifty miles of open water to the mainland.

The umiak or women's boat is much larger, and like the former is made from seal-skins stretched on a wooden frame. In shape and size it resembles a deep, flat-bottomed punt, and is capable of carrying the heavy seal-skin tent and all the other belongings of a family, when moving from one place to another. In winter, dogs and sleds are used to travel with, the Eskimo not being nearly as good a walker as the Indian. The sleds are made of two runners of wood, from nine to eighteen feet long, held in position, from eighteen to twenty-four inches apart, by numerous cross pieces. The sled is shod during the cold winter months with walrus ivory or whalebone attached to the runners with wooden pegs, or else the bottom of the runner is coated with vegetable mould, which is frozen on and then shaped with a knife or plane so as to resemble the head of a large T rail, both in shape and size. This is coated with a thin skin of ice and answers admirably during the cold unbroken winter. In the spring time, runners of hoop-iron are preferred. During the winter, cooking is carried on in the snow houses over soapstone lamps in the form of a shallow triangular dish, about fifteen inches long and eight inches wide. These dishes are nearly filled with seal oil, and the wick is formed of dry moss placed round the sides. Formerly soapstone kettles were used for cooking, but these are almost entirely superseded by tin or copper kettles purchased from the Hudson's Bay Company.

Sleds.

Cooking utensils.

Disease.

The habits of the uncivilized Eskimo are far from cleanly, and they appear to have a decided objection to the use of water except for drinking purposes. In consequence, the principal diseases from which they suffer arise from their filthy habits and the close vitiated atmosphere in their tightly closed houses, laden with the odours of decomposing animal food and other filth. Over half the Eskimo die of pulmonary troubles due to these causes and to exposure. Many suffer and die from scurvy, caused by devitalized blood and their excessively fatty food while remaining sedentary during the winter. As a rule, monogamy is practised, although many of the better hunters among the unchristianized natives have two and some three or four wives. The women are married early, generally at about fourteen or fifteen years and often before that age, and these early marriages result in few and weakly children. The marriage ceremony is very simple. The consent of the parents or other relatives of the girl is obtained by presents or favour, and, if the girl is favourable to the union, she goes with her husband. When the girl refuses, she is soon coerced by her relatives. The marriage tie is easily broken, and it is seldom that a man lives with a woman for a number of years. Jealousy, resulting from a laxity of morals or incompatibility of temper, dissolves the marriage without ceremony, the woman returning to her relations

Marriage.

until taken by another man. The family is usually of two or three children, although there are sometimes eight or ten, but many die in childhood. Like the Indians, the Eskimo never inflict corporal punishment on their children, who without it early learn, however, to obey and respect their elders. Children.

The dead are placed in a sitting position, with the knees drawn tightly up, and the whole body covered with seal-skin or deer-skin. The body is placed in this manner on the bare rock, and is covered with stones to prevent the birds and animals getting at it.

Like the Indians, they believe in a future state, where the spiritual conditions closely resemble those of the material world. As every object is endowed with a spirit, clothing, spears, gun, kaiak and other articles, are deposited near the grave, so that the departed may use the spirits of these articles, in his new existence separated from the body. The spirits of material objects are supposed to be released as soon as they decay and if they are found removed, it is said, that the spirit of the dead has taken them for use in the spiritual world. All objects animate or inanimate, have both a material and a spiritual existence; and there are other spirits, mostly of a malignant character, which can be appeased by gifts. Beliefs.

It is easy to understand that, holding such beliefs, they highly esteem, fear and respect the conjurers, whom they suppose to have power over the various spirits, including those that cause disease and death. The conjurers also claim to influence the movements of the deer and other animals, and are supposed to control the weather. Unlike the Indian conjurer, who performs his incantations concealed in a small tent, his Eskimo confrère invokes and exorcises the malignant spirits openly, or with only his head covered up. Conjurors. Some of the Eskimo while away the time during winter, by making rude carvings out of walrus tusk or bear teeth. The carvings represent various birds and animals, or models of their boats, sleds, or implements. Some of the carvings show considerable skill and artistic taste, especially those made under the direction of the Moravian missionaries. Art.

The Eskimo are very fond of singing, instrumental music and dancing, and readily learn to play the violin. At Hopedale and Nain the natives have orchestral music to accompany part singing in the church services, and many of the Eskimo of the Atlantic coast play second parts on the violin, showing that they have a fair idea of harmony. Music.

FISHERIES.

In the appendices at the end of the present report will be found lists and short notes on the mammals, birds and fishes of the interior of the

Labrador Peninsula, and it remains only to remark here on the value of the inland fisheries. The numerous large lakes of the several watersheds, and most of the rivers, especially those flowing north and east, are stocked with an inexhaustible supply of food fishes of large size and superior quality, including among other species the lake and brook trout, land-locked and sea-run salmon, whitefish, pike, pickerel, suckers and ling or freshwater cod. Along the southern, eastern and northern coasts, the cod is taken in large quantities as far as Ungava Bay, which is the present limit where trial has been made for taking this fish. Salmon are found plentifully along the coasts as far as the west side of Ungava Bay, which appears to be the western limit of the Atlantic salmon. Very little is known officially or otherwise concerning the fisheries of that great inland sea, Hudson Bay, and a great amount of wealth may be lying dormant in its waters from lack of knowledge concerning its fisheries. As regards the inland fisheries, owing to the distance from available routes to a market, they will probably never be used to their full extent, and even the best situated lakes will not be fished for many years to come, or until railways are built through the interior. Three large lakes of the interior are known to contain considerable numbers of harbour seals (*Phoca vitulina*), which are completely land-locked, and never visit the ocean.

Food fishes of inland lakes.

Hudson Bay.

Detailed Description of Routes Explored.

Chamouchouan River.

Chamouchouan River.

The Chamouchouan River enters Lake St. John at its north-east corner. It is about three-quarters of a mile wide at its mouth, and is very shallow when the water of the lake is at its lowest stage, there being a difference of twenty-seven feet between the high and low water level of Lake St. John,* owing to its contracted discharges being unable to carry off the great volume of water brought down in the spring by the numerous large rivers emptying into it. The river, in its lower part, is obstructed by three large and several small islands, that extend upwards to St. Felicien, some eight miles from its mouth. Its current for this distance is sluggish, the river flowing between low banks of clay and alluvium. During high water the lake backs up to this point, flooding much of the low lands on either side.

At St. Félicien, there is a small rapid full of large boulders, and for five miles above, the current continues swift, to the first heavy rapid,

*Levels of Q. & L. St. J. Ry.—High water, 353 ft; low water, 326 ft. above sea-level at Quebec.

where a portage is necessary. This portage is 150 yards long, and passes over the bare rocks. Twelve hundred yards above, is the Salmon Portage, where the river falls over two cascades, the upper being a direct fall of fifteen feet.

One mile above the portage, the Salmon River enters from the west. This stream is about fifty miles long, and takes its rise in a number of small lakes, near the sources of the Crôche and Windigo branches of the St. Maurice River. Salmon River.

The third portage is about seven miles above the second. Between them the river is about 500 yards wide and flows with a swift current, the banks, which have been gradually rising from St. Félicien, are now in places above 100 feet high, and are composed of clay overlain by stratified sand.

It is three miles and a half from the third portage to the Bear Portage, where there is a fall of fifty feet. This portage is on the east side, and is a mile and a quarter long. From its upper end to the Little Bear Portage, the distance is a mile and a half. Here, a rocky point jutting out from the east side, causes the river to make a sharp turn, with a fall of about twenty-five feet. The portage is 300 yards long and crosses the point. Bear Portages.

Within the next two miles, there are two other portages on the east side, past heavy rapids, the whole bringing the river up nearly to a level with the surrounding country.

Beyond the last portages there are small rapids at intervals for a mile, then the river widens out to about a third of a mile, and flows with a strong, even current, in a shallow sandy channel, for seven miles, to the thirty-fourth mile from its mouth. Five large islands lie in this portion of the river. They are all low and sandy and are well wooded with swamp ash, elm, balsam poplar and willow. Along the lower parts of this course the banks are low, and the surrounding country flat, with a soil of sandy loam. As the other end is approached, the banks rise gradually, until at the sharp bend to the westward, one mile from the end, those on the east side rise abruptly over one hundred feet above the water, and are composed wholly of stratified sand. At this bend a portage-route passes up the steep bank to the flat sandy plain above, which it follows northward through several small lakes on the head-waters of Picouabi River. From there the route passes into Lake Jim, a long narrow body of water that extends northward in what appears to be an old river-valley, until it joins the Washimeska River, which, above the junction, flows in a continuation of this valley, while below it turns eastward, and with numerous rapids and falls empties into the Mistassini River. Sandy soil above the Bear Portage.

After the westward course of one mile, before mentioned, the Chamouchouan River again turns north, and a series of long, heavy rapids begin, the lowest of which is called the Pimonka (last pine) Rapid.

The land on both sides of the river, as for as Pimonka, has been laid out into townships, and sub-divided by the Quebec government. The townships of Parent and Normandin are on the east side, while those of Ashouapmouchouan, Demeules and Dufferin are on the west side. The soil along the lower parts of the river is very rich and strong, being formed of a clay sub-soil, with sandy loam on top. Above the Salmon River, the deposits of sand are thicker and the soil is lighter, but still sufficiently good to produce excellent crops of wheat and other cereals.

Good land along the lower river.

The Archæan highlands come within a mile of Lake St. John, on its west side. These continue northward, but do not cross the river until the foot of Pimonka Rapid is reached, thus leaving a wide margin of flat land on the west side. On the east side there is a flat clay and sand plain between the Chamouchouan and Mistassini rivers. This plain rises in a succession of terraces from Lake St. John northward.

Settlements.

Settlements extend up the west side of the river about five miles beyond Salmon River. On the east side, they approach close to the Bear Portage, while the road to Normandin, a large settlement along the Picouabi River, passes close to the Little Bear Portage. Advantage is taken of this road to transport canoes and outfit past the rapids and portages below.

From the above, it will be seen that, although considerable settlements exist along the river, there is much good land still unoccupied, especially between the Little Bear Portage and Pimonka Rapid.

Above this rapid, the character of the country and river change completely: the former, instead of spreading out into a flat, sandy plain, is high and rough, with rocky hills that rise from 150 to 300 feet above the river. These are covered with sand and boulder-clay, and are not nearly so fit for purposes of agriculture. The river becomes contracted and very rapid, rising 341 feet in twenty-two miles, including the Chaudière Fall and rapids, where the rise is 120 feet in less than a mile. The Pimonka Rapid is three-quarters of a mile long, and is followed in the next mile by two short ones. Extending from the thirty-ninth to the fortieth mile, is the Deep-bottom Rapid, which cannot be ascended with canoes during high water, owing to the depth inshore being greater than the length of the poles, and also to the steep rocky banks, which render tracking impossible. With the exception of one short rapid, there is quiet water from the head of that rapid to the forty-fourth mile.

At the forty-second mile, the Great Mouchipon River comes in from the west. It is a small stream, flowing in a valley about a mile wide, and draining a number of small lakes to the north-west. A portage route, for light canoes in the spring, passes up this river, and comes out above the Chaudière Fall, thus avoiding the heavy rapid between. From the forty-fourth mile to the Chaudière Fall, twelve miles above, the river is a continuous succession of rapids connected by short stretches of swift current, rendering it necessary to make the whole ascent with poles. At the White-spruce Rapid, near the forty-ninth mile, there is a short portage on the west side past a heavy pitch. Chaudière Fall.

The country becomes more rugged as the river is ascended. The hills rise abruptly from 200 to 400 feet above the water, and, as they were burnt over some years ago, their rocky sides are now only partly wooded with small second-growth aspen, white birch, Banksian pine and spruce, while the standing blackened trunks of the older forest give the whole region an uninviting, barren appearance. Timber.

The portage past the Chaudière Fall is nearly a mile long. From its lower end it rises sharply 200 feet to the summit of a sandy hill, and then runs along its edge, to within a short distance of its upper end, where it passes along the rocks near the river. There are here three distinct falls connected by heavy rapids, the lower fall having a sheer descent of sixty feet.

Within half a mile of the upper end of the portage, is another, about 400 yards long, called the Little Chaudière Portage. It passes a deep heavy rapid, impassable with canoes.

A short distance from the head of this portage, the river leaves the narrow rocky gorge in which it has been confined, and its valley broadens, leaving a wide margin of low land on either side. The course of the river can be seen up the valley for over ten miles. The river has a moderate current in a wide valley, bounded by low, rounded, rocky hills, covered with small second-growth timber. Much of the land in this valley appears fit for agriculture. Good land above the Chaudière Fall.

About one mile above the Little Chaudière Portage, the Chegobich River comes in from the westward. This river is much used as a route by the Indians who travel to or beyond Lake Ashouapmouchouan. By it the distance to that lake is greatly shortened, as this route is the hypothenuse of a right-angled triangle, of which the main river forms the other two sides. Chegobich River.

The Chegobich River varies from fifty to one hundred yards in width near its mouth, and is quite shallow. As far as the first portage, a mile and a half up, the banks are low, and are composed of coarse boulder-clay. The first portage is one hundred and twenty yards long, and passes a heavy rapid; it is followed, a quarter of a mile above, by a second portage, over one mile long, past another heavy rapid, ending in a chute of forty feet. Then follows a mile and a quarter of swift water, with two short portages, to the Penché Portage, 700 yards long, with the Savanne Portage, of 200 yards, a half mile above. Beyond this there are stretches of sluggish water, broken by small rapids for four miles, when a portage of 300 yards passes a chute of twenty-five feet.

From the first portage to beyond Savanne Portage, the country surrounding the river is rolling and somewhat rocky, with small second-growth forest covering it. Beyond the Savanne Portage, the banks are low and sandy, with swampy land extending to the low hills that bound the valley on either side, from half a mile to a mile away from the river. Patches of old forest remain on the swampy land, but by far the greater part is small second-growth trees.

Above the chute, the river for nine miles winds through a wide, swampy valley, its sluggish current being broken only in a few places by short rapids. In this distance a number of small tributaries enter, chiefly from the south-west, where they take their rise in numerous lakes on the eastern slope of the Partridge Mountains. These form a ridge of rounded hills, that appears to run nearly north-and-south and to cross the river near Chegobich Lake.

The river, having now become very small, is inclosed in a narrow valley between rocky hills that rise from one hundred to three hundred feet above it, and in the next two miles to the lake it is much broken by rapids, filled with large boulders, entailing several short portages.

Chegobich Lake.

Chegobich Lake runs northward for nine miles from its discharge; it then turns sharply to the eastward, and extends in that direction some fifteen or twenty miles. The general width of the southern arm is about one mile. It is said to be very deep and the water is clear and brownish. Only three small rocky islands are found in the southern arm. The lake is surrounded by low rounded hills, highest on the east side, where they culminate in Chegobich Mountain, a bold rounded hill rising 420 feet above the water near the outlet, and forming a conspicuous landmark. The other hills on this side never exceed an elevation of 350 feet, while on the west side they are less than 200 feet. There was more unburnt timber about this lake than had been seen anywhere along the route from Lake St. John; but it is not large, and is chiefly black spruce. From the angle between the two arms of the lake, a portage a mile and a half long, passes westward over a flat, dry, sandy plain, and ends at a small sluggish stream. This stream has a very tortuous course through a wide swamp. After passing two small lakes, it finally flows into the south-east end of Lake Ashouapmouchouan, two miles and a half from the portage in a straight line, but over seven miles by the crooked course of the river. A few low, rounded hills of gneiss rise out of the swamp, but, apart from these, there is very little solid land, where small black spruce, larch and Banksian pine are found growing.

Lake Ashouapmouchouan.

Lake Ashouapmouchouan is about six miles long with an average breadth of one mile. Its shore-line is broken by a number of rocky points and shallow bays, while the surrounding country, as a rule, is low and flat, with a few ridges, never more than a hundred feet above the level of the lake, which, according to Richardson, is 1184 feet above the sea. The water is not nearly so deep or clear as that of Chegobich Lake. The surrounding country seems to be highly fertile, and in the clearings about the old Hudson's Bay post timothy grass grows in abundance, while small fruits appear to ripen early.

Nikaubau River.

The Chamouchouan River, above here called the Nikaubau River, flows in at the north-west angle of the lake, and about a mile beyond leaves it again at the north-east corner. The northern part of the lake is silted up with material brought down and deposited by the river, and is a favourite place for nets, great quantities of fine whitefish being caught there.

Above the lake, the Nikaubau River for several miles, to the Pole Rapid, flows with a sluggish current through a low country broken by a few rocky hills. Above the rapid, the land becomes higher and the soil, composed of boulder-clay, rises from twenty to eighty feet above the river, and is broken by an occasional rocky ridge sometimes 200 or 300 feet high. Little Nikaubau Lake is about twelve miles above Pole Rapid portage, and between are a number of short heavy rapids, with a short portage past one of them. This lake is one mile across, and is connected by a couple of lake-expansions of the river with the larger lake three miles above. Lake Nikaubau is four miles long, and from a half to one and a half miles broad. It is surrounded by low and apparently swampy country covered with a medium growth of spruce, larch, balsam fir, Banksian pine, aspen, balsam poplar, and white birch, with a few small cedars. It may here be noted that the ravages of the imported larch saw-fly *(Nematus Erichsonii,* Hartig.) extend to the height-of-land; the greater part of the larch trees have been attacked, and large numbers are already dead. It is learned from the Indians that these trees first showed signs of death

Timber.

north of Lake St. John, some three or four years ago. The trees north of Lake Mistassini still remain unattacked, but it appears to be only a matter of time before all the larch of Labrador will be destroyed, as the pest is spreading rapidly northward.

The Foam-fall River is the largest stream entering Lake Nikaubau; it flows from the south-west, and enters the lake near its outlet at the south end. There is a route by this river to the head-waters of the St. Maurice River, which was surveyed by Richardson.

Country about height-of-land.

A small stream, flowing into the north end of the lake, leads by a chain of six little lakes to the watershed between the St. Lawrence and Hudson Bay. From Lake Nikaubau it is twenty-four miles to the head of the stream and the surrounding country is flat, low and swampy. One hill about 500 feet above the general level, lies close to the watershed and forms a conspicuous landmark.

Short stiff rapids are met with along the stream between the lakes. At the fourth or Branch Lake, the river divides, the larger branch flowing in from the north-east, where it is said to drain a number of small lakes immediately south of Lake Wahwanichi. Owing to numerous rapids and other obstructions it is unused as a canoe route.

Height-of-Land to Lake Mistassini.

The general course of the route from Lake St. John to the height-of-land is about north-west, while the distance is nearly one hundred and sixty miles. From the watershed to Lake Mistassini the general direction is nearly N. 30° E., or almost at right-angles to the former course, the distance being about one hundred and ten miles. On crossing the height-of-land the route passes through three large lakes before reaching Mistassini. These lakes are named Obatogaman, Chibougamoo and Wahwanichi, and they are connected with one another by portage-routes passing through small lakes and the streams flowing from them.

Elevation at watershed.

The height-of-land, according to Richardson, is here 1360 feet above sea-level. It is crossed by a portage of half a mile, ending at a small stream that flows into Lake Obatogaman, five miles distant. The fall to the lake is one hundred and fifty feet. The surrounding country is uneven and sandy, and supports only a small growth of black spruce and birch.

Lake Obatogaman.

Lake Obatogaman is very irregular in outline, being broken up into a number of deep bays by long narrow points; its surface is also crowded with innumerable small rocky islands to such a degree that navigation without a guide is almost impossible. The lake is estimated to be about twelve miles long from north-east to south-west, and about ten miles broad. Its shore-line must considerably exceed one hundred miles in length, owing to the great irregularity in its shape. The water is not very clear, and as a rule appears to be shallow. The outlet is in the south-western part of the lake, and forms a branch of the Nottoway River, which empties into Rupert Bay, the south-western extension of James Bay. Whitefish, pike, pickerel and suckers are caught in abundance here, and sturgeon are also said to ascend to the lake, and are taken at certain seasons in large numbers near the outlet. Fish.

The surrounding country, except toward the south, is generally flat and low, with ridges of low granite hills rising above the general swampy lands. The soil is thin and sandy and the timber small along the shore and on the islands. It consists chiefly of black spruce, along with balsam fir, white birch, Banksian pine and larch. The canoe route crosses the lake in a north-west direction for ten miles, between islands and past long points, to a narrow bay, which is followed north-east four miles to the first portage on the route to Lake Chibougamoo. Character of country.

The portage-route is nine miles long, and first passes up a small stream falling into the head of the bay. Along this stream three portages are made past rapids, and then a portage leads from the small swampy lake at its head, to another small lake which discharges into Lake Chibougamoo. Following this sluggish stream four miles, through a swampy country with low hills of rock rising at intervals, the south-west bay is reached. Along the portage-route most of the timber has been burnt off, leaving only clumps of black spruce and larch growing on the lower swampy ground. The level of Lake Chibougamoo is forty feet above that of Obatogaman. Its greatest length is about twenty-five miles, from N. 30° E. to S. 30° W., and it is over six miles wide in the broadest part. The southern end is divided into two bays by a narrow point, three miles and a half long. A high rocky ridge projects twelve miles from the northern end, dividing that portion of the lake also into two bays, of which the eastern is the larger, being about twelve miles deep and four miles broad. The western bay is seven miles long, and is very irregular in width, being a succession of small lakes connected by narrows. The lake has on its western side two outlets, about three miles apart. The northern one is near the mouth of the north-eastern bay. They are both only about 200 yards long, and the water falls twenty-five feet into another lake lying parallel to Chibougamoo, and separated from Timber. Lake Chibougámoo.

it only by a narrow rocky ridge. This smaller lake is twelve miles long, and from one to two miles wide. The lake is well stocked with large lake trout and whitefish, and its water is very clear and deep. From it flows another branch of the Nottoway River, which unites with one from Obatogaman some considerable distance to the south-west.

Character of country about Lake Chibougamoo.

Lake Chibougamoo is studded with numerous low rocky islands, especially along its eastern side and in the north-east bay; a few are also scattered up the western half, as an apparent extension of the ridge forming the southern point. The shores of the lake are low, and are either formed of solid rock or of large rounded boulders, often found piled up in low walls by the action of the lake ice. The land rises gently from the eastern side to the height-of-land some eight or ten miles distant.

Hills.

The ridge between the two lakes, on the west side, is low in its southern part, but between the two discharges rises to a height of 250 feet, in a bare rocky hill, called Paint Mountain, from the rusty colour of the rocks, due to the decomposition of iron-pyrites in them. The north-west bay is surrounded by high rocky hills, arranged in sharp ridges parallel to the direction of the lake. These culminate in the Sorcerer and Juggler mountains. The former is situated near the end of the point between the two northern bays, and is estimated to rise 425 feet above the water; the latter lies a short distance to the north of the head of the north-west bay; it appears to be somewhat higher than the other, and ends in a sharp cone, having perpendicular sides fifty feet high, and is probably composed of massive diorite. From its resemblance to the tents used by the Indian conjurors, it has been called the "juggler's house," and is supposed to be the dwelling place of evil spirits. The outline of the hills in this locality is sharply serrated, in marked contrast to the rounded outline usually seen in the Laurentian hills. This difference is probably due to the nature of the rocks forming the hills, which are chiefly a soft, green chlorite or altered hornblende schist easily affected by the weather. The timber about the lake is larger and better than at Lake Obatogaman. Black spruce predominate; white spruce, balsam fir, larch and Banksian pine also occur, together with medium-sized birch, aspen, and a few cedars. The higher country at the north end has been mostly burnt over, and is covered with small second-growth aspen, birch and Banksian pine.

Timber.

From Lake Chibougamoo to Lake Wahwanichi, the distance is four miles, the portage-route passing from the head of the north-west bay up, over a burnt hill about 300 feet, to a small lake, and thence through three other small lakes, by intervening portages, to Lake Wahwanichi, which is about 200 feet higher than Lake Chibougamoo. The country passed through by the portage-route is rough and rocky, and, as all the green wood has been burnt off, it presents a very barren appearance. Lake Wahwanichi lies parallel to Lake Chibougamoo. It is twenty-four miles long, while its breadth varies from half a mile to four miles, with an average of one mile. The south-west end is divided into a number of long parallel bays by narrow rocky ridges, which rise from fifty to 200 feet above the surface of the lake. There are three of these bays on the western side, and one on the east side. The former are all about four miles deep, and vary from a quarter to half a mile in width; the eastern one is nearly six miles long. From the mouths of these bays, the main body of the lake to the northward is less than a mile wide, for five miles, when it gradually expands and is divided into two bays by a low narrow neck of land connecting a rocky peninsula with the mainland. The north-west bay is some three miles deep, and its head is only a few miles from one of the southern bays of Lake Mistassini. In winter the route between these lakes passes up this bay, and thence a short distance over low hills to the valley of a small stream falling into the Mistassini. The north-east bay is deep, and narrows to less than a quarter of a mile at its head, where the discharge flows out towards Lake Mistassini. Towards its southern end, the lake appears to be shallow, but in the narrows and northern part it is quite deep. There are only four or five small islands on the lake. Its water is clear and cool, and it abounds with fine whitefish and lake trout. In its northern part the inhabitants of the Hudson's Bay Company post at Mistassini make their fall fishery, and take in nets an immense quantity of lake trout averaging six pounds in weight. On the north-east side of the lake, the country rises gradually some 300 feet to the height-of-land, which skirts that side of the lake at a distance of from three to six miles. In only a few places along this shore is the bare rock seen, the soil being made up of thick layers of fine glacial drift, composed largely of débris of the limestone found to the northward about Lake Mistassini. This forms an excellent soil, as can be judged from the number of large trees upon it. The south-west side of the lake is more rocky. At its southern end and along the narrows, the rocky shores rise abruptly from fifty to 200 feet above the surface of the lake. The shores of the north-west bay are low, but the western side of the north-east bay is high and rocky, rising near the outlet 350 feet above the water.

Lake Wahwanichi.

Fish.

Excellent soil.

Much of the country surrounding the lake has been burnt. What remains of the old forest, as already stated, is of good size, and trees

Timber.

eighteen inches in diameter three feet from the ground, are not uncommon, while the general average is larger than that of any district seen northward of Lake Ashouapmouchouan. Black spruce, white spruce, balsam fir, larch, Banksian pine, white birch and aspen grow abundantly on the unburnt tracts along the eastern shore, and cedar of medium size is found close to the edge of the water.

Lake Wahwanichi discharges into the south-west bay of Lake Mistassini by a small stream four miles long. In this distance there are a number of small lake-expansions connected by rapids and falls, to pass which three short portages are necessary, the total fall being sixty feet. The height-of-land passes close to the river on the south side, while the country is slightly broken to the north.

Lake Mistassini.

Early narratives.

Lake Mistassini is the largest and by far the best known lake of the Labrador Peninsula. Tales regarding its great size were told by the Indians of the lower St. Lawrence to the earlier pioneers, and the first explorers of the region brought back exaggerated accounts of the extent of the lake, derived from like sources of information and not from actual observation. Quite recently similar stories excited the imaginations of various writers in the public press, and numerous speculations were indulged in regarding the magnitude of this mysterious body of water, which, by some, was held to be even greater than Lake Superior. When at last a survey of the lake was completed in 1885, there remained some persons who refused to give up their belief in its supposed great size, asserting that only a bay had been surveyed and that the lake stretched out indefinitely beyond, far to the northward, notwithstanding the fact that branches of the East Main River rise a short distance northward, and that other branches extend to the eastward, over two hundred miles beyond the northern end of the lake.

Survey.

Position.

Although Lake Mistassini does not reach the size ascribed to it by many, it is still a very large body of water, situated between latitude 50° and 51° 24′ N., and longitude 72° 45′ and 74° 20′ W. A straight line drawn from the south to the north end of the lake would run about N. 30° E. The lake itself has a perceptible curve between its ends, with the concavity of the curve towards the south-east; the shore-line nearly coincides with an arc of a circle, so that the general trend of the lake changes gradually from north in the southern portion until at the northern end its direction is north-east. The greatest length in a straight line, between the heads of the north-east and

Size.

south-west bays, is roughly one hundred miles; the average breadth of the main body is twelve miles, and it varies but little from that measurement. A low, narrow, rocky point extends out from both the north and south ends of the lake, dividing each end into two deep bays. Between the points, and formed by the same rocky ridge, there is a continuous chain of low islands; these overlap one another, so that only in a few places along the shore is a view of the opposite side obtained. A slight lowering of the present level of the lake would connect these islands and points, so as to form two lakes, as the water between the islands is quite shallow, in marked contrast to the depth between the islands and the mainland on either side. There the depth averages over 300 feet, but in some places exceeds 400 feet. The water is very clear, and the temperature of the main body rarely if ever rises above 50° Fahr. Islands.

The south-east bay is called Abatagush. It is three miles wide at its mouth, and from there gradually lessens for six miles to the Big Narrows (Chabatok), where, for about a quarter of a mile, it is not over two hundred yards wide. Again expanding to an average breadth of nearly two miles, it extends to the south for eleven miles, where it is subdivided into two arms by a long narrow point. Bays.

The eastern arm, called Cabistachuan Bay, averages a mile and a half in breadth, and runs south nine miles, and then east four miles to its head, where a portage leads to the Little Perch River. This stream drains a number of small lakes to the south-east, and is used as a route to the head-waters of the Chief River, the main branch of the Chamouchouan.

The western arm is larger and more irregular than Cabistachuan Bay. From the end of the dividing point, where it is two miles wide, it gradually narrows for four miles, so that along the last half-mile it is only about fifty yards across; this part is called the Little Narrows. Passing the narrows, the bay expands to one mile in width and runs a few degrees east of south for five miles; then it widens out to four miles, and continues on the same course eight miles further, to the discharge of Lake Wahwanichi that comes in at its head. Where the bay widens, there is on the western side, an arm called Sassikan Bay, that runs due north four miles, and is nearly parallel to the main body. Four miles from the head of the bay, a narrow point stretches out three miles from the eastern shore, and almost meets a shorter point from the western side, leaving only a narrow channel between. This point is called Eliquabit, and on it was situated the old King's Post of the North-west Company. The Hudson's Bay Company's post is established on the east side, just inside the Little Narrows. Trading posts.

The south-west or Poonichuan Bay, for a distance of twenty miles from its entrance, has an average breadth of five miles, and its shore-line is broken by a number of smaller bays, from one of which a portage of two miles leads to Abatagush Bay, reaching it near the Hudson's Bay post. This portage is much used, as it obviates a canoe trip of nearly fifty miles, around the point to the spawning grounds in Poonichuan Bay, where immense quantities of whitefish are taken in nets during the spawning season in October. After the first twenty miles the bay narrows to less than half a mile, and extends in a south-west course for over fourteen miles, a small river coming in at its head.

Fisheries.

The bays at the north end of the lake are not so deep as the southern ones. The distance from the end of the point to the head of the north-west bay is fifteen miles, and its average breadth is rather more than four miles. The north-east bay extends nineteen miles from the same point to its head, and has an average breadth of four miles.

Besides the great bays already described, many smaller ones indent the shores of the lake, especially on its west side, where the coast-line is very irregular and many islands occur.

Character of shore-line.

As a rule, the shore is rocky, with only a steep, narrow bouldery beach, and moderately deep water close in. On the east side, the shores and islands are formed of limestone, that dips at a low angle towards the south-east; consequently, beaches facing in that direction shelve gradually into deep water, while those with a western aspect are generally cut off perpendicularly with deep water close up to them. On the west side of the lake, the limestone is only found on the outer islands and points, where similar conditions exist, but the greater part of the shore-line here, being formed of gneiss, perpendicular faces are wanting and the slope is more even in all directions. In some places no rock is seen, and then the beaches of the islands and mainland are formed of boulders, often piled up by ice in low ridges close to high-water mark.

Surrounding country.

As before stated, the escarpment forming the height-of-land passes close to the southern end of the lake, and continues on in a north-easterly direction at an angle to the trend of the lake, so that it is soon a considerable distance to the eastward as it is followed towards the north. The general height of the escarpment appears to be about 300 feet above the lake, but some points may rise to 500 feet. The only other elevation of any consequence, is a range of hills that lies about five miles beyond the north end of the lake, and from there appears to trend away to the westward. Its highest point is not over 500 feet. There is also a limestone ridge running along the eastern side of the lake which seldom or never rises 100 feet above the water, but often presents a perpendicular face. This ridge separates Lake Mistassini from Lake Mistassinis. On the west side, the country is generally low and swampy, being broken by rounded gneiss hills, never over 100 feet high, and generally less than 50 feet.

The principal rivers flowing into Lake Mistassini, are named the Temiscamie, Papaskwasati, Tokwaoio and Wabassinon. The Temiscamie River is the discharge of Lake Mistassinis, and is the largest stream entering the lake, coming in on the east side, about twenty miles from the north end. It is only two miles long, and as the difference of level between the two lakes is 55 feet, the river descends in a continuous heavy rapid, through a shallow limestone gorge. The Papaskwasati and Tokwaoio rivers are large streams flowing into the heads of the north-west and north-east bays respectively. Both come from the northward, and rise near the head-waters of the Tichagami Branch of the East Main River. A canoe route to Nichicun is said to pass up the Tokwaoio River, and to cross from its head to the East Main River. The Wabissinon River is a smaller stream flowing into the lake on the west side, nearly opposite the mouth of the Temiscamie River, and draining an area of country to the north-west of the lake. Besides these larger rivers, there are numerous smaller streams that rise in lakes and swamps in the surrounding region; notably the discharge of Lake Wahwanichi and the Little Perch River, both flowing into the southern part of Abatagush Bay. Rivers.

The soil of the region about Lake Mistassini is made up of boulder-clay, derived from the disintegration of the neighbouring rocks. Large Laurentian and Huronian boulders, with blocks of limestone, are scattered about in profusion. The finer material of the soil is sandy clay, with a large percentage of finely divided and intimately mixed limestone, especially about the southern and eastern shores of the lake. Good Soil

The climate of the country surrounding Mistassini is such as to preclude the possibility of its ever becoming an important agricultural region, chiefly owing to the prevalence of summer frosts. At the Hudson's Bay post, a most favourable locality, the average temperature of the three warmest months is about 60° Fahr., but, unfortunately, no summer passes without severe frosts in June and August, which cause great damage to the potato crop grown there. Climate.

Snow covers the ground from the middle of October, and remains until the middle of May, all the smaller lakes being frozen over during that period. Owing to its great depth and consequent slow change of temperature, the main body of the lake rarely freezes over before the 20th of December, and it breaks up a couple of weeks later than the smaller lakes and bays in the spring. From the same cause, the general summer temperature of the region surrounding the main lake is lower than that about the post, and even in the month of July, in the swampy lands adjacent, the soil is frozen solid within a few inches of the surface.

Timber. Covering the higher ground towards the southern end, white and black spruce, balsam fir, Banksian pine, aspen and white birch are found, some trees having a diameter of eighteen inches three feet from the ground. Similar trees of smaller size are found along the limestone ridge on the eastern side. On the western side, where the Archæan rocks occur, the soil is scant and sandy, and, in consequence, the trees are much smaller. They are chiefly black spruce and larch, along with small Banksian pine, balsam fir, aspen and white birch. Black spruce and larch alone grow in the swamps, and also form a fringe along the shores and islands of the main body of the lake, where the sweep of cold winds probably interferes with the growth of other species. Cedar reaches its northern limit at the southern end of the lake, where only a few stunted trees are seen.

Fish. Fish of various kinds and of large size are caught in abundance throughout Lake Mistassini. Lake trout are taken weighing from four to forty pounds, brook trout up to six pounds, whitefish to fourteen pounds, and pike, pickerel, red and white suckers and chub of correspondingly large size. These fisheries would prove of great value if access to them could be had by railway, as the supply is practically unlimited here and in the adjoining large lakes.

Animals. Caribou and moose, once plentiful in the region, are almost extinct, and can no longer be relied on as a source of food by the Indians, who now live wholly on fish, rabbits and the fur-bearing animals. Of these beaver and bear are the most plentiful, the former being still found in considerable numbers in the small lakes and streams tributary to the lake. Black bears are common on the extensive areas of burnt land on all sides of the lake, but most especially to the south-west. Besides these, marten, mink, fisher, otter, lynx and foxes are taken in large numbers, the fur of the marten being particularly dark and valuable.

Indians. There are about twenty-five families of Indians belonging to this post. Very few are now pure-blooded, being mixed with the whites, who have traded in the region for the past one hundred and fifty years. In the spring all the able-bodied men are employed in the large bark canoes that descend the Rupert River to James Bay with the hunt of the previous winter, returning with the outfit of goods and provisions for the coming year. The canoes depart about June 20th, and return about August 20th. As nearly all the women and children accompany the large canoes in their own small craft, very few persons remain about the post during the summer, and as a consequence parties from the outside find it impossible to obtain guides or other assistance there during that period. Those who remain live altogether on the fish caught from day to day, as only sufficient provisions are brought in to supply the post during the winter and to provide for the men engaged transporting the furs to Rupert House. From these causes, the exploration of central Labrador is attended with many difficulties, especially as the country cannot be depended on to supply any food during the summer months, and consequently provisions to last the entire season must be brought in from the coast, up very rough and rapid rivers at great cost and loss of time.

Lake Mistassinis, as before stated, lies to the eastward of Lake Mistassini, from which it is separated by a ridge of limestone varying from two to six miles in width. Lake Mistassinis.

The difference in level between the two lakes is fifty-five feet. The smaller lake is about sixty miles long, extending from opposite the north end of Mistassini to a place east of the Big Narrows. In its northern part, the lake is about six miles wide and is free from islands or bays, but south of the discharge it narrows considerably and splits up into a number of deep bays, while its surface is covered by numerous low islands. These are formed from limestone reefs running parallel to the direction of the lake, and are most numerous about the outlet and between there and the Temiscamie River which flows in on the east side some three miles south of the outlet.

The water of the lake between the rivers is brownish and not clear, in consequence of the impurities brought down by the river. In other parts the water is clear, deep and cool. Large fish, of the same species as those taken in the great lake, are also abundant here. Fish.

The land on the west side of the lake is low, with rocky shores of flat limestone. The country to the eastward is higher, and consists of a plateau formed of limestone, which separates the lake from the Temiscamie River. The face of the plateau fronting the lake is steep, and has in places a perpendicular cliff of limestone rising from 50 to 200 feet above the water.

The hills mentioned as bounding the north end of Lake Mistassini, also extend part way across the north end of this lake, with an interval of low ground to the north-east, where a portage of less than two miles crosses to the Temiscamie River. This river is the only important one falling into the lake. It takes its rise to the north-eastward along the northern side of the watershed separating it from the head-waters of the Mistassini and Peribonka rivers flowing into Lake St. John. It passes through Lake Temiscamie, a large body of water near the height-of-land, and then flows south-west twenty miles, to within a short distance of the head of Lake Mistassinis, when, instead of entering the lake, it keeps to the eastward of the limestone ridge already mentioned and flows within a short distance of and parallel to the lake for nearly twenty-five miles, where it falls into a small bay on the east side.

The climate, soil and timber of the country surrounding Lake Mistassinis are similar to those of the eastern side of Lake Mistassini.

Lake Mistassini to the East Main River.

Rupert River.

From Lake Mistassini, the route to the East Main River first descends a branch of the Rupert River for fifty miles almost due north, and then leaving that stream passes north-westward, through a number of small lakes, to and down a small tributary into the East Main River. The distance between the two rivers is fifty-eight miles.

Contracted discharge of Lake Mistassini.

The Rupert River forms the discharge of Lake Mistassini. It leaves the lake on its west side, thirty-five miles from the head of the North-west bay. The outlet is at the bottom of a small bay, where the river flows out, over a ledge of gneiss, forming a small rapid. Here the stream is not over one hundred yards wide, and is hemmed in by rocky banks. This contracted discharge is insufficient to carry off the waters poured into the lake by the numerous large rivers previously mentioned, and as a consequence the level of the lake rises during the spring, and reaches its highest level about July 15th, after which the water slowly subsides. The period of lowest level is about the middle of May, or just before the spring freshets, so that the lake rises much more rapidly than it falls, making the volume of water in the Rupert very constant in comparison with that of other rivers flowing into Hudson Bay. On leaving the lake, the river flows almost on a level with the surface of the surrounding country, widening out into deep bays and separated into numerous channels by low rocky islands. For the first eight miles of its course, it flows south-west, or roughly parallel to the shore of the lake, and so close to it that at the end of the distance a portage of less than 200 yards leads from a bay in the lake to the river. Below this portage for two miles, the river continues between rocky banks, with a swift current, and then flows out into a lake-expansion extending westward more than ten miles, and varying from one to three miles in breadth.

The river flows out of this lake by two main and several smaller channels separated by large rocky islands. The two main channels are soon joined by the smaller ones, and then form large rivers, separated from each other by a very large island, and not uniting again for over 100 miles.

The western channel is followed by the Hudson's Bay Company's brigade in going down to Rupert House. This channel is descended in a north-west direction about fifty miles, where the route passes from the western end of an expansion called Lake Miskittenau into a chain of lakes on the Marten River, a small branch which joins the Rupert over 100 miles below. Two channels.

The eastern channel forms part of the route to the East Main River. It runs comparatively straight for fifty miles, having a general course a few degrees east of north, and leaving the above-mentioned lake-expansion at its eastern end, by a number of channels on its northern side. For five miles it is obstructed by innumerable small rocky islands, and is so deeply indented with bays, that were it not for the strong current the stream could not be easily followed. Near the end of this distance the river narrows to a general width of less than a quarter of a mile and passes over two small rapids between islands. For the next five miles the average breadth of the river is 300 yards, and it flows with a steady, swift current to a small rapid, below which the breadth increases to nearly half a mile, and continues so for two miles to a heavy rapid, that falls twenty feet in 200 yards. Islands in Rupert River.

The portage past this rapid is a quarter of a mile long, and runs on the summit of a ridge of boulder-clay. The crest of the hill is about 150 feet above the water, and is so narrow and sharp that there is only room for the portage-road on it.

Below the portage the river is about 300 yards wide for five miles and a half, with a strong current and numerous islands. It then expands to an average width of half a mile, and is quite deep, with a sluggish current. These conditions continue for seven miles, when, turning sharply westward, the channel contracts and the stream falls twenty-five feet, over a chute, into the head of Kachikakakuaiats or Pinched-neck Lake. This lake extends north-westward ten miles, and in its widest part is about two miles and a half across. The river flows out on the west side five miles from the inlet, and thence runs in a westerly direction to join the other main branch, some fifty miles farther down. Pinched-neck Lake.

From Lake Mistassini to the first portage, the country surrounding the river is very flat, with no hills over 150 feet high. The river appears to have no channel proper, merely filling the depressions and fol-

Character of country along Rupert River.

lowing the general slope of the country. The islands, shores, and a greater part of the high land are rocky. The depressions where they are not occupied by swamps, appear to be filled with broken rock and boulders, while the finer material of the drift has to a great extent been carried away, not enough remaining in many places to fill the interstices between the heaped-up boulders. The boulders and broken rock are also profusely scattered over the rocky hills and in the river-bed. What soil remains is poor, thin and sandy, supporting only a scant stunted forest growth of black spruce, larch, aspen, and white birch. These trees never exceed forty feet in height, or ten inches in diameter. The underbrush in the low-lying portions is "laurel" *(Kalmia glauca)* and Labrador tea *(Ledum latifolium)* while the higher ground is covered with white reindeer moss. The growth of trees in this region is exceedingly slow, as may be seen from the length of time required to cover areas burnt over years ago, and where now only a scattered growth of black spruce and Banksian pine is springing up.

Timber.

Burnt country.

Below the first portage, the river flows in a valley cut transversely through several ridges that appear to run east-north-east and west-south-west. These hills, as the river is descended, rise gradually from 100 feet to 400 feet in the neighbourhood of Pinched-neck Lake, where they occupy both sides of the lake. Along this lower part of the river more than half the country has been burnt over, thus removing all the trees and vegetable soil, and leaving only the bare rock and scattered boulders, giving to the region a very barren, desolate appearance.

Portage-route between Rupert and East Main rivers.

The portage-route between the Rupert and East Main rivers leaves Pinched-neck Lake at its western end, and there passes, two miles up a small stream through four small lakes (1, 2, 3, 4) connected by short portages. Then a portage of 200 yards leads to lake No. 5. This is one mile long, and is connected by a portage of 500 yards with a larger lake No. 6, which drains into another small branch of the Rupert. This lake is full of small islands and has numerous little bays. It is followed three miles and a half northward to its discharge, where a great mass of boulders, 200 feet wide, separates it from lake No. 7. The outlet of this last lake is close to the inlet, and is said to flow westward through a chain of small lakes to the Rupert River.

Passing northward for a mile and a half, the route then turns westward for one mile, into a bay, and then northward again three-quarters of a mile, to a portage of 800 yards which leads to lake No. 9, which is about a mile long and three-quarters of a mile wide. It crosses this lake to another portage of 800 yards through a swamp, ending in a slightly larger lake, No. 10, which is followed N. N.E. one mile and a quarter to its head, where a portage of 400 yards passes over a boulder-ridge 200 feet high, and ends in a broad shallow stream. Another branch of the Rupert River, which is one mile and a half to the eastward, flows out of a large lake, No. 11. The western end of this lake is crossed, and a short portage made along a small stream flowing into it. This stream is followed northward about two miles and then turns directly west for another two miles, where two short portages, with a pond between, lead to lake No. 12. This lake is followed north-west for two miles, when a portage of 200 yards is made to lake No. 13, at the head of the Kawachagami or Clearwater River, a small branch of the East Main River. Following this lake two miles to its outlet, a portage of half a mile ends at the head of the eastern bay of Clearwater Lake.

This lake is roughly triangular in shape, having east, west, and north bays, with minor ones. Its water is brownish, clear, and moderately deep. Islands are numerous especially at the end of the north bay, where the shore-line is rocky and irregular. From east to west the lake measures about seven miles, and about three miles and a half from north to south. Two small lakes with narrows between, lead from the north-east corner of the north bay, to a long lake lying to the westward, about four miles from Clearwater Lake. The outlet is on the east side of the north bay. It is very small and narrow, and as it turns off at right-angles to the direction of the bay, cannot be seen until entered. Clearwater Lake.

Leaving the lake by the outlet, the river flows directly east for two miles and a half; then it bends sharply to the north-west, around a long narrow point and enters a small lake. Following this lake northward for two miles, a short portage is made past a small rapid at its discharge, after which the course is west, for two miles and a half, through a small lake-expansion to another short portage past a fall of eight feet.

The river thence flows northward in a shallow, sandy channel for four miles to another small lake, a mile and a half long, with a rapid at its outlet. The river, now about twenty yards wide, flows with a sluggish current in a very crooked channel through an extensive swamp, until it empties into Tide Lake on the East Main River. The distance between the last two lakes in a straight line is five miles, while by the river it is considerably more than double that; the general course is W. N. W.

From Pinched-neck Lake to Clearwater Lake, the country passed through by the portage-route is broken by roughly parallel ridges of Character of country along portage-route.

rocky hills. These hills rise from 200 to 500 feet above the surrounding water level, and appear to run nearly north-east and south-west. The hills of each chain are usually connected with one another by sharp ridges of coarse boulder-clay. These ridges are highest and thickest on the south-west side of the hills, where their material seems to have been accumulated in the lea of the rocky obstructions to the ice during the glacial period. Like the sharp ridge described at the first portage on the Rupert River, these ridges are largely composed of boulders and semi-angular blocks of gneiss with very little finer material, and have the same characteristic narrow crests, sloping on either side.

Between the ridges the lower ground is often swampy and covered with a network of small lakes. From a rocky hill, 250 feet high, at the portage between lakes No. 10 and No. 11, over thirty of these small lakes were counted, filling the valleys on all sides.

Forest fires. The greater part of the region is destitute of forest trees, these having been removed by frequent extensive fires. The bare rocks of the hills are thickly strewn with boulders, often of great size, while the valleys are filled with the same, often to a depth of many feet, and without sufficient sand or clay to conceal the space between them. Usually a thin covering of vegetable mould is found on the heaps of boulders. In a few places on the lakes, sandy shores are seen, but the greater part of the shores and islands are formed of solid rock or of heaped up boulders.

Small trees. The unburnt forest is made up of small trees never more than thirty feet high nor exceeding ten inches in diameter. Black spruce is the most common, and on the lower ground grows thickly together, while on the hillsides it is only found in open glades. Larch occurs in the swamps, and there grows to a larger size than any of the other trees. In abundance, Banksian pine ranks next to the black spruce, but is generally small. A few small trees of white birch are seen in clumps on the higher ground surrounding the lakes, and are accompanied by an occasional clump of struggling aspen never over four inches in diameter.

High ridges. From the top of a hill rising 350 feet on the north-west side of Clearwater Lake, an uninterrupted view of the surrounding country was obtained. To the southward, the high hills of the ridges already passed are seen extending north-east and south-west. To the eastward, they appear to have about the same altitude as those seen along the route, but to the westward they are considerably higher, and some of them, ten or fifteen miles to the south-west of the lake, must rise from 500 to 800 feet above the general level. Their tops are bare, and large patches of snow were observed on their northern sides on July 14th. Northward, the country is not so broken, and none of the ridges rise above 300 feet, while the valleys are broader, with more swampy land and fewer lakes. Farther away in this direction, there is another range of higher hills extending east-and-west beyond the East Main River.

Flat country.

The country surrounding the discharge of Clearwater Lake is at first rolling, but after passing the small lakes it becomes flat, and the river winds through an extensive swamp, with only a few isolated rocky hills rising from it. The swampy lands are thickly covered with small black spruce, larch and Banksian pine, the trees increasing in size as the East Main River is approached. Boulders are less numerous, and there is a considerable amount of fine yellow sand arranged by the river in small terraces along its banks and about the small lakes.

On an island in Clearwater Lake the soil was found to be frozen solid, at a depth varying from six to nine inches below the surface.

East Main River.

Position of the mouth.

The Hudson's Bay post at the mouth of the East Main River, on the east shore of James Bay, has been determined by W. Ogilvie, D.L.S., in 1890, to be in latitude 52° 14′ 45″ N. and longitude 78° 29′ 15″ W.

Hudson's Bay Company.

Head of tide.

The river, at its mouth, is a mile and a half wide, but is obstructed by a number of sand and shingle shoals, bare at low water, with shallow channels between them. The river-banks are low and sandy. As the river is ascended, the sand gives place to clay, cut in places by the river into steep faces. The Hudson's Bay Company's post is situated on the south side, three miles from the mouth, where the banks are about fifteen feet high. The river opposite the post is a little under a mile wide. Three large islands of clay occupy the southern side of the river for two miles and a half above the post, with a narrow, shallow channel between them and the mainland on that side. Opposite the head of the upper island a small river, called Fishing River, falls into the main stream from the north-east. Tide-water extends seventeen miles up the river, and for this distance the course is about due east. The banks are low, formed of stiff blue clay, and much of the land on either side is low and swampy. The river gradually narrows from a width of three-quarters of a mile, above the islands, to about a quarter of a mile at the head of tide, where a small stream, called Coldwater River, comes in from the south. The current, from the mouth to the head of tide, varies from two to four miles per hour. Along the river-bottom there is an abundant growth of medium-sized white and black spruce, balsam fir, aspen and balsam poplar.

Immediately above the head of tide, the character of the river changes to a succession of rapids, and for the next six miles the banks become increasingly higher, with steep cut faces, showing clay overlain by sand, or sometimes coarse boulder-clay, with an occasional exposure of rock coming up from beneath. The banks here rise from fifty to one hundred feet. The valley becomes gradually narrower and the rapids heavier, until in the upper mile and a half the river is only about 100 yards wide and falls seventy-five feet through a shallow, rocky gorge, called Basil Gorge. The general course of this stretch is N. 75° E. Immediately above these rapids the river again changes to a quiet-flowing stream about 600 yards wide, with low banks and a flat country on either side.

Basil Gorge.

Two miles above the head of the gorge and twenty-five miles from its mouth, the river divides into two branches, which appear to be nearly equal in size, one coming from the north-east, the other from the east, the latter being the one surveyed. From the Indians at East Main post, it was learned that the north-east branch is called the Opinaca or Straight River, and that its volume is about two-thirds that of the other branch. It is much the easier river to ascend, being free from long rapids and portages, and takes its rise in a number of large lakes between the head-waters of the East Branch and those of the Big River.

Straight River

Above the forks the course of the east branch is due east for seven miles, while its width varies from 600 to 800 yards; the current is sluggish and the banks low, but they rise gradually as the stream is ascended, so that in the last mile and a half of this course, they are from fifty to seventy-five feet above it, and present cut faces of stratified sands and clays, or of boulder-clay. The river here narrows to a width of 300 yards and becomes rapid.

Talking Falls.

At the end of this course there is a sharp bend to the south, and a quarter of a mile above the bend is a chute of twenty feet called Talking Falls, with strong rapids below and above it. From this chute, the river, with several minor bends, has a general south-east course for the next six miles, being almost a continuous rapid, with about 120 feet fall, including a chute of sixty-five feet, called the Island Falls, at the upper end. At this chute the river is divided into a number of narrow channels by several small rocky islands. The banks along this portion of the river are not high, and the country appears to rise with the river. There is a portage of 400 yards on the south side past the chute, and two miles above it a small river, called the Miskimatao, comes in from the south.

Above the chute, the river again expands to an average width of 600 yards, and flows from N. 60° E., almost on a level with the surrounding country, for ten miles between low banks of clay capped with sand. The timber continues the same as before, but is somewhat smaller. The river now narrows to 250 yards, and continues with small rapids northward for a mile, between rocky hills, then turning east, it widens slightly and is less rapid for another mile, to the foot of a narrow rocky channel called Clouston Gorge. This gorge for a mile and a half from its mouth is perfectly straight, and is never more than 100 feet wide, narrowing in one place to thirty feet, with rocky sides that rise almost perpendicularly 100 or 200 feet above the river, which rushes through it in one great rapid, falling in the interval 105 feet. Clouston Gorge.

Above this the course changes to S. 70° W., and the river becoming slightly wider, mounts in the next three-quarters of a mile twenty feet to the foot of a rocky island 1200 yards long with a narrow channel on either side. Through these channels the river falls over 100 feet in a succession of chutes. For three-quarters of a mile above the head of the island, there are a number of small islands with rapids between them.

To pass these obstructions it is necessary to portage canoes and outfit three-quarters of a mile through a deep swamp, with only one spot sufficiently dry to allow the loads to be laid down. The portage begins immediately below the gorge on the south side, and ends in a small bay near the head of the islands. Bad portage.

The river is now found flowing nearly at the level of the surrounding country, with a sluggish current between low banks that become more and more sandy. The general course of the next stretch is N. 60° E., and the distance twenty-two miles, the breadth of the river varying from a quarter to three-quarters of a mile, with an average of about half a mile. The limit of balsam poplar is reached near the upper end of this course, a fact due probably to the absence of low clay banks, along the river above. The other trees are smaller, and white spruce beyond this becomes scarce. White birch is now a common tree, and Banksian pine is found wherever second-growth timber occurs on sandy soil. Limit of balsam poplar.

Continuing on the same course for three miles and a half, the river again becomes rapid, and flows in a valley which at first is about 200 yards wide, with scarped sandy banks which rise about 150 feet above it. Soon the channel narrows to less than 100 yards, and the sandy banks give place to rock as it enters Conglomerate Gorge. In the upper half of the distance the fall is very steep, the river passing with a succession of chutes, in small channels between a number of small, narrow, rocky islands. The total fall here is over 100 feet, including three chutes of twenty, ten and thirty feet respectively.

Conglomerate Gorge.

Character of the lower river.

From the head of this rapid, the river bends to the south for a mile, then S. 30° W. one mile, and again south another mile to a chute of ten feet. At this last fall, the character of the river and surrounding country changes. From its mouth to this point the river has flowed in a shallow valley, nearly on the surface of a number of broad terraces of stratified sand and clay, arranged one above the other. Where it descends from one level to the next, the river has cut a valley back into the sands and clays of the upper terrace until the underlying rock has been reached, over which it falls in a succession of rapids and chutes, often hemmed in by steep rocky walls.

Marine terraces.

The terraces are composed of marine deposits laid down during the depression of the land at the close of the glacial period, when the level of the western side of the Labrador Peninsula was over 600 feet lower than at present. Farther up the river, marine deposits are wanting, and the surface material is formed of unstratified, coarse boulder clay. Owing to the absence of terraces, there are no marked drops from level to level, but rather a more or less gradual slope of the whole country, while the river, without even a shallow valley as in its lower part, flows almost at the level of the country and follows the general slope, except where diverted by rocky ridges that cross its course obliquely in several places. In the lower part the river is obstructed only by islands at the various falls, and there are few rock-exposures elsewhere; while in the upper part rocky islands are everywhere numerous, and long stretches of the shores are also formed of rock.

Country surrounding the lower river.

The surrounding country, in the lower part, is generally flat and often swampy, but there is a marked absence of small lakes though about the upper part of the river some are found in every valley between the low, rounded, rocky hills that characterize this region. The soil in the hilly country is scant and poor, being composed wholly of boulder-clay, often with very little finer material. The climate also appears to be more rigorous than it is nearer the sea-coast, and the timber is much smaller, consisting of the following species arranged in order of abundance:—Black spruce, Banksian pine, larch, balsam fir, white birch and a few stunted aspens. The larch grows to the largest size, a few trees being upwards of twelve inches in diameter near the base; the other species seldom or never have a diameter

Timber.

exceeding nine inches, and in the upper part of the river are only found growing thickly on the lower ground, about streams or lakes, with the hills only partly covered by small trees of black spruce and Banksian pine. The white spruce does not grow beyond the limits of the deposits of marine sands along the East Main River.

Above the last-mentioned chute, the next course is about due east, including two short sharp bends to the south, in a distance of eight miles. Along this course, the river flows in a shallow, rocky channel, about a quarter of a mile wide, through an almost flat region, broken only by a few low, rounded hills. The descent is sharp, there being five rapids and two chutes of six and eight feet, separated by short intervals of swift current. At the upper rapid and chute, the river bends to the south-east, for another eight miles. In this interval it is broken into several channels by a number of large low islands, strung out along the entire distance. The current in these channels is moderate, with only one small rapid near the upper end. The Kausabiskau River is a small stream, that falls in on the south side near the foot of this rapid.

Character of river above Conglomerate Gorge.

Further up, the river for twenty-five miles, forms a long gentle curve, bending first slightly north and then south of east, so that a line joining the ends of the curve would run east-and-west Here, stretches of quiet water connect five short heavy rapids. Rocky islands are numerous and the shores are low and in places rocky, but more commonly swampy. To the south, there are hills running in ridges roughly parallel to the course of the river. These culminate four miles up this course, in Flat-topped Mountain, that rises nearly 500 feet above the water-level. The rest of the range rarely exceeds 300 feet, and 250 feet may be taken as its mean height above the general level. Similar ridges of rounded hills are seen to the northward, but they do not appear to be as high as those on the other side and they are more distant, leaving a wide margin of low swampy land between their bases and the river. The trees on these hills have almost all been burnt recently, leaving only a few patches of green wood. Where the rapids occur in the river, the hills close in on either side.

Swamps.

Medium sized rivers fall into the main stream at the second, sixth and tenth mile of this course. The first and third are called respectively, Wabistan and Akuatago, both coming from the southward; the second is called the Wabamisk, and comes from the northward. It is much larger than the others, being about 200 feet wide, at its mouth, with a slow current.

Wabistan and Akuatago rivers.

The main river above bends to the south-east for eight miles, and then to the east again for eight miles. The country and river have much the same character as the part last described; the current being somewhat stronger, with three small rapids. At the upper end of the last course, there is a small stream, called the Clearwater River, that comes in on the north side, and flows in a wide straight valley from E. N. E., a continuation of the valley in which the main river flows below. The Indians who hunt in this region, say that it is only a half day's journey from the mouth of this stream to a large lake on a branch of the Straight River.

The Great Bend.

Turning now sharply to the south-west, the main river, which has had an average breadth of over a quarter of a mile, enters the Great Bend, and contracts to about 100 yards, and for the next fifteen miles is nothing but a succession of heavy rapids and chutes. Its banks are high and rocky in most places as it breaks the range of hills before mentioned on the south side. The surrounding country is much rougher than any before seen, with rounded hills, from 200 to 300 feet high, arranged in close parallel ridges. The lower six miles of the river are particularly rough, and as the perpendicular cliffs on both sides render portaging impossible in many places, it is with difficulty that this part of the river is passed with canoes. At one place about three miles from the foot of the rapids, there is a sharp bend to the northward, and the water rushing down is deflected by a sharp point running out from the east side at the bend, which causes the greater volume of the water to enter a small bay, where a great whirlpool is formed. It is stated that many years ago two large canoes belonging to the Hudson's Bay Company were drawn into this whirlpool and all on board drowned.

Broken country.

Whirlpool.

At the upper end of this south-west course, a small stream, called Misiatawagamisistic River, comes in from the south-west, and it is believed that there is a portage-route by it, past the rapids below.

Turning now to S. 40° E. for three miles, the river gradually widens, and passing two small rapids, again becomes easily navigable. It flows, with a sluggish current, in a channel 500 yards wide, and only slightly below the level of the surrounding low, flat, swampy country. This continues for fifteen miles, the general course being N. 60° E. Two small rivers come in along this course from the north. At the upper end there is a fall of ten feet, above which the river, continuing along the same course for fourteen miles, has a similar sluggish current, with the exception of one small rapid at the head of two large islands. The surrounding country remains low and swampy, except in the vicinity of the rapid, where a low range of hills passes close to the river on the south side.

Country above the Great Bend.

Above the two islands, the river again turns to the east, and flows with a remarkably straight course for nineteen miles. The hills on either side here close in and narrow the valley, through which the river runs at a uniform rate of about four miles per hour, in a shallow channel averaging 400 yards in width. The hills, as a rule, do not rise much above 200 feet from the water, and only an exceptional one reaches 300 feet. They are arranged in ridges nearly parallel to the course of the river.

Along the upper three miles of this course, the channel narrows to about 150 yards, and the current increases where a descent is made through a narrow cut in the hills. There is now a sharp bend to the south and then to the south-west for a mile and a half, as the river cuts through a range of hills, with a fall of twenty-five feet, including a chute of fifteen feet. At the bend, a small river comes in from the north-east. Narrow channel.

The surface material covering the hills along the last two courses is generally thin, and is in places composed largely of boulders, often of large size, with the spaces between them only partly filled with finer material. Soil.

The forest, for the most part, is made up of small second-growth black spruce, Banksian pine, larch, balsam fir and white birch, with a few aspen poplar. Forest.

Above the bend, the river again enters another valley between parallel ridges. Its courses are: first, east five miles, then N. 60° E. four miles, and again east eight miles. The average width is again about 400 yards, with a swift uniform current and only one small rapid. As this portion is ascended, the country becomes rougher, and the hills rise with steep slopes, from 200 to 400 feet above the water. The greater part of this region has been recently burnt, only patches of blackened soil being left to partly cover the rocky hills, while innumerable boulders are seen scattered everywhere over the surface. A river about three chains wide at its mouth comes in from the south at the end of the first course. Rougher country.

Another sharp bend of three and a half miles to the west of south now follows, and in the lower mile and a half the river passes through a narrow rocky channel with perpendicular sides, called Prosper Gorge, and falls in a succession of chutes and rapids over one hundred feet. To avoid this obstruction, the river was left four miles and a half below the bend, by a portage of three-quarters of a mile, which passes over a ridge and ends about the middle of the west side of a lake three miles long and three-quarters of a mile wide. This lake discharges from its Prosper Gorge.

north-east end by a small stream, nearly a mile long, into a second lake one mile long by half a mile wide. Crossing this lake, the small crooked stream by which it discharges, is followed some two miles to where it falls into the main river, two miles above the bend, and thus above the chutes and rapids. There is only a slight fall from the upper lake to the river, and as a consequence, when there is a freshet in the main stream, the water from it backs up into the lakes instead of discharging from them.

Above this portage the river becomes very crooked. It first flows from the east for a mile and a half, then from south-east one mile, N. 80° E. three miles, S. 30° E. three-quarters of a mile, S. 45° W. a mile and a half, and finally S. 45° E. six miles, where it leaves an expansion over one mile wide, and full of large islands, at the foot of the Ross Gorge, running south.

Ross Gorge.

Through this gorge the river falls sixty feet in two miles. The portage past it starts from a small bay on the west side, and is divided into two parts by a small pond. The first part is 300 yards long and rises about 150 feet; the second is three-quarters of a mile in length, passing over a steep ridge of boulders and ending in a small stream which enters the river a short distance above the head of the chutes.

Lake Nasaskuaso.

About half a mile below the upper end of the portage, a river falls in on the north side. It flows in a deep, rocky valley running east-north-east for several miles, and has a long heavy rapid above its mouth. Its size has been estimated at about one half that of the main branch, and it has been called Ross River. Above the gorge the main river is split into a number of small channels by several low islands. These islands form a delta in the eastern end of Lake Nasaskuaso, which extends to the westward six miles, and is a mile and a half across in its widest part. The river passes only through the east end of the lake, which formerly must have extended to the head of the portage, the portion now occupied by the delta having been filled up with alluvium brought down by the river. Surrounding the lake are rocky hills that rise from 200 to 400 feet above its surface. The greater part of the adjacent country has been burnt over recently.

Hudson's Bay Company's canoe route.

From its west end, the canoe route of the Hudson's Bay Company leaves the East Main River to cross to the Rupert River on the way from Nichicun to Rupert House. This lake is considered by the employees of the company to be situated half way between these two places. The Indians who hunt in this region are in the habit of congregating here and on the lakes at the foot of the large island above, to meet the canoes going to and returning from Rupert House.

Above Lake Nasaskuaso the character of the river and country again changes, the latter becomes flatter and less rugged, the hills seldom rise over 150 feet above the river, and the ridges are farther apart, with swamps and small lakes filling the broad shallow valleys between them. The river flows almost on the surface, and is often divided into several channels by large islands. Small lakes and bays also branch off on either side, so that it is difficult to tell when a tributary river falls in.

Character of country above Lake Nasaskuaso.

In this manner the river continues for nine miles, when it becomes divided into two main channels by Grand Island, fourteen miles long and five broad. The north channel is more than twice the size of the south one, and it is further sub-divided, especially in its lower part, by large islands. The south branch, from the foot of the island, passes southward about five miles and widens out into two lake-expansions with numerous bays, all having an east-and-west direction. Into the south-west bay of the upper lake, five miles from its outlet the Clearwater River enters. This is a small stream flowing out of a large lake of the same name on the portage-route from Lake Mistassini.

Grand Island.

The upper lake referred to has been called Tide Lake, on account of the deposits of mud that cover the shores and islands up to freshet mark of the river, giving the lake the appearance of a tidal bay at low water.

For seven and a half miles above the head of Grand Island, the river averages 500 yards in width, but is shallow and much obstructed by sandy shoals. Its direction is again east, and at the head of this course is the junction of the Tichegami River. This stream takes its rise, according to the Indians, to the south-east, near the head-waters of the rivers flowing into the north end of Lake Mistassini. In volume, it appears to be about two-thirds that of the main branch, and it has a heavy rapid at its mouth.

Tichegami River.

There are only a few families of Indians who hunt along the lower part of the East Main River, there being a long interval from Lake Nasaskuaso to below the Great Bend, that is totally uninhabited. Owing to the numerous rapids and chutes, this river above the mouth of the Straight River, is not used as a highway to the interior, and only one family ascends it above that stream. Previous to 1889, there were three families who hunted in the neighbourhood of the Wabamisk River, but during that winter, with the exception of one woman and a small boy, these all perished by starvation or cannibalism. In 1892, the scene of this tragedy was found at the mouth of that river, but, nothing being known of such an occurrence, it was only remarked as

Indians of the East Main River.

Famine.

unusual that Indians should leave their tents standing, and their household effects scattered about.

Above Lake Nasaskuaso, from the many old camps seen along the river, there must be a number of families who hunt in this vicinity, and who in the summer descend to Rupert House, by the portage-route to the Rupert River. Owing to the absence of hunters along the greater part of the river, the fur-bearing animals are rapidly increasing, and beaver signs are quite common; bear tracks are also numerous in the burnt regions. Not a sign of caribou was observed from Lake St. John to James Bay, and these animals seem to have been totally exterminated in the region about Lake Mistassini and from there westward to James Bay, being now only met with to the north and north-east of the East Main River.

Increase of fur-bearing animals.

Fish.

Fish are found in abundance in every lake and river, throughout the region. The following kinds were taken in the net along the East Main River:—Whitefish, pike, pickerel and suckers. In the lower parts, where the banks and bottom are formed of clay, sturgeon are taken in abundance by the Indians; and from the mouth to the first fall, and in the tributary streams, small whitefish and sea-trout ascend from the sea in large numbers, from about September 1st, until the river is closed by ice. Trout are also caught in the rapids of the upper part of the river.

Upper East Main River.

Three miles above the Tichegami, a rocky ledge crosses the river diagonally, causing a low fall, where the survey of the lower part of the river in 1892 began. Above this fall the river bends sharply northward for a half mile, and then about south-east for three miles, to the head of a long, but not strong rapid, which occupies the upper half of that distance. The direction now changes to north-north-east for two miles and a half to the mouth of the Kowatstakau River, a large branch coming in from the northward and entering the river from a considerably higher level by a heavy rapid or low chute. According to Indian estimation this stream carries about one-sixth of the water of the main river. Immediately above the forks, what appears to be another branch, also broken by rapids, is seen on the south side; but it is only a channel passing on the south side of a large island or islands, and separating from the main channel above the rapids and portage, five miles farther up. The north or main channel contracts from a width of nearly half a mile, below the island, to less than a quarter of a mile, and the current is quite strong, with two rapids, the lower of which

Kowatstakau River.

two miles above the foot of the island, is a half mile long; but the upper one is short and steep, with a tremendous rush of water, the river falling eight feet in one hundred yards. The portage is on the north side, and is called the Sunday Portage.

Up to this portage the country surrounding the river is low and almost flat, with only a few isolated hills that seldom or never exceed one hundred feet in elevation above the general level, while the river flows only slightly below it, in a shallow valley from 300 to 1000 yards wide, having in most cases low sandy banks never more than seventy feet high. The sand and gravel of the banks are made up of modified boulder-clay arranged by the action of the river. On either side of the river, the soil appears to be light and sandy, and, as small fires only have traversed this region, the timber has not been destroyed, but thickly covers the country, the trees occurring in the following order of abundance:—black spruce, Banksian pine, larch, balsam fir, white birch and aspen, the last being exceedingly rare and only found along the river in low straggling clumps. Character of surrounding country.

Above Sunday Portage the river flows directly from east for the next four and a half miles. The average width is nearly 400 yards and the current is strong, with two rapids one and two miles above the portage, the upper one being so heavy that canoes must be lightened to ascend it. The portage past it is about 200 yards long, on the north side. At the foot of the lower rapid a small branch from the south joins the river.

The river now turns sharply to the northward, and, flowing from that direction, in the next mile breaks through a low ridge in a shallow, narrow, rocky channel, and falls fifty-five feet from the level above, the descent taking the form of a heavy rapid. To pass this the Pond Portage is made on the east side. To reach it a small stream is ascended about 200 yards, and from there 200 yards portage up a low hill leads to a small pond; crossing this, a rough road over boulders and through swamps for half a mile ends at a small channel of the river, behind an island. From here the course is N. 45° E. for a mile, and then in a general direction N. 45° W. for five miles, with many minor bends and crooks. About one mile up this course, what appears to be a large branch comes in on the east side, but it is probably only a channel leaving the main stream several miles above, and so forming a large island. The river continues about a quarter of a mile wide, is shallow, and flows with a strong steady current, breaking into small rapids at points and narrows. Another small stream comes in from the northward at the upper end of the course. Now again bending Pond Portage.

eastward a mile above, the river widens out into a small lake, so crowded with low islands that its limits cannot be seen.

Character of country above Sunday Portage.

From Sunday Portage to this lake, the character of the river banks and surrounding country is similar to that before described, the banks being low and the country nearly flat, with isolated hills and rocky ridges generally under 100 feet, and never exceeding 250 feet in elevation.

Height above sea-level.

Owing to an unfortunate accident on the Koksoak River, through the upsetting of one of the canoes, the barometer readings were lost, and only a few booked in the survey note-book remain. From the mean of these data the height of the river in this vicinity is roughly found to be 1400 feet above sea-level, which agrees closely with the supposed difference of level between here and Lake Mistassini, that place being fixed from the mean of readings taken from two aneroid barometers and extending over several months.

Hills.

From the lake-expansion, the river bends southward for a mile, and then directly east, flowing from that direction four miles, from the base of a high rocky hill on the north side, which forms a part of a range extending from beyond the north side of the lake to the eastward. These hills are very steep and rocky, being formed of the hornblende-granite that now takes the place of the softer schists and gneisses of the flat country below. They rise from 400 to 500 feet above the river.

Trees.

Before reaching the foot of the hills, the river becomes somewhat wider and flows between low banks of sand and gravel with a moderate current in a shallow channel, much obstructed with low sandy shoals. Much of the surrounding country has been burnt over, and in part is covered with small second-growth trees, Banksian pine then predominating. Where unburnt, the forest is somewhat larger and thicker than that seen lower down; this is owing most likely to a better soil.

Lower country about Sharp-rock Portage.

At the foot of the hill the river again abruptly bends to the south for a mile and then gradually turns and resumes its easterly course for five miles to Sharp-rock Portage. Up to here the character of the river is similar to that lower down, being flat and shoal, with a moderate current broken by two short rapids, the lower on the bend and the upper two miles above it. The range of hills on the north side continues along the river and crosses it at the portage, but so much lower that at the crossing it is little over a hundred feet high. To the southward the country is almost flat and both sides have been almost totally burnt over, the fire on the north side being most recent.

Sharp-rock Portage is on the north side and is about 400 yards long, the lower half passing over sharp vertical bands of hornblende-schist. The river falls ten feet over the same ledges.

Above the portage, the course is N. 60° E. for three miles to another portage, 200 yards long, where a chute of eight feet occurs. Between the portages the banks are low, with traces of a terrace twenty feet high on the south side.

Farther up, the river flows from the north for a mile, and then from the east four miles to where it passes out from between rocky hills, from 200 to 250 feet high. From the last portage to this point, the flat valley is somewhat wider, and the shallow channel of the river is obstructed by a number of islands and gravel shoals, the current here being very strong. *Wide valley above Sharp-rock Portage.*

After the hills are entered, the course is south-east for two miles, and then north for two miles. Along the south-east course the river is less than 300 yards wide, but on the northern course the width is irregular, varying from 300 to 800 yards. The current everywhere is strong.

At the bend, a medium-sized stream comes in from the south, and perhaps another on the north side a mile below. Another bend to the eastward, and a mile of river, leads to Mink Chute, thirteen feet high, passed by a short portage over the rock on the east side. *Mink Chute.*

The country surrounding the river from Sharp-rock Portage to here, is rougher than that seen below. The ridges of rocky hills are closer together and slightly higher, and there are also ridges of till apparently arranged roughly parallel to the direction of the glacial striæ, or S. 70° W. On both sides of the river there have been extensive fires and little of the original forest remains. The trees continue similar in size and numbers to those described below, aspen being the only one now absent. Terraces of sand and gravel are seen on both sides up to thirty feet above the water, and occasional cut-banks of boulder-clay are noticed, where the river has eaten away parts of the low hills of drift mentioned above. The rocky hills are moderately strewn with boulders. *Character of country above Sharp-rock Portage.*

Mink Portage is followed closely by another short one, on the south side, past a chute of nine feet; and then for five miles the river flows rapidly between low and rocky banks to Channel Portage. This portage is on the north side, and is about 800 yards long, terminating in a small channel above a fall and behind several rocky islands. Up to the head of the islands there is but one small rapid in the next mile, whereas the main or south channel is a succession of chutes and heavy rapids for nearly two miles. *Channe Portage*

From the head of the islands, the river widens to over half a mile and flows evenly from the north-east between low sandy banks, over which can be seen high hills in the distance to the north-east, east, and south-east.

Four miles of quiet water is followed by a shallow, flat rapid, full of small rocky islands and large boulders. After a sharp bend the course is to the north for a mile, and then north-east for two miles to another small lake-expansion. Along the two last stretches, the river, contracted to less than 300 yards, flows between rocky banks, and is greatly obstructed by rocky islands and ledges, which cause short heavy rapids with very swift water between them.

Character of country above Channel Portage.

On the south side, at the head of the rapids, a conical hill rises 350 feet above the river. From its top a good, unobstructed view of the surrounding country may be obtained, as it is totally burnt over and bare. To the north-east, the river is seen flowing with but one bend, through a wide, straight valley, surrounded by low hills. Those on the north side are about 200 feet high, and are arranged in close, compact ridges, everywhere well wooded. On the south side, there is a wide valley filled with small lakes, that separates the conical hill from a higher range parallel to, and forming the north wall of the river-valley. The highest of these hills reach and may exceed 500 feet. They are bare and rocky, and have a very barren, desolate appearance, due to the absence of green woods; fire rather than unfavourable climatic conditions being the cause, as some of the hills have small patches of unburnt trees upon their summits. The sides and tops of these bare hills are strewn with innumerable boulders of all sizes, from masses several tons in weight to small gravel, but there is not much of the finer material on the upper parts.

Timber.

In the river-valley, larch is seen eighteen inches in diameter, and black spruce and balsam fir of twelve inches, are common. The only evidence of an approach to barren ground, is afforded by the thinning out of *Ledum* and *Kalmia* and the substitution of white reindeer moss as undergrowth, while the trees begin to grow wider apart with frequent open glades.

Abundance of till in this region.

Above here the character of the river changes somewhat, long islands of till are numerous, and there is a marked absence of terraces or stratified deposits, these being replaced by banks of irregular height and outline, formed by the river cutting through the low lenticular hills of moderately fine boulder-clay. The islands formed of similar materials, appear to be hills of the same description, and have only been separated from those on either shore by shallow channels cut between them. For three miles and a half the river is over half a mile wide, but is very shallow, and its bottom is thickly strewn with boulders and subangular blocks of gneiss and granite, very similar to the rock-masses seen in place in the vicinity. The descent, both here and in the expansions further up stream, is constant and quite steep, causing the water to flow with a very swift smooth current, which is more difficult to ascend in canoes than broken water, where the eddies and quiet places behind boulders and other obstructions are available to rest before the canoemen attempt other short ascents; whereas in the steady, strong, smooth current no such chances to rest occur, and every foot gained must be held.

Bending from east to north-east, the river contracts to about 300 yards for two miles, and again expands at the head of a large island, at the end of the course. Two small streams enter from the north, at the upper and lower ends of the stretch.

Turning eastward again, the banks become more rocky and irregular, with numerous small bays, so that the breadth of the stream varies from 300 to 1200 feet. There is a small rapid one mile and a half up, and at its head a large stream named the Misask River enters on the north side. From this place the general course is N. 50° E. for six miles, to the Cascade Portage.

Misask River.

Immediately above the Misask River, the main stream is divided into two equal channels by a large island. The north channel is followed east for two miles and then south for three-quarters of a mile to the head of the island. The whole distance is a continuous rapid, culminating on the south bend in a chute of fifteen feet, which is passed by a portage of 800 yards on the east side. There is a steep rise of one hundred feet at the lower end of this portage, from the river up a cut-bank of till, to the level of the ridge above. From the head of the island, half a mile of quiet water leads to another portage, on the west side, 1000 yards long, past heavy rapids, followed by small rapids for half a mile, to the foot of another large island. Following the smaller and southern channel, another half mile of stiff current leads to the Meat Portage, 300 yards long, on the west side. Another short rapid is then passed, to the head of the island. The rise in the river has now brought it to a level with that of the surrounding country, which is broken only by low ridges of till and an occasional rocky hill, seldom exceeding one hundred feet, so that the surface presents the appearance of a very rolling prairie, especially to the southward, where most of the trees have been burnt. Everywhere the surface is covered with innumerable boulders and subangular blocks of granite and gneiss.

Heavy rapid to Meat Portage.

Character of the river below Long Portage Creek.

Having now reached the general level, the character of the river changes, and for the next nine miles, to Long Portage Creek, it is a succession of lake-expansions, connected by short rapids. These expansions are broken by deep bays, running between the low ridges, and often pass by small narrows into other lakes, the country being now covered by a perfect network of small lakes and watercourses, lying between the low hills. The general course is slightly south of east. The first lake is about one mile and a half wide, and it is two miles from the head of the island to the next narrows and rapid. The water is shallow and there are several large islands. The rapid above is half a mile long and is followed by a smaller lake, one mile long, to a very heavy rapid, passed by a portage of 900 yards on the south side. Above, there is quiet water for half a mile, and then rapids, half a mile long, are followed by swift current for two miles to the next lake-expansion. This lake is also full of large islands, and a narrow channel on the north side leads into a chain of lakes extending over ten miles to the north-east and branching off into numerous other small lakes on either side of the main chain. A mile and a half of steady current leads to another small lake, into which the Long Portage Creek flows.

River above Long Portage Creek.

Here the main river takes an abrupt bend to the south-west, and after a short sharp rapid is ascended is found to widen out into a string of lakes with numerous deep bays, for about fifteen miles; it then breaks into a heavy rapid two miles long, above which it continues south-west for a considerable distance, when it again turns eastward, passing behind a high hill some fifteen miles south of the forks.

Character of country above Long Portage Creek.

The country about the forks is very similar to that already described, consisting of a series of low ridges of boulder-clay, arranged in broken roughly parallel lines, coinciding with the direction of the glacial striæ, or S. 70° W. The general height of the ridges is about fifty feet, while the highest rarely exceed one hundred feet. Between and parallel with them are innumerable small shallow lakes, irregular in shape and full of high islands formed of mounds of till. These lakes are joined together by small watercourses, following each valley, and the different chains often have lateral connections where an interval occurs between overlapping ridges. The only conspicuous landmark in this vicinity is the rocky hill situated about fifteen miles south of the forks; it rises about 500 feet above the general level, and is unconnected with any other high land. To the south, south-east, east and north-east the horizon is bounded by chains of high hills, at a distance ranging from twenty to fifty miles from the forks.

Upper East Main River.

The East Main River was explored only as far as the head of the two-mile rapid mentioned above. The route to Nichicun leaves the main stream at Long Portage Creek, where the river is still a large stream, being nearly 200 yards wide at the rapid there, with an average depth of three feet. According to information received from the people at Nichicun, the main stream, although large where the route leaves it, soon splits up into numerous branches, none of which are of any considerable volume or length. The river bends to the south-west for some twenty miles, and then turns eastward again along the northern foot of the mountains that here form the watershed between the Rupert, East Main and Big rivers, flowing into Hudson Bay, and the Peribonka and Outardes rivers, emptying into the St. Lawrence.

Long Portage Creek.

Misawau or Long Portage Creek, from its mouth to the portage, following the stream, is thirty-three miles long; but in a straight line the distance is twenty-four miles, and the general course is slightly north of east; the difference in length being due to its crooks and turns. From the East Main River, for the first six miles the course is north-east, the stream here consisting of a number of small irregular lakes, joined by short stretches of river. At these narrows the river is generally about one hundred feet wide, with a moderate current and deep water. This course terminates with a rapid of six feet fall, passed by a portage of 400 yards on the north side.

For the next four miles the river flows from the east, with a uniform breadth of one hundred feet. The current here is strong, with three short rapids, the upper passed by a *demi-charge*. Next follow small lake expansions and swamps for four miles, in the same direction, with one short rapid near the upper end. Still further up, the river is crooked, and forms a reversed curve, ending at the forks, four miles beyond, where it splits into two equal branches, the route following the eastern one.

Rocky Portage.

Above the forks, the average breadth continues to be about one hundred feet, and where small rapids or swift current occur the water is so shallow that wading is resorted to in order to pass loaded canoes. For nine miles from the forks, to the Rocky Portage, the character of the river is constant; it has in most places a sluggish current, with small shallow rapids at long intervals. The banks are low, and the immediate surrounding country swampy. The portage is 500 yards long, and follows the side of a hill on the south shore. The river here passes through a narrow valley, between high rocky hills, and in so doing falls thirty feet. The valley widens above the portage, and the river again flows from the east, in a low valley, filled with numerous small lakes on both sides, connected with the river. As the Long Portage is approached, the river becomes more rapid and shallow, and it is only with great difficulty that loaded canoes can be taken up it. It is left at the Long Portage, where it turns to the northward, rising in the small lakes in that direction, at no great distance above this place.

Character of country about Long Portage Creek.

The country surrounding the lower part of this stream is almost flat, and is traversed by ridges of till never more than fifty feet high. These gradually rise until the forks are reached, where they average 100 feet. From the forks to the Rocky Portage the hills recede, leaving a low swampy valley through which the river flows sluggishly in a channel but little below the general level. At this portage the first rock seen in place along the river occurs. The stream here falls over ledges of red granite as it passes down a narrow valley between two steep rocky hills that rise abruptly to 300 feet.

From here to the Long Portage the valley is again wide and strewn with numerous small lakes and swamps, connected by short channels with the main stream. The hills on either side now have an average elevation of 300 feet, and often show rocky faces.

Over one half of the country surrounding the river has been burnt, and is now covered only with low shrub and reindeer moss. Owing to the want of forest growth, the innumerable boulders and angular blocks of all sizes stand out in remarkable distinctness, giving to the hills the appearance of gigantic plum puddings. These blocks and boulders with the amount of drift are a feature of the country, the drift along the lower parts of the stream being so thick that it covers all the underlying rocks which can be determined only from the profusion of angular, untravelled blocks scattered about. On the very summit of the high granite hill on the north side of the river, at the Rocky Portage, there is a perched boulder over ten feet cube. Its corners are only partly rounded. Numerous other large boulders are scattered over the highest parts of this hill, and so thickly are they everywhere strewn that one might walk for miles over the country in almost any direction without touching the soil with the foot. The trees along the river are small and somewhat scattered, with little underbrush, the ground being covered with white moss and arctic berries. Black spruce predominates, with larch in the swamps and Banksian pine on the higher lands. There are also a few small white birches and balsam firs. One very small clump of aspen was noted.

Long Portage

The Long Portage is two miles in length, and from the creek passes S. 30° E. over a ridge 200 feet high, terminating at a small lake 150 feet above its lower end. The lower half is burnt bare, but there is at its upper end a thick growth of small black spruce, with a few Banksian pines and larches. This portage is over the watershed which divides the creek from the waters of the Pemiska Branch of the East Main River.

From the portage at its upper end, a small shallow lake is followed by a portage of one mile to a slightly larger shallow lake full of great blocks of granite, which in turn is followed by another portage of a half mile, ending in another small lake, triangular in shape. The route to here has been due east; it now turns south, and in a half mile leaves the lake by the stream flowing out, with a short portage past a small rapid at the outlet, and so into Opemiska Lake. The country surrounding the small lakes consists of low ridges of till from fifty to one hundred feet high, well covered with small black spruce and larch to the exclusion of all other trees.

Opemiska Lake. Opemiska Lake is six miles long, with an average breadth of three-quarters of a mile. Its longest axis lies nearly east-and-west. The water is clear and shallow. There is one deep bay at the north-west end, full of small low islands. The shores are generally low and sandy, and the surrounding country is also low, with small ridges of till. Ten miles to the south-east of the lake, a high isolated hill rises about 500 feet above the general level, forming a conspicuous landmark; is regarded by the natives as the dwelling place of spirits, and on that account given a wide berth. The country about here is unburnt, and is well wooded with black spruce and larch, the former constituting over ninety per cent of the trees. The only other tree met with is balsam fir, found sparingly about the shores of the lake.

Pemiska Branch. The Pemiska branch of the East Main River, flows out on the south side, about the middle of the lake, and leaves it with a heavy rapid. Its volume here does not exceed one-quarter of that of the river at the mouth of Long Portage Creek. The route follows the lake to its eastern end, where it ascends for two miles a small river about fifty feet wide and full of rapids, with a total fall of twenty-five feet. Three short portages are necessary to pass the strongest parts of the rapids. The country surrounding the river is low, rough and rocky, with a superabundance of loose blocks and boulders, many of great size. Two were seen resting on a rocky knoll at the head of the rapids; the larger is more than twenty feet cube, and the smaller more than fifteen feet cube.

Wahemen Lake. The river ends in Wahemen Lake, another large body of water stretching to the eastward, divided by long, low ridges of till into a bewildering number of deep bays. The route closely follows the southern shore, and, passing a small narrows, ends at a portage four miles from the outlet. The portage is 1400 yards long, and joins the river above a heavy rapid. From there to Patamisk Lake, at its head, the distance is eight miles, in a general east course. The river passes through five small lakes, each full of deep, narrow bays, and connected with the next lake by short, rapid stretches. The numerous bays and the small size of the stream makes it very difficult to follow the route without a guide.

Patamisk Lake.

Lake Patamisk is reached by a portage of 1000 yards past a rapid in the river, which is here not above twenty-five feet wide and very shallow. This lake is the largest passed through between the East Main River and Nichicun. The route traverses the lake to the end of the north-east bay, seven miles from the outlet. Large deep bays indent both sides, and the main body is filled with large islands, which obstruct the view and hide the real size of the lake. A deep bay extends westward from a point half a mile above the outlet on the south side. The limits of the shore on the north side could not be determined, nor those of a wide deep bay on the south-east side, but the lake evidently extends to the foot of some hills about ten miles from its entrance. The water is very clear and in places deep, but as a rule shallow.

Watershed between East Main and Big rivers.

A portage of 500 yards leads from Patamisk Lake to a small shallow lake one mile long, with a portage 200 yards from its east end into another smaller lake half a mile long. The portage from this lake crosses a low bouldery ridge and ends in Kawachamack or Crooked Lake, about twenty feet below the level of the last, draining into the Big River; so that the last portage is over the height-of-land between the Big and the East Main rivers.

Character of country at the watershed.

The country surrounding the route from Lake Opemiska to the height-of-land is everywhere the same, consisting of ranges of hills of boulder-clay seldom more than 100 feet above the general level. These are separated by wide irregular valleys filled with small lakes, so that fully one-third of this area is covered with water. An occasional rocky hill may be seen rising from beneath the masses of till, sometimes attaining a height of 300 to 400 feet. Immense numbers of boulders and loose angular blocks continue to be scattered in wild profusion everywhere. As the height-of-land is approached, the forest growth becomes smaller and less thick, and is made up almost wholly of black spruce, the largest of which are about six inches in diameter; the only other tree is the birch, which forms less than ten per cent of the whole. Where fire has passed, a number of years elapse before the second growth of black spruce springs up, which it does then only in a thin straggling manner.

Crooked Lake, stretching N. 60° E., is nearly five miles long and averages one mile in width, with numerous small lateral bays, which give it an irregular outline. The western part is filled with islands. The north shore is almost wholly burnt and bare, while small black spruce and larch cover the hills on the south side. The country becomes higher and rougher, with more rock showing up from beneath the drift. A short portage at the east end leads directly into the south-west branch of the Big River. This river rises about sixty miles to the south and south-west, where it drains a number of lakes lying along the northern slope of the mountains, close to others emptying into the head-waters of the East Main River to the west and those of the Outardes River on the south side of the mountains. The watershed in consequence runs east-and-west here, on or near the fifty-second parallel of latitude. Crooked Lake.

The route enters the river at a bend, where its course changes from north to east. In size it is nearly as large as the East Main River at the mouth of Long Portage Creek, being in the rapids about 200 feet wide, with deep water flowing four or five miles an hour. Big River.

From the portage, the river flows N. 60° E. for eight miles, to the foot of a sharp rocky hill 280 feet high. It flows almost level with the general surface, and, like all the streams of the region, is made up of a series of small irregular lake-expansions, connected by short narrow stretches of swift water. Even in the widest parts a moderate current is appreciable. At the foot of the hill, the river enters a large lake that stretches several miles to the eastward, and has several deep narrow bays separated by low parallel ridges of till. This body of water is called Big Back Lake. The river flows only through its north-west part, leaving it half a mile below its entrance, and then bending sharply to the west, passes close to the foot of the hill, and enters Back Lake. From the top of the hill, looking north-west, the country as far as could be seen in that direction appears as if covered by a great number of small lakes that lie parallel to, and are separated from each other by low ridges running east-and-west. These are not separate lakes but deep bays of either Back or Nichicun lakes, these two bodies of water being separated only by a small short rapid. Back lakes.

This rapid is five miles from the foot of the hill, through Back Lake, but the irregular shore-line of the lake must be at least fifty miles long. From the hill, the irregular outline of Nichicun Lake is seen stretching away toward the north for a great distance, bounded by Lake Nichicun.

7

bold rocky hills often rising from 400 to 500 feet above its level. Through breaks among these are seen the valleys of the outlets of the lake. Toward the east, the country beyond the Back Lakes is seen rising in ranges of hills from 300 to 800 feet high, of sharper outline than the ordinary Laurentian hills. These bound the horizon to the south-east and south, and are said to form the north-east flanks of the central mountain range of Labrador which extends along the watershed in a north-east and south-west direction from the bend of the East Main River to about thirty miles east of Nichicun. Thence it gradually sinks and is lost in the general level of the country, which must there be over 2000 feet above sea-level. To the south-west and west the country is lower, with isolated rocky h ls rising above the level of the low ridges of till.

Forest fires.

The only signs of an approach to the barren lands is the lack of trees on the tops of the highest hills, but the rest of the country is well wooded where unburnt. Fires have destroyed great areas of forest in this region. They are sometimes caused by lightning, and when once started, burn with surprising rapidity, travelling as quickly through the dry, white reindeer moss as over the grass of the western prairies. The Indians too are often accountable for these fires, most of which, it is likely, have been started by them, as they use smoke for signalling from great distances. Islands in small lakes are usually fired for this purpose, but brands are often carried by the wind to the mainland, and thousands of acres burnt over in a short time, the fire continuing until the first heavy rain and often breaking out afresh when dry weather again sets in. At times the Indians purposely burn large areas in order to prepare the ground for bear-hunting; for within a few years after a fire, in this region, the surface becomes thickly covered with blueberries and other small fruits, forming feeding grounds for bears during the autumn months.

Climate.

The climate at Nichicun does not permit the growth of grain, and in the small patch of land under cultivation at the Hudson's Bay post, only potatoes are grown, and these rarely if ever ripen properly, the tops being frozen early in September, or even in August. Summer frosts are also common and often severe.

Trees.

The following information concerning the trees and shrubs about Nichicun was obtained from Mr. Jos. Iserhoff, who is in charge of the Hudson's Bay post there. Black spruce is found on the shores and islands of the lake in abundance, and trees that will square six or seven inches for twelve feet, are not uncommon. White spruce is not plentiful, and is seen only in certain places along the sides of the lower hills. Balsam fir is common, and is found everywhere near the water, some of the trees growing as large as the black spruce. Banksian pine is very rarely seen, its eastern limit being defined by a line drawn nearly north-and-south through the Long Portage, beyond which line to the eastward, only a few straggling trees are found, while on the west side it is very abundant. White birch is common about the sides of the small hills, especially where fires have passed long ago; but no trees of a size sufficient to afford bark for canoe-building are found in the vicinity, and all the bark is supplied by way of Hudson Bay. Although common about Lake Nichicun, a short distance to the north and north-east, it is very rarely met with. Small straggling aspen and mountain ash, found in little clumps at wide intervals, complete the list of trees of this interior portion of Labrador. Small fruits are very abundant, but the prevalence of early summer frosts seldom allows the fruit to ripen.

Size and outline of Lake Nichicun.

Lake Nichicun is 1760 feet above sea-level, and is a very irregularly shaped body of water, with numerous deep bays. It is so plentifully strewn with islands, that it is difficult to form an idea of its size; many of the islands are large, and one, Big Island, is six or seven miles long and about two miles wide. The greatest length of the lake is from east to west, about thirty miles, and at the western end a narrows continues on into Little Nichicun Lake, which extends several miles farther. At its widest part the lake does not exceed ten miles across, and it is so obstructed with islands there, that it appears much less. The average width is about five miles. The numerous long points stretching out from both sides, together with the islands, make it almost impossible to pass through the lake without great loss of time unless with a guide. One of its deep bays, to the south-west, heads within a short distance of the river, near the portage from Crooked Lake, and advantage is taken of this to pass the rapids in the river when travelling from Nichicun to the East Main River. The shores are low and covered with rows of boulders shoved up by the ice. The country surrounding the lake is rough, and covered with numerous ridges of boulder-clay. To the north-west, north and east, there are high rocky hills rising from 300 to 600 feet above the lake. The islands are mostly portions of boulder ridges, but some of the larger are high and rocky, especially Big Island. The water is very clear and moderately cold. As a rule, the lake is not deep and in many places it is quite shallow, with large boulders rising above the surface. It discharges on its east side, the river flowing out by three channels. The two southern ones soon join, but the northern channel does not unite with the others for nearly fifty miles, or until the river changes its course from north-east to westward.

Nichicun Hudson's Bay Company post.

The Hudson's Bay post is situated on an island a short distance from the inlet of the lake. This post has been long established, probably before the beginning of the present century. No record of the date is known, but in 1840, a Mr. John Spencer was in charge, and made a sketch-map of the surrounding country. At that time an outpost was situated at Lake Kaniapiskau. The map is now in the office of the Geological Survey, and is very interesting, as it shows the watershed between the St. Lawrence, Hudson Bay and Ungava Bay. At present the post consists of five small log buildings: the master's house, two servants' houses, a small store, work-shop and powder magazine.

Canoe route to Hudson Bay.

The supplies for the post are brought in from Rupert House by three large canoes, each manned by six Indians. In order to reach Nichicun in time to prepare for winter, the canoes leave the lake at the first open water, or about June 15th. The trip to Rupert House is made by the route to the East Main River, down it to a small lake called Nasaskauso, thirty miles below where the route to Mistassini turns off. From this lake a portage-route through a long chain of lakes is followed, and the Rupert River reached a few miles above Lake Nemiskau, about 100 miles above Rupert House, the river being descended to that place. The total distance from Nichicun to Rupert House, by the route followed, is somewhat over 500 miles. It takes two weeks to go down with the canoes partly loaded with the furs taken during the previous winter, Rupert House being reached about July 1st. Three or four days are spent there, and then the return trip up stream is commenced, and by working throughout the long summer days, from daylight to dark, Nichicun is again reached between the 15th and 30th of August. On leaving the coast, the canoes are loaded down to the gunwales, but before their destination is reached over a quarter of their loads are consumed. This gives some idea of the difficulty experienced in supplying an inland post like Nichicun.

Sustenance of the inhabitants.

Sufficient provisions cannot be brought in to support the people at the post, who have thus to depend largely on the country for food. During the summer they subsist almost wholly on fish, caught in nets in the lake, and are often for months without small luxuries such as tea, sugar and tobacco. During the winter the living is better, for then, besides the small rations of flour and other provisions, they are able to obtain abundance of fresh meat. About a dozen caribou are killed by the people of the post during the year, besides beavers, musk-rats and bears. Usually rabbits and ptarmigan are abundant during the winter season, and are shot and snared as required. In some years, however, both rabbits and ptarmigan are not plentiful, and caribou are scarce. During such seasons the food supply is very limited, and great care must be taken to prevent starvation, especially as the Indians are affected by the same circumstances and flock to the post for relief. A supply of salt fish is laid in, every autumn, in case of need. The fish are principally whitefish and lake trout, caught with nets late in the autumn on the spawning grounds in various parts of the lake. The articles of trade in the store embrace small quantities of cloth, clothing, tea, sugar, tobacco, powder and shot. Fish.

There are about thirteen families of Indians who trade at this post, but this does not represent all the people inhabiting this portion of the interior, as a number of families prefer to descend to Rupert House and trade there, bringing in their year's supply themselves. Others living to the southward, who formerly traded at Nichicun, now descend the rivers flowing into the Gulf of St. Lawrence, and do their trading at Bersimis, Seven Islands, or elsewhere along the north shore. Indians.

These Indians belong to the western Nascaupee tribe. They speak a dialect closely resembling that of the Montagnais. The men are of medium height and fairly good physique. Some are tall and well developed, but the average height does not exceed five feet seven inches. Like other Indians they are sinewy rather than muscular. As a rule, they are less cleanly than the Montagnais, taking little care of their clothes or persons; and they generally swarm with vermin. Owing to the small numbers of caribou killed in this region, the natives are forced to clothe themselves in garments bought from the Hudson's Bay Company. They live in wigwams covered with cotton, as they cannot get either the deer-skin used in the north or the birch bark covering of the south.

The hunting grounds of the Indians of Nichicun extend from the height-of-land on the southward, to the head-waters of the Great Whale River on the north. To the eastward they hunt as far as Lake Kaniapiskau and down its discharge about fifty miles. There appears to be quite an extensive area between their eastern boundary and the western limit of the hunting grounds of the Hamilton River Indians, who trade at Northwest River post. There is also a large area without hunters on both sides of the Koksoak River, from where the Nichicun Indians leave off, to where those from Ungava begin, as no signs of Indians were seen along that stream for nearly 200 miles. The greatest number hunt to the westward of Nichicun, or about the head-waters and tributaries of the Big and East Main rivers. Hunting grounds of Nichicun Indians.

The presence of a trading post in the interior of Labrador, such as that at Nichicun, is at present absolutely necessary to the Indians inhabiting that region, and it is doubtful if the country would support half the present population without it. In seasons of plenty it is not necessary, the Indians transporting their furs to some point on the Necessity of a trading post in the interior.

coast, and returning inland with their next season's supply, but in seasons of starvation, without the aid furnished by the post, a majority of the people would die. The greatest number of deaths from starvation occur about the Rupert and East Main rivers, in the country midway between Nichicun, Mistassini, and Rupert House, where the distance is too great from any of these posts to obtain assistance during the winter. So great has been the mortality in this region, during the last few years, since the extermination of the caribou there, that the country is nearly depopulated, and a supply of provisions is kept by the Hudson's Bay Company at Lake Nemiskau on the Rupert River, to relieve the Indians in extreme cases of necessity. From the above, it will be seen, that although at present the population of the interior is small, it appears to be in excess of what unassisted nature would sustain with the present habits of the Indians.

Education and religion of the Indians.

The Indians of Nichicun all read and write the syllabic characters invented and taught by the missionaries of the Church Mission Society, and letters written on birch bark with charcoal are commonly seen on the portages along the various routes. The missionaries have also a number of books printed in these characters, including a selection of hymns and almost the whole of the Bible. These books are greatly prized by the natives. Although nominally Christians, their religion is greatly mixed with pagan ideas, and as their opportunities of acquiring a knowledge of Christianity is limited to the short stay every summer at Rupert House, it is no wonder that they retain many of their old beliefs. The visit to the coast is the occasion for the celebration of marriages and baptism.

Route from Nichicun to Lake Kaniapiskau.

Big River below Lake Nichicun.

We left Lake Nichicun by the middle discharge, on August 5th, 1893. The general direction of the stream is north-east. For two miles, to the first portage, its breadth varies from 50 to 300 yards, with swift water in the narrows. The shores are very irregular and are made up of low ridges composed almost wholly of large boulders, with little fine material. Along the river and in the small bays, are distinct traces of a terrace twenty feet above the present water-level. When the lake stood at that height, it must have covered an area nearly twice as great as it does at present, extending over a great deal of land now dry, more especially to the south and south-west.

The first portage is on the north side, following along the summit of a low ridge for 300 yards. The river here falls eight feet over a rocky ledge. Two other short portages in the next two miles pass similar small falls over ledges of rock. The third portage terminates in a bay of a small lake-expansion, the river taking a short turn toward the north and falling into the lake about half a mile beyond the portage. The next portage is three miles below, the river in the interval varying from 50 to 800 yards in width, with numerous small deep bays running off on either side. Into one of these small bays the south discharge falls. The portage crosses a narrow point, around which the river, greatly enlarged, rushes in a heavy rapid, obstructed by many huge boulders. On both sides of the river here are sharp rocky hills rising from 400 to 500 feet above the water. Below the hills the valley widens out, and the surrounding ridges are low, with isolated rocky hills rising at intervals above them. For the next eight miles the course is north, and the river alternates from rapid narrows to small lake-expansions covered with little islands and broken by narrow deep bays. In the narrows, the river breaks into small rapids full of boulders, and has a strong current even in the widest expansions. A small lake is then entered with the river passing out to the north-west. The route crosses the lake and goes up a narrow bay for one mile and a half to its head. From here a portage of 400 yards leads to a small lake two miles long, surrounded by steep rocky hills 300 feet high. This lake is left at its east end by a half-mile portage, to another small shallow lake one mile long, surrounded with lower boulder-strewn hills, followed by another portage, a quarter of a mile long, that ends in Square Rock Lake, seven miles long, but very narrow, the average breadth being 400 yards, with small expansions at both ends and in the middle, where a small branch of the Big River flows out on the north side.

Character of river and surrounding country.

Square Rock Lake.

The lake is surrounded with hills from 200 to 400 feet high. These, like most of the country from Lake Nichicun, are burnt, and their exposed sides often appear from a distance to be solid rock, but on close examination they are found to be made up of angular masses and boulders, closely packed together. Where the forest remains, it consists almost wholly of small black spruce, with a few larches on the lower ground, and very small white birch on the hillsides. A few white spruce trees are seen growing on the low sandy terraces about the lake. The route leaves Square Rock Lake by a small stream flowing in on the south side nearly one mile from its east end. This stream comes from the eastward, in a wide valley, now filled with modified drift arranged in beds of sand and gravel, which appears to have once been the bed of a much larger stream than the present. The stream is ascended for four miles, passing on the way two short portages, where the river falls in shallow rapids from one expansion to another.

Trees.

The last portage ends in a lake four miles long and about half a mile wide, strewn with small islands of till, or stratified sand. There is evidence of a terrace twenty feet above the present water-level, and there is a good deal of stratified sand and gravel seen along the shores. High rocky hills rise from either side of the broad valley partly filled by the lake. These hills have been more than three-quarters burnt over recently, and have a very desolate appearance. The trees are somewhat smaller than those seen about Nichicun, but they still grow up to the summits of the highest hills. A short portage leads to another lake, to the eastward, a half mile up which another portage is made past a shallow narrows; then the lake widens out and continues eastward for two miles. The hills on both sides are high and are burnt bare; the boulders, having been whitened by the action of the heat, stand out in marked contrast to the blackened vegetation. A portage of 400 yards leads to Eagle Lake, on another small branch that flows into the Big River, some distance below. This river is now divided into numerous channels by large rocky islands, which thus form a net-work of lake-expansions over a wide area. Beyond this place the route is very difficult to follow, passing as it does through chains of lakes filled with islands, with deep bays branching off on both sides. The route in some places leaves the main lakes, passing by shallow narrows into large bays. The dividing up of the river into various channels, that often do not join for several miles, also leads to great confusion. Even with the aid of a map of the route, much time will be lost in following it here, owing to the sameness in appearance of the lakes and bays.

Eagle Lake.

Crossing Eagle Lake, to its east side, one mile, the north channel of the branch is ascended one mile to Snipe Lake. Betweeen the lakes the river is rapid and varies from ten to fifty yards in width. The latter lake is two miles and a half long by three-quarters of a mile wide, and runs northward, with a narrow bay stretching to the east for a mile from its north end. A south channel leaves the lake in a bay about one mile above the other outlet. The river again divides, giving two inlets to Snipe Lake with a large hilly island between. The lake is covered with small islands. Many of the surrounding hills are rocky and precipitous, well wooded on the south side, with many blocks and boulders scattered over them. The route follows the narrow bay to the north-east. A portage of three-quarters of a mile leads from it to another lake-expansion of this branch, eleven miles in length, which is called Long Lake, and lies about N. 60° E. It is very shallow and full of small islands, while great areas are obstructed with boulders and angular blocks of rock resting on the flat, shallow bottom. Many

Snipe Lake.

Long Lake.

irregular bays indent the shore, especially on the north side where the land is low. The river flows out at the south-west end, and must be broken by a considerable fall, as the sound of it is heard well up the lake. Several small streams feed the lake, the largest flowing in on the south side. The surrounding hills are rocky and burnt over, and are lower than those about the last lake. They gradually sink towards the east end, where the country is appreciably flatter and lower, with many lakes separated by low ridges.

Two short portages and a narrow lake one mile long, lead to a lake surrounded by low, rocky, boulder-strewn hills, and stretching towards the north-east. The route passes only two miles through the west end of this lake, and up a small irregular bay to the northward. Here a portage of 500 yards ends in a small lake twenty feet above the level of the last. Half a mile beyond, another short portage is made to the last lake on the head-waters of the Big River. The route merely crosses this lake, which is large, and stretches away to the north-east, and then passes for 500 yards over a low ridge of boulders, forming the height-of-land between the rivers of Hudson Bay and Ungava Bay. The portage ends in a very large, irregular lake thirty feet below the last.

Watershed between the Big and Koksoak rivers.

From the watershed, the route runs northward for six miles, in an irregular course, through Ice-bound Lake. This is another large body of water with wide, deep bays stretching off to the north-east and south-west. The water is very clear and shallow. The east side is bounded by rocky hills about 200 feet high, while to the westward the land is low, and is probably made up of points and islands in this, or in similar lakes, in that direction.

A small stream flows eastward, from the north side of the lake, and the route follows it for six miles to Enchukamao or Male-otter Lake. The character of this stream is similar to that of others in the region, consisting of small, irregular lake-expansions, connected by short rapids, with portages past three of them. The surrounding country is comparatively low; rocky hills are seen to the eastward 200 or 300 feet high; the rest are much lower, and are composed of till. Where unburnt, the country is covered with small, scattered, black spruce, with white moss coating the ground. Male-otter Lake stretches eastward eight miles, and varies from two to five miles in width. At its east end it is split into two deep bays by a broad rocky point, that rises about 500 feet above the lake. The summit of this hill is destitute of trees and is covered with white moss. Islands are numerous, and are generally well wooded with small black spruce.

Male-otter Lake.

On the south side bare hills of granite rise often perpendicularly from 300 to 400 feet, while similar hills bound the north side, but appear to be somewhat lower. Both sides have been burnt bare, causing the scattered boulders and blocks that cover the hills to stand out prominently. Along the base of the hills, on the south side, there is a sandy terrace fifteen feet high, marking a former level of the lake. The water is remarkably clear; this is the case with all the water north of the East Main River, and is probably due to the lack of vegetable decomposition in the swamps and small shallow lakes, which to the southward gives the water a dark-brown colour. To the northward decomposition does not take place, at least it is not appreciable, on account of the short summer season during which the heat is insufficient to warm the cold waters fed by streams from the swamps that thaw out only on the surface, to a depth of twelve to eighteen inches.

Character of surrounding country.

Male-otter Lake discharges by a short stream from the head of its north-east bay into Lake Kaniapiskau. The route passes up the south-east bay, to its head, whence a portage of one hundred yards, over a low ridge, leads to the great lake. The difference of level is ten feet.

Lake Kaniapiskau.

Lake Kaniapiskau.

Lake Kaniapiskau is probably the largest in this part of Labrador. Its greatest length is from north to south, and is said to be considerably greater than that of Lake Nichicun, or above fifty miles. The lake is divided into two parts by a narrows, where the current is said to be strong. The southern part is much the larger. As the route passed only through the northern portion, nothing is known of the lake above the narrows, except from information derived from the guide. A high rocky point stretches out from the east side of the northern part, and along with some islands in continuation of it, practically divides that portion of the lake into two great bays.

Height above sea-level.

From the hill on this point, 300 feet high, a good view is obtained, but unfortunately the smoky state of the atmosphere obscured it when we were there. From the hill, the south bay is seen extending about ten miles to the base of a conical hill of granite over 500 feet higher than the level of the lake, which is estimated to be 1850 feet above the sea. This hill cuts off the view of the southern portion of the lake. To the westward a deep wide bay stretches towards the south-west to the foot of high hills in that direction. Northward from that bay, a lesser one runs close to Male-otter Lake, where the portage is. The lake-shore then sweeps eastward along the point, which extends about five miles in that direction. The bay on the north side of the point extends to the north-westward about five miles, where the river from Male-otter Lake comes in. Near here the Hudson's Bay Company formerly had an outpost from Nichicun, but it has been abandoned for over twenty-five years. Another deep bay extends to the northward, with a channel flowing out of it, between low rounded hills.

East shore of Lake Kaniapiskau.

The east side of the lake is less irregular in outline, but a wide fringe of low islands extends from its north end to the narrows, with the river passing out by two channels, one opposite the point, and the other a few miles to the south. The country to the east of the lake is much lower than that on the other side, and consists of low rocky ridges, with wide valleys between, filled with lower ridges of till. The north end of the lake appears to be shallow, and is filled with islands, as is the case with the eastern half of the south bay. The western part of the latter is almost free from islands, and is said to be very deep. The islands about the southern discharges are arranged in parallel lines running north-east, and are chiefly composed of till, with many large boulders. Some are made up of stratified sand, which is also often seen resting on the till. The surrounding country is more than half burnt. The lower unburnt portions and islands are well wooded with small black spruce and a few larch trees. The summits of the high hills along the west side rise above the tree-line.

Koksoak River.

Headwaters of the Koksoak River.

The largest stream falling into Lake Kaniapiskau flows in at its south end. Its main branch rises in Summit Lake, a body of water situated on the watershed about 100 miles south of the latter. A curious feature is that it has a discharge at each end, the northern one flowing into Ungava Bay, while the southern one, is a tributary of the Manicuagan River, that empties into the Gulf of St. Lawrence. This is not an uncommon case with lakes situated along the watershed in the northern region underlain by Laurentian rocks. The river flowing north from Summit Lake is joined by many other streams, draining the lake-covered region to the south and south-east of Lake Kaniapiskau, so that the river where it flows into that lake, is of large size.

Double discharge of Summit Lake.

Three outlets to Lake Kaniapiskau.

As before stated, Lake Kaniapiskau has three discharges, and the route follows the middle and least rapid one. Where it leaves the lake, the channel varies from 50 to 200 yards in width; it flows swiftly, and is soon broken by a succession of heavy, shallow rapids, full of great boulders, the channel being cut in boulder-clay. These rapids are almost continuous for five miles, and no rock is seen in place. The south channel joins the middle one a mile and a half below the lake, and, just above the junction, makes a very heavy rapid. Below the junction, the river is 200 yards wide, and carries about twice as much water as above.

Character of the river below Lake Kaniapiskau.

Below the rapid, the river, flowing north, widens out into a shallow lake four miles long and about one mile wide, with two deep bays on the west side, into one of which the north channel is supposed to empty. Northward of the lake there is a range of hills, partly wooded, while in other directions the hills are isolated and the country covered with low ridges of till. Boulders are still common, but not nearly as obtrusive as in the region west of Kaniapiskau. Leaving this lake the river narrows to a quarter of a mile, and is broken for a mile by a small shallow rapid; then, narrowing to 100 yards, it flows swiftly for another mile to a second lake-expansion. Here, widening to three-quarters of a mile, the river continues northward for two miles in a shallow channel full of sandy shoals and small islands. These islands have a thick growth of stunted trees, not over ten feet high, of black spruce, larch, balsam fir and white birch. A straggling growth of spruce covers the low hills on both sides. Next, turning north-west, the river continues in the same manner two miles and then passes into a large lake, full of islands, that extends eastward. Where the river turns east, there are two distinct terraces of stratified sand twenty and thirty feet high, with sharp conical hills of boulder-clay protruding from the highest. Along the west shore of the lake three miles, a narrows 500 yards wide is passed, leading into another lake-expansion three miles long and over a mile wide, with a deep bay toward the east. The country here is almost flat, with low hills along the eastern horizon. The river now turns northward again, and for the next three miles flows rapidly in a shallow channel about 400 yards wide, with swampy shores backed with bare hills, less than 200 feet high. Another lake-expansion, one mile across, is followed by a stretch of three miles of river ending in a lake that extends away to the west-ward. Passing along its east shore, the river flows out one mile beyond its entrance. Now narrowing to 200 yards, it flows rapidly north-east for two miles, then widens to 500 yards for two miles, and, bending to the eastward, flows in that direction for three miles; at two short narrows it is broken into heavy rapids where it passes over low rocky ledges. With the exception of one small hummock, this is the first rock seen below Lake Kaniapiskau, but judging from the scattered

Character of surrounding country.

boulders, the rocks underlying the thick deposits of drift are likely to be soft mica-schists and mica-gneisses, and this accounts for the change in the character of the country. These soft rocks having been unable to stand the abrading action of glacier ice, have been planed down, and only the harder parts rise in the low isolated ridges seen here. The granites of the region west of Kaniapiskau, being much harder and tougher, resisted the glacial action, and now stand up in the rugged hills previously mentioned.

Absence of rock.

The river below is split into two main, and a number of smaller channels, with the stream in a shallow channel almost on a level with the surrounding flat country. Our route followed the east channel, which flows north-east four miles, and then north four miles, to the head of a heavy rapid. Two large channels join it at the fourth and eighth miles, and there is a heavy rapid between the second and third miles, with a large rocky island dividing it. When again united, the river runs north-north-east for five miles, and flowing on the surface over low, flat ledges, is almost a continuous rapid for the whole distance. Throughout, the breadth is 400 yards. Three short portages are necessary to pass low chutes.

Turning due east along the southern flank of a low range of hills, the river next narrows to less than 300 yards, and flows swiftly between rising banks of till, with outcrops of rock along the shore. Now bending east-south-east for three miles and then south for two miles, the stream narrows to less than one hundred yards, and descends in a narrow valley, cut out of till, with a rocky bottom. On the north side, the hills increase in height as the river descends below the general level, and at the lower end rise abruptly 500 feet above the stream. Those on the south side are somewhat lower. In the five miles, the river falls over 150 feet, and is very difficult to pass with canoes. The Indians of Nichicun hunt only to the head of these rapids, and below there is an interval of over one hundred miles of the river untravelled, as it is utterly impossible to ascend the stream with loaded canoes. Along this portion no portages are cut out past the falls and rapids, and in consequence portage-roads had to be made by us. At the rapid above, the sides of the valley are composed of almost perpendicular walls of till one hundred feet or more in height, resting upon jagged rocks covered with great rounded boulders for thirty feet above the water-line. These boulders are piled up by the ice passing through the gorge in the spring. The till banks at frequent intervals are deeply cut by small tributary brooks. On account of the broken character of the bank above, a portage had to be made along the water's edge over the loosely piled boulders and jagged rock. The

First gorge of the Koksoak.

Walls of packed boulders.

river is here so rough, that the outfit had to be carried the entire five miles, and then the empty canoes were let down along the shore with frequent short portages past heavy pitches. A day and a half of hard work was necessary to accomplish this.

Character of the river above the gorge.

From Lake Kaniapiskau to the head of the gorge, the river wanders about almost on the surface of the country, spreading out into lakes, where the surface is flat, and contracting into narrow rapids where it passes between low ridges. It follows the main slope of the country, and falls with the general surface. Where it is obstructed with rapids, these are frequently over boulders without any rock in place, especially along the upper parts. The absence of a distinct valley and the presence of rapids over boulder-clay, show that the river is here flowing in a modern course, and does not follow its pre-glacial valley, which is still filled with glacial débris. At the gorge, this changes, and the river passes down from the general level into a deep distinct river-valley, probably of very ancient origin. This valley, during the glacial period was at least partly filled with till, which in scarped banks and terraces is seen along it, resting on its rocky sides. The river follows this old valley from the gorge to its mouth. The valley is, of course, not of constant depth, but descends in a series of steps, with the gradual slope of the surrounding country.

River below the gorge.

From the foot of the heavy rapid, the river, now in a distinct valley, takes an easy bend to the east and flows in that direction for eight miles. Here the current runs from four to seven miles an hour, with constant small rapids. The river averages 200 yards in width, and descends in a valley from a quarter to a half mile wide, walled in by steep rocky hills that rise 500 to 800 feet above it. These hills are almost wholly burnt, but where unburnt are covered with a straggling growth of black spruce to within 200 feet of their highest summits. The tops are treeless, and are covered with white moss and low arctic shrubs. Boulders are now nearly absent from the sides and tops of the hills, in strong contrast to the hills about Nichicun and Kaniapiskau. Some boulders are seen, but they are so few as not to form a noticeable feature.

The lower parts of the valley are filled with drift, often extending high up the rocky hills in the cuts between them. In the drift the river has cut its narrow channel down to the solid rock below. The rock, where not covered with packed boulders, is seen along the water's edge. In many places the river-banks are formed of tightly-packed, large, round boulders, that line the side to a height of fifty feet above its summer level. These have been transported and packed in their present position by the ice passing down during the spring freshets, and their height gives an idea of the volume and power of the stream during flood time.

Turning south-east, the river continues in that direction under similar conditions for three miles; then it turns east-north-east, and the valley and river both broaden. The river, now a quarter of a mile wide, flows in a perfectly straight course for nine miles. Owing to its greater width, the water is very shallow, and the continuous rapid is full of bouldery shoals; the deepest channel being very crooked, requires constant crossing of the stream to follow it. No part of the rapid is rough enough to be dangerous, and the only source of danger is the frequent shoals, on to which the swift current quickly carries a canoe, if a sharp outlook is not kept. The packed boulders still rise from thirty to sixty feet above the water, with stratified sand and fine gravel, up to seventy feet, where a distinct terrace is seen, marking an older level of the river. Along the margin of the water there is an almost continuous exposure of solid rock. The hills are less precipitous, especially on the west side. The valley is filled with drift, of which sections are seen along the banks. The river now turns north-east for four miles, and broadens slightly, the rapids giving place to a strong, steady current of nearly six miles an hour. A mass of ice, twenty-five feet long and six feet thick, was seen at the bend on the north side, piled up on a great quantity of packed boulders, sixty feet above the water, the remains of a great mass shoved there by the freshet in the spring, and left by the receding water. But a short time before, it had covered an area of over 100 yards square, but at the time (August 16th), it was melting quickly. Similar masses were seen along that shore for a mile below; they were all about thirty feet above the level of the water, and the largest was 200 feet long by thirty feet wide.

Continuous rapids.

Ice on banks.

Both shores remain rocky, the rock coming out from beneath the packed boulders. On the west side, near the lower end of the course, there is a well marked terrace, seventy-five feet above the water, that is seen extending downwards for two miles. In places it is flanked by a lower one forty feet high, with the boulders often packed to the top of it. The hills forming the sides of the valley are now about 500 feet high, and this nearly represents the height of the surrounding country, as all the little streams entering the river do so with falls from small cuts slightly lower than the summits of the hills. From the head of the rapids at the gorge, to this place, the river has fallen 420 feet without any direct drop exceeding four feet. The grade is nearly constant, and exceeds ten feet per mile.

Valley much lower than surrounding country.

The river next once more bends to the southward, and flows south-east for six miles, with a strong current, in a slightly wider and lower valley. A large brook comes in from the eastward at the fourth mile.

Trees.

For the last twenty miles the country on both sides is unburnt, and is covered with scattered black spruce and a few larches, never more than twenty feet high or exceeding nine inches in diameter. The tops of the hills rise from 100 to 200 feet above the tree-line. Turning again directly east, the river flows in that direction for six miles. The channel along here is wide and shallow, being filled up with sand and fine gravel, borne down by the strong current above and deposited over the flats of this part. Sandy shoals rise slightly above the water in places. The hills on both sides are slightly burnt and are lower, with gentler slopes towards the river than those further up stream. Rock-exposures are less numerous, and the ice does not bank the boulders on the shores to more than fifteen or twenty feet high.

Parallel valleys.

After a bend to the east-south-east, a small rapid is passed, and three miles below a little river falls in on the south side. This is the first tributary of any considerable size that joins the main stream below the commencement of the river-valley proper, and there must be only a narrow strip on either side draining into the river, the rest of the country probably being cut up into parallel valleys, with watercourses in each, which only join the main stream at long intervals. The small branch comes in with heavy falls, along the side of a rocky hill of 800 feet. Below, the river again flows eastward for three miles, with a strong current, and has a terrace of thirty feet on the south side. A bend of a mile and a half to the north-east is followed by another long stretch to the eastward. A heavy rapid, four miles long, begins at the upper part of the north-east course. Then the channel broadens somewhat, and the current is considerably slacker for the next eight miles. The valley here slopes gently upward, on both sides, and is partly filled with drift. The hills are high, those on the south side rising from 600 to 800 feet, with well marked terraces at sixty and thirty feet, cut out of the drift along their flanks. The north side is unburnt, and the trees are all small, stunted black spruce, that grow to within 200 feet of the summits.

River terraces.

The general course for the next ten miles is east-north-east, and, the valley narrowing, the river for the first six miles is a succession of heavy shallow rapids, full of boulders. Along the flanks of the hills on the south side, several distinct high-level terraces are seen at 30, 60, 75, 100 and 150 feet above the present river-level. The upper ones are broken, and only the lowest two are continuous. Below the rapids the river widens to more than half a mile, and is correspondingly shallow, with a sandy bottom. The hills on both sides now gradually lower, and those on the south side retreat, leaving a wide, low, drift-covered valley between their base and the river. A bend of two miles to the south is followed by a stretch towards the east five miles long. At the foot of the first bend there is a rapid of three-quarters of a mile where the river is over half a mile wide, and is in consequence very shallow. Below this rapid the river is nearly a mile wide, and flows with a strong current until it reaches the base of a low range on the north side, where it narrows to 400 yards and is broken into heavy rapids. The river now appears to break through this low range 200 to 400 feet high, and in doing so bends sharply to the south-east for two miles, then north-east two miles, again south-east two miles, and finally south for three miles, passing out into a broad valley, where it is joined by the Katakawamastuk or Sandy River, a large branch from the eastward. While passing through the hills, the river forms a continuous strong rapid, culminating in a twenty-foot chute a short distance above the forks. Although the river descends rapidly, it does not fall as quickly as the general level of the country here, and, in consequence, below the forks it flows nearly on the general level, with only low rounded hills seldom more than 100 feet above its shallow valley. Sandy River.

In this manner it flows eastward for five miles, with only one small rapid, to the head of a rocky gorge. From the head of this gorge a very distinct drop is seen in the country to the eastward, with high hills that appear to be on the level with the land about the gorge bounding the horizon. At the head of the gorge the river is split up by little rocky islands into a great number of small channels, and it passes through them in a succession of small chutes or heavy rapids, gradually collecting into one channel; after half a mile, the stream, a mass of foam, rushes down a narrow gorge from thirty to one hundred feet wide, with perpendicular rocky walls from 50 to 100 feet high. In one mile the river falls 110 feet without any direct drop of more than five feet. The portage passes over the bare rock on the south side. Below the gorge, the channel widens to half a mile, and continues eastward, with strong current and flat rapids for three miles. Here again narrowing to 100 feet, it falls thirty feet into a narrow rocky gorge, which was named Eaton Cañon, and turning directly south, rushes down between jagged perpendicular walls with a width varying from fifty to one hundred and fifty feet. As the stream descends, the banks rise and become 200 feet high a quarter of a mile below the first fall. Here the river turns sharply to the north-east and continues as a rushing torrent, through a deeper and still Second gorge. Eaton Cañon.

narrower gorge, with overhanging walls of red granite on the east side. The overhang is so great, that a stone dropped from the top on this side would almost reach the foot of the opposite cliff when it struck the water 350 feet below. After falling in this manner for a third of a mile, the river widens to a hundred yards, and changing its direction to east, descends less abruptly for a quarter of a mile, while the walls of the cañon are a hundred feet lower, and much less abrupt. Next, turning north, it makes a direct fall of a hundred feet into a circular basin about fifty yards in diameter. Nothing but seething water and foam is seen in this rocky basin, which resembles a gigantic boiling cauldron. A small brook, on the north side, also falls into the basin, descending the perpendicular wall in a cascade 200 feet in height. The river leaves the basin by a narrow rocky channel, rushing out with a fall of thirty feet in immense waves that gradually subside in a second and larger circular basin at its foot, where it widens to 150 yards. On each side of the central current there are strong eddies rushing up to join the down stream, where it passes out from the basin above; and, where the conflicting currents meet, great whirlpools are periodically formed. A small rocky island divides the river into two narrow channels where it leaves the larger basin, whence it flows north-east for two miles, and then gradually bending south in the next mile and a half, still a hundred yards wide, it rushes along in heavy deep rapids, between vertical walls of granite capped with drift that rise from 100 to 300 feet above its surface, until it suddenly bursts out into a wider valley running north-north-east, with a large branch called Goodwood River flowing down it from the southward.

Goodwood River.

Portage past Eaton Cañon.

The portage past the cañon was made along the east side, leaving the river above the first fall, coming out on the top of the bank at the sharp bend to the north-eastward, and thence striking due east for a mile over low rocky hummocks, with swamp between, and descending the steep rocky course of a small stream to a narrow valley 200 feet below. It then follows this valley for half a mile to a small lake, after crossing which a portage of 150 yards leads out through a narrow gorge, with perpendicular walls 160 feet high. Large masses of rock have fallen from above and have filled the valley completely to a depth of seventy-five feet. The small river passes under this mass of broken rock, and in so doing falls twenty-five feet, to where it enters the main stream on the south side of the larger basin at the foot of the cañon. Over this mass of broken rock canoes and outfit were carried, as there was no other place where the main valley could be entered, and the difficulty of the undertaking may be imagined when it is stated that over half a day's labour was required to pass these 150 yards of broken rock.

In the small valley, the trees are much larger than any seen since leaving Lake Mistassini. Growing on a rich alluvial soil along the banks of the brook, is white spruce eighteen inches in diameter at the ground and sufficiently long to make two twelve-foot logs. The trees are, however, very knotty. Larch of similar size is also seen here, along with white birch eight inches in diameter. The first white spruce on the banks of the river was found on a low bank of sand and gravel at the mouth of the Sandy River. Below that point, small trees of this species are commonly found growing on the lower terraces of stratified drift. The higher lands support only a small growth of black spruce and a few larches. Large trees.

Below the junction of the Goodwood River, the main stream runs north-north-east for six miles, with a rapid current, in a channel 300 yards wide. On the west side there are scarped banks of stratified drift one hundred feet high; and rocky shores on the east side are capped with drift and have two well-defined terraces at 60 and 100 feet above the river, the lower terrace being cut in fine sand and grown over with fair-sized white and black spruce. Four or five miles beyond the lower end of this course there is on the east side a range of bare rocky hills over 1000 feet high. Widening out to nearly half a mile, the river then turns north, and for fifteen miles flows with a moderate current in a shallow channel filled with sandy shoals. The eastern bank is very rocky, and from 200 to 300 feet high, with patches of sand along the gulleys where the brooks tumble in. These rocky banks form the foot-hills of the barren range before mentioned. The west side has also high and in many places rocky banks, but the country behind is much lower than on the other side, with a few isolated hills more than 500 feet high. On this side the surface is mostly unburnt, with fair-sized black and white spruce and larch growing on the stratified sands of the terraces, but with only a scant, straggling growth of black spruce on the rocky and drift-covered hills above. River below Goodwood River.

Remains of terraces are seen along both sides at 10, 60 and 75 feet, that at 60 feet being the most constant. Contracting now to less than one hundred yards in width, the river falls eighty feet over a ledge of rock at the Granite Fall. Two small rocky islands divide the stream into three channels, the largest being on the north side. There is a first chute of twenty feet followed by a perpendicular fall of sixty feet in the smaller channels. In the main channel, a large mass of rock broken away, is apparently lodged at the foot of the fall, as the water dashes up from below in a great wave forty feet high. The river falls into a beautiful, circular basin, nearly half a mile in diameter, formed by a deep semi-circular bay on either side. These Granite Fall.

bays are surrounded by well wooded, perpendicular cliffs 200 feet high. A wide beach of small, well rounded boulders, rises sharply from the water and stretches for sixty feet to the foot of the perpendicular walls.

Deep channel cut in drift.

Below the falls the river again passes into a deep valley less than a mile wide, with rocky walls that often rise sheer from 800 to 1000 feet. This valley during the glacial period has been partly filled with drift and the river has since cut into it a narrow channel, with high scarped banks of from 100 to 300 feet, with terraces from 50 to 150 feet above the present level. The direction of the valley is nearly north-west, and the river, about 300 yards wide, rushes down it in a zigzag. At every bend the stream strikes against the rocky walls, while a low bar of large, round water-worn boulders extends out from the opposite shore, throwing the waters with force against the rocky banks, and forming deep wild rapids at these points. In this manner the river continues falling rapidly for ten miles; then the valley gradually widens and there is a considerable interval of drift-covered land between the river and the rocky hills on the east side, where terraces at 20, 50 and 100 feet are seen, cut in the drift. The west side is still bounded by rocky hills, that rise about 400 feet. In the valleys of small streams cut into the drift, and on the terraces, white spruce trees forty feet high and eighteen inches in diameter are not uncommon.

This valley continues from three to five miles wide for twenty-five miles and is remarkably straight, the course being about north-west. The river skirts its west side, where it flows close to the base of the rocky walls, that rise from 200 to 400 feet above it. For seven miles it does not average over 400 yards in width, is very shallow and greatly obstructed by sand and shingle bars, over which it breaks into rapids. At the end of this stretch, a small river comes in from the west, through a deep narrow cut in the mountains. Terraces are continuous along the east side at heights varying from 20 to 150 feet above the river. Balsam poplar trees forty feet high and ten inches in diameter were seen on the lower terraces, along with white spruce trees sixty feet high and over eighteen inches in diameter.

Balsam poplar.

Below this branch, the river soon widens out to more than a mile, and is broken by sand bars into a number of wide shallow channels. The bottom is formed of shifting sands. The banks are lower and are composed of stratified sand cut into terraces. The current is slacker, and at the end of fourteen miles another and larger branch, called the Tipa or Death River, comes in from the west, joining the main stream by three channels, as it falls over a low ledge of gneiss. Below this tributary the river narrows somewhat, but still

Death River.

remains shallow, with lower banks, for four miles; then, narrowing to less than 400 yards, it bends to the northward into the head of Cambrian Lake, which is about two miles wide and surrounded by high rugged hills of Cambrian rock.

In fourteen miles, the lake gradually sweeps round from north to north-west, and at the end of the curve, another small branch from the west flows in from a wide valley between high barren hills that rise from 800 to 1200 feet above the water. Cambrian Lake.

The physical aspect of the country changes as soon as the Cambrian area is entered. Where the underlying rock is Laurentian gneiss or granite, the hills, though often high and with perpendicular sides towards the river-valley, always have rounded tops, with long gently curved outlines, while the hills formed from the stratified Cambrian rocks, are much sharper and more rugged. Character of the country.

The general dip of the rocks is towards the north-east, and, in consequence, the mountains which they form show steep cliff-faces towards the west, with long gentle slopes on the opposite side. These hills run in ridges roughly parallel to one another and to the general strike of the rocks, that is, from south-east to north-west. They rise from 800 to 1500 feet above the surface of the lake, which is about 400 feet above sea-level, and on the western side often have perpendicular cliffs over 500 feet high, with a great talus of broken rock at the bottom. The cliff-faces have generally a reddish colour, due to the oxide of iron present in all the rocks of this series. All except the lower slopes of these hills are barren, or covered only with arctic shrubs and mosses, with patches of snow in gullies near their summit; this adds greatly to the grand and desolate scenery, while the beauty of the pleasant, wooded valley of the river is enhanced by the contrast.

From the entrance of the small branch, the valley again turns northward, and continues in that direction for eleven miles, to where the lake gradually changes into the river again, with high hills on the east side, in which the Cambrian rocks are seen resting on rounded masses of gneiss. The hills on the west side retreat, leaving a wide sandy plain, through which a large branch called the Piachikiastook or Ice-dam River flows, entering the main stream with a heavy rapid two miles above the end of the course. The main stream gradually narrows, and becomes shallow along the lower part of this stretch, where it runs between low banks of sand. Turning next to the north-east for seven miles in a wide sandy valley, it flows along with increased current in a shallow channel three-quarters of a mile wide, until it reaches a barrier of black shale and limestone, Ice-dam River.

Shale Falls.

where it falls sixty feet in about 200 yards, at the Shale Falls. Below the falls, there is a circular basin with steep sandy banks sixty feet high, and from it the river passes out to the north, and flows in that direction for two miles between terraced banks sixty feet high, covered with large spruce, with outcrops of iron ore showing beneath the sand along the water's edge.

Swampy-bay River.

Gradually bending around to the north-west, the river flows in that direction for twenty miles, until it is joined by a large branch from the eastward called the Swampy-bay River. By this stream, the Indians formerly travelled to Fort Nascaupee, which was situated on Lake Petitsikapau on the upper waters of the west branch of the Hamilton River, and only a few miles from the watershed separating it from the Swampy-bay River. Along the first five miles of this course, the river is about half a mile wide, and flows between sharp rocky hills, which rise 600 to 800 feet above it. Here an almost continuous exposure of bedded iron ores is seen, consisting of red and specular hematite, magnetite and sidertie, interbedded with siliceous limestones and jasper. After five miles, the hills retreat on both sides, leaving a wide valley of drift, through which the river runs with a steady current in a shallow channel half a mile wide. The drift is cut into terraces at 30, 50, 100, 150 and 300 feet. A small branch from the east flows in here.

After four miles the hills again approach the river on the west side, where they are sharp and rugged and rise from 600 to 800 feet in precipices often terminated in sharp peaks. Two miles above the forks there is a strong rapid half a mile long, where the river narrows to less than 200 yards. The sands in the valley are greatly drifted by the winds, and in one place the drifts are covering up trees twenty feet high. The country is nearly all burnt from the falls to the mouth of the Swampy-bay River.

Character of river below Swampy-bay River.

For eight miles below the Swampy-bay, the main stream flows north-west in a narrow valley, between sharp rocky hills, from 400 to 600 feet high. The river-channel is from 200 to 600 yards wide, and the current is strong. The lower parts of the rocky hills on the east side, are covered with sandy drift and are terraced at several levels up to 200 feet above the present height of the river. The hills on the west side rise directly from the water and have very little drift on their flanks.

The river next turns north-north-west for seven miles, and then north for seven miles more. Along the upper of these courses the valley widens to over two miles, and is filled with drift, terraced to the 200 feet level, behind which it slopes gently upwards with a few sharp rocky hills projecting above it. Along the second course the land on the east side is only about fifty feet high, for three or four miles to the base of the hills. The country on the west side is higher and the hills come out at intervals along the river, with a large brook flowing in from the west, about two miles from the upper end of the course. The river here widens out to nearly a mile, and its current is not strong.

Along the last mile, the river narrows to 400 yards and flows swiftly between hills of limestone from 200 to 600 feet high, very sharp and irregular in outline. The rock has the appearance of being greatly faulted. Turning now sharply to the north-east, the river continues to flow swiftly in a narrow, rock-bound channel for three miles, where it again turns northward, and continues in that direction ten miles to the Pyrites Chute where it falls thirty feet in a half mile over black shales on edge. Along the upper half of this course, the limestones are almost continuously exposed along the river-banks, rising in sharp ridges on both sides from 100 to 800 feet high. Along the lower half, the hills retreat and leave a wide sandy valley, covered with black and white spruce with a few larch and white birch. The largest trees rarely exceed twelve inches in diameter and are much shorter than those seen about the Cambrian Lake.

Pyrites Chute

Below the chute, the course is north-west for fifteen miles. For four miles the channel averages three-quarters of a mile in width, and the surrounding country is low and flat, with sharp hills of rusty rock and a few exposures of limestone on the east side. A number of low islands of limestone occur in the next mile, at the end of which the river, at the Limestone Falls, descends sixty feet over ledges of that rock, which cross the river-valley obliquely, and form a dam over which the water pours in three main channels. The middle channel follows the strike of the rock and forms a chute, while the other two fall vertically, directly across the strike. Below the falls, for four miles, the river, about a half mile wide, flows between scarped banks of sand and gravel seventy-five feet high; and then, narrowing to less than 200 yards, for five miles it rushes through a narrow valley called Manitou Gorge, cut out of limestone and shales, with walls from 50 to 300 feet high. Heavy rapids are met with throughout the gorge, and considerable danger was encountered running these with half loaded canoes, especially at the lower end, where outcrops of limestone cross the valley, hemming the water into narrow channels and causing small chutes. Below the gorge, the river for six miles gradually bends towards the east until it is joined by the Natwakami, Larch or Still-water River, a large branch from the west. Along this portion the current is strong, and a number of large islands of sand and shingle

Limestone Falls.

Manitou Gorge.

divide the river into several channels. The banks are cut out of clay, overlain by sand, and often over one hundred feet high. As the forks are approached, the banks on the west side become lower, and form a broad sandy plain between the two rivers. The Stillwater River has about half the volume of the main stream, and flows in from the westward, through a wide valley. There must be a considerable quantity of clay along its banks, as its water is quite muddy, in marked contrast to the clear water of the main stream.

Stillwater River.

By this branch the Indians journey to Hudson Bay. They follow it to its head, and cross from there to Clearwater Lake, and by the discharge of this lake reach Richmond Gulf. The Rev. Mr. Peck, a missionary of the Church Mission Society, crossed by this route in 1885, and the first expedition of the Hudson's Bay Company to Ungava, traversed the same route from Hudson Bay in 1824.

Route to Hudson Bay.

Immediately below the Stillwater, the river turns to the north-east, and for five miles is less than a half mile wide, flowing with a swift current between low, terraced banks in a valley two or three miles wide, bounded by sharp hills from 500 to 600 feet high. These hills, still composed of Cambrian rocks, run in sharp ridges from a quarter of a mile to two miles apart. The direction of the ridges is roughly at right-angles to that of the river. They resemble one another very closely, and sixteen of them were noted in as many miles. They have a cliff face towards the south-west, and a gentle slope towards the north-east, apparently coinciding with the dip of the rocks. All the cliffs show a thick capping of hard rock, probably trap, with rusty weathering shales beneath. On the steep side, the hard capping rock often projects beyond the softer shales, and so forms overhanging cliffs. The lower valley, where unburnt, is wooded with small black and white spruce and larch, growing in open glades upon the terrace. These trees also grow on the hillsides, up to about 200 feet above the river. Above this, only mosses and arctic shrubs are seen about the watercourses, the remainder being naked rock, which forms over one half of the area under consideration. Ten miles below the Stillwater, a small river comes in from the westward. The valley, five miles below the forks, widens to five or six miles, and the river spreads out to over a mile, becomes very shallow, and is greatly obstructed by sand and shingle shoals, as it flows along with a strong current, in the same direction for twenty-one miles.

Character of river and country below the Stillwater.

Trees.

Toward the lower end of this reach, the sharp Cambrian hills give place to others of Laurentian rock, whose outline is less rugged and more rounded. The interval between the river and the rocky hills is occupied by a terraced sandy plain from twenty to fifty feet above the river and is partly covered with small trees.

Low ledges of gneiss now cross the stream and form a number of small rocky islands, causing a heavy rapid for nearly a mile, followed, two miles below, by another a quarter of a mile long. At both rapids, the water is shallow, and the channel is obstructed by reefs and large boulders. The foot of the second rapid marks the head of tide-water. Head of tide-water.

From here the course changes to east-north-east for eighteen miles. The hills on both sides retreat still farther, and appear to be considerably lower. The river is now from two to five miles wide, and is broken into numerous channels by long low islands of sand, and shoals bare at low water. The river banks are from ten to twenty feet high, with a wide drift plain extending to the foot of the bare, rocky hills, on which the remnants of terraces are seen up to 300 feet above the present water-level. This plain is only partly wooded with small black and white spruce, and but two clumps of small balsam poplar were seen on the north bank. Turning again to the north-east, the river becomes still wider, with a deep bay on the north side, around which the rocky hills sweep; these then cross the river seven miles down the course, where they form a number of high rocky islands, that hem the water into deep channels, through which it rushes rapidly in and out according to the state of the tide. At and below the islands, the river varies from a mile to a mile and a half in width, and its valley is bounded by rounded rocky hills, rising from 100 to 300 feet directly from the water, with only in a few places a narrow border of drift between, which is sometimes terraced one hundred feet above the present sea-level. The course continues nearly north-east to the mouth of the river, some twenty miles below.

Fort Chimo, the Hudson's Bay Company's establishment, is situated facing a small cove on a low terrace on the south shore, about two miles below the islands. The terrace is about 200 yards wide, and is backed by low rounded hills of gneiss. Small black spruce trees grow only in protected hollows about the post, and the general aspect is very uninviting, with barren, rocky hills bounding the horizon on every side. The post consists of about a dozen buildings, including a dwelling house for the officer in charge, four or five for the servants, a trading shop, office, two provision stores, oil shed, salt shed, carpenter, cooper and blacksmith shops and a dwelling house for the Indians. These buildings are all, or nearly all, made of imported lumber. There are a number of small boats attached to the post, along with a small sloop and a steam launch, used in connection with the salmon fishery. At present a vessel of about twenty tons is being built there, Fort Chimo.

from wood obtained about Ungava Bay; most of it coming from some distance up the Whale River, which is the next large stream flowing into the bay to the eastward. Firewood for the post is cut during the winter in the vicinity of the first rapid, and is rafted down the river in summer.

The post is supplied by the company's steamer "Eric," which arrives at Fort Chimo about the first week in September, and remains there, loading and unloading, for about two weeks. This is the only communication with the outside world, and when the ship leaves, all touch with civilization is lost until the following year.

Fur trade.

The fur trade is, of course, the most important, and is carried on both with the Indians and Eskimo. Foxes are the most numerous of the fur-bearing animals, and are found throughout the barren and wooded country; they occur as to numbers in the following order: white, red, cross, black and blue. Martens come next, and are chiefly taken by the Indians along the edge of the wooded country, about the head-waters of the rivers. Their fur is very thick, dark and long, and the skins are generally larger than those caught farther south. Wolverines are common along the edge of the barrens and northward. White bears are killed frequently along the coast. Black bears are very rare, and specimens of the barren-ground brown bear are obtained only at infrequent intervals. Mink and otter are not common, and the beaver is not found north of the thickly wooded area. Formerly a great number of dressed caribou skins were traded at Ungava; but during the last two years very few were brought in, owing to a change in the routes of migration of that animal.

Salmon fishery.

The salmon fishery is carried on at a number of places along the river, below the post, during the month of August, and the annual catch averages one hundred tierces for export. Salmon are also taken in the mouths of the Whale and George rivers, the average catch at the former place being fifty tierces, and at the latter one hundred and twenty tierces. Formerly the company employed a small refrigerator steamer in this trade at Ungava, and the frozen salmon were taken to London for sale. This has been abandoned for several years, and the salmon are now split and salted. The white porpoise is also taken at Ungava, on the Leaf River, a stream a short distance north of the mouth of the Koksoak, and at George River. The total amount of oil so obtained is about eighty tierces of forty gallons each. Other articles purchased are feathers, ivory and eider down.

Seven years ago there were ninety families of Indians trading at Fort Chimo. But in the famine, due to the failure of the caribou hunt, during the winter of 1892-93, nineteen families starved to death in a body, and at another place six families were totally lost; besides these, all the other Indians were throughout the winter in a state of chronic starvation, and many died, so that out of a population of two hundred and fifty persons, less than one hundred and fifty survive. Indians.

Hamilton Inlet.

Hamilton Inlet, Invuktoke, or Esquimaux Bay is the largest and most important of the many long, narrow fiords or inlets that indent the Atlantic coast of Labrador and Newfoundland. Its greatest length, from Indian Harbour to the mouth of the Hamilton River at its head, is slightly over one hundred and fifty miles, while its average breadth is about fourteen miles. The longest axis lies north-east and south-west. At its mouth, from the mainland near Purple Island, on the north shore, to Grinder Point, on the south side, the distance is twenty-three miles. Thence the inlet gradually narrows for forty-three miles to the mouth of the Double Mer, where the width is less than two miles. Here the inlet is divided by a long rocky ridge, the northern portion, or the Double Mer, extending westward some forty miles. A narrow, less than one mile wide, extends from the point five miles into the main, or Groswater Bay. Again widening, the channel is divided by a large rocky island five miles long called Henrietta Island. At its head, on the south side, a long narrow bay, called Back Bay or Backway, runs off to the eastward for about twenty-five miles, with an average breadth of four miles. At the east end of this bay a ridge one hundred and fifty feet high separates it from a small lake, with a sluggish brook that empties into a bay on the coast. The total distance between the head of the bay and the sea coast is not over ten miles; the country between appears to be wholly formed of drift material, and it is quite probable that in pre-glacial time there was an opening of the coast here. Hamilton Inlet. Double Mer. Backway.

The main bay above Henrietta Island quickly expands to four miles, and then more gradually to twelve miles, at the mouth of Valley Bight, eighteen miles above the narrows. Valley Bight is a small bay on the north side, about three miles wide at its mouth, and gradually narrowing for five miles to its head. From the mouth of this bay the main body has an average breadth of eight miles as far as Charley Point, some eight miles up. This portion is greatly obstructed by islands, of which Neveisik, St. John and Haines islands are of large size, and are also high and rocky. From Charley Point Valley Bight.

to Mulligan Point the distance is thirty miles, and the average breadth of this portion is fifteen miles, with two large bays, one on each side. That on the north side is called Nebavick or Mulligan Bay, and extends behind the long, low point of the same name. It is about four miles wide at its mouth, and of about the same depth, with a small river coming in at its head. The bay on the south side is called Etagaulett or Big Bay; it is ten miles wide and nearly five miles deep.

Mulligan Bay.

From Mulligan Point to the mouth of the Northwest River, some twenty-three miles, the breadth gradually decreases to eight miles, and considerable intervals of low sandy land intervene between the water and highlands behind, while the waters on both sides are shallow, and are greatly obstructed by sandy shoals and low islands, especially on the north side, where a fringe of islands extends several miles out from Mulligan Point to within four miles of the mouth of the river. The Northwest River flows in at the foot of a small shallow bay, and at its mouth is about 100 yards wide, with an average depth of fifteen feet. The narrows are only half a mile long, and then the river expands into a shallow lake, one mile wide and three miles long, at the head of which is another contraction of about 400 yards, with a strong current where the river flows out of Grand Lake. This is a large body of fresh-water extending westward some forty miles, and is from two to five miles wide, and very deep. As only a comparatively narrow strip of low sandy land separates this lake from the bay, and the sand has probably been deposited there by aqueous or glacial agencies, it is probable that at no very remote time the lake formed an extension of the present inlet.

Northwest River.

On the south side, immediately opposite the mouth of the Northwest River, is Carter Basin. This is about three miles long and a mile and a half wide, and is connected with the main body by a channel little over one mile long. Into this basin two rivers empty, the larger or western one is called the Kenamou River. It is a large stream that rises on the highlands to the south-west, where its sources interlock with those of the St. Augustine and Natashquan rivers, which empty southward into the Gulf of St. Lawrence. The Indians report that it flows through a deep valley in the Mealy Mountains and is unnavigable with canoes, owing to the almost continuous, steep, shallow rapids. No high falls are reported on this stream. The smaller stream is called the Kenemich River, and takes its rise on the top of the Mealy Mountains only a short distance inland, to the south and south-east of its mouth. It descends the steep sides of the hills close to its mouth in a succession of high and beautiful waterfalls.

Kenamou River.

From the mouth of the Northwest River, the shore trends southward nine miles to the end of Sandy Point, a low, broad expanse of sand stretching this distance out from the north side, evidently the remains of drift brought down by the Hamilton River. Opposite Sandy Point the bay is only three miles and a half wide, and shoal water, caused by an extension of the point, continues to the south side, with only eighteen feet of water at the deepest part, where the channel is less than a half-mile wide. Sandy Point.

Beyond the point, the shore again trends northward, forming Goose Bay, which averages nine miles in width and is nearly twenty miles long, to the head of Terrington Basin, where Goose Bay River flows in. This is a shallow stream, draining a considerable area of country between the Grand and Northwest rivers. Goose Bay is in most places quite shallow, being filled up with sand brought down by the Grand or Hamilton River, which flows in on the south side, nine miles above Sandy Point. A low sandy point, about five miles wide, separates the river from the upper part of Goose Bay. Goose Bay.

The country surrounding Hamilton Inlet is generally high and rocky. On the north side, commencing at the entrance to the bay, the hills range from 100 to 400 feet, and are only partly wooded with small black spruce, in the valleys and on the protected sides. As the narrows are approached, the land rises from 200 to 500 feet, and continues between these heights, until Valleys Bight is passed. Beyond, it is still higher, seldom under 500 and often over 800 feet, forming a high rocky ridge separating Double Mer from the main bay. Fifteen miles above Charley Point, the hills pass inland around the head of Mulligan Bay, leaving a wide interval of low land between their bases and the shore. Character of surrounding country.

Still continuing inland, the hills cross from the head of Mulligan Bay to the shores of Grand Lake, and are more irregular in height and outline than below. One hill called Mokami, or Kokkak, rises in an imposing cone of over 1000 feet, with bare rocky sides and top, forming a conspicuous landmark, said to be visible from any high hill, within a radius of seventy-five miles. The hills above Northwest River skirt the north side of Goose Bay, and gradually close in beyond it, to form, with those of the south shore, the wide valley of the Hamilton River. Mokami Hill.

The country along the south side of Hamilton Inlet at its entrance, is comparatively low and swampy. The hills first reach the shore about fifteen miles below the narrows, and then follow it closely to the mouth of Backway. Along the narrows they rise abruptly from 500 to 1000 feet, and in places are flanked with sandy terraces up to 150 feet above the sea. Along Backway they average 600 feet, and culminate in a rounded conical peak called Monat, over 1000 feet high.

Monat.

Mealy Mountains.

On the other side of Backway there is generally an interval of low land, rising in terraces to the foot-hills of a high, barren range called the Mealy Mountains, that occupies a large area of country between the south side of Hamilton Inlet and the head of Sandwich Bay. These mountains rise precipitously from 800 to 1200 feet along the side of the inlet, without any low land, from the mouth of Backway to within ten miles of the mouth of Carter Basin, where they pass inland, and ultimately form the south wall of the Hamilton River valley. Along the inlet the sides and tops of these hills are almost totally devoid of trees, owing to the blasts of the prevailing cold north-west wind that sweep across the bay, especially during the winter season. Inland, it is reported that small trees grow abundantly in protected valleys. As the head of the inlet is approached, the trees are seen to cover the lower slopes and to rise higher and higher, until near the mouth of the Hamilton River, they are found extending to the very tops of the hills, here from 600 to 800 feet high.

George Island.

Below the narrows, the inlet is obstructed by a number of large rocky islands; of these the most conspicuous is George Island, which lies about six miles off the south shore, at the entrance. It is nearly four miles long and in its highest point 750 feet above sea-level. A number of smaller islands are clustered along the shore, on the north side at the entrance, and Indian Harbour, an important cod fishing station, is situated among these. From the entrance the inlet is practically free of islands to within half way to the narrows, where it becomes obstructed by several large ones scattered up its middle. The islands above the narrows have been referred to previously as extending as far as Charley Point.

Depth of water.

Below the narrows, the greatest depth laid down on the chart is fifty fathoms, and the average depth is about thirty fathoms. The channel at the narrows and on the north side of Henrietta Island, ranges from ten to twenty fathoms in depth. Above, the water rapidly deepens, and soon shows ninety-two fathoms; it continues very deep to beyond Mulligan Bay, where it begin to shoal, especially along the shore, a fact probably due to the filling up of the bottom with material brought down by the large rivers emptying into the head of the bay. Twenty fathoms appear to be the average depth of the deeper parts to nearly opposite Northwest River, then it rapidly shoals to fifteen and to five fathoms, until the bar at Sandy Point is crossed, after which slightly deeper water is found, which again shoals gradually to three fathoms at the mouth of the Hamilton River.

At Indian Harbour the tide rises seven feet at springs; at the lower end of the narrows the rise is four feet, while above the narrows the rise is only about two feet and continues the same to the head of the inlet, where the rise and fall of the tide is much modified by the direction and strength of the wind. Below the narrows, there is a strong current formed by the ebb and flow of the tide; while through the narrows the rising and falling water rushes with a velocity varying from four to seven miles an hour, and in a number of places heavy rapids occur, which, with whirlpools and eddies, render the passage of small boats dangerous when the current is at its strongest. Above the narrows, there is no perceptible current, except that caused by winds. The shores of the outer part of the inlet are partly wooded with small black spruce and larch, while the hills and islands support only a growth of low arctic shrubs and willows. As the narrows are approached, the trees become larger and on the protected north side cover the hills to their tops. White spruce, balsam fir and small white birch are seen. Continuing up the bay, the trees become larger and better until on the low lands about its head, plenty of trees of the above species grow to sizes that fit them for commercial purposes, and aspen and balsam poplar are abundant. At Northwest River, and also at the mouths of the Kenamou and Hamilton rivers, good crops of potatoes and other garden vegetables are grown annually, and it is said that oats will readily ripen also. At and below the narrows, the cold arctic current, which passes down the coast, so lowers the general summer temperature, that potatoes cannot be profitably grown, and garden crops are confined to turnips, radishes and lettuce.

Rise of tide.

Trees.

Crops.

Hamilton Inlet is the present southern limit of the Eskimo on the Atlantic coast. There is now a little tribe of some half dozen families living in log houses on the shore of a cove called Carawalla at the head of Henrietta Island. A few more families are scattered along the shores of the lower half of the inlet. They are in a state of semi-civilization, having adopted European dress, and all talk more or less English. They are poor and dependent on the fishery and seal hunt for a livelihood. The Hudson's Bay Company have two establishments on Hamilton Inlet; the larger, called Rigolet, is situated on the north shore at the narrows, about three miles above the entrance to Double Mer. This is the head-quarters of the Labrador Coast, or Esquimaux Bay district, the officer in charge having under his care the posts of Cartwright on Sandwich Bay, of Northwest River at the mouth of that stream, as well as those of Davis Inlet, and of Nachvak, both situated on the coast to the northward.

Eskimo.

Hudson's Bay Company posts.

Trade. The post at Rigolet consists of about a dozen houses and stores, and trade for fur and fish is carried on with the Eskimo and "planters." The trade of the post at Northwest River is made with the "planters" living about the upper part of the inlet, and with the Indians, who hunt in the country drained by the Hamilton and Northwest rivers, as well as with those hunting to the southward in the Mealy Mountains. A Roman Catholic chapel was erected some years ago near this post, and a missionary priest from the St. Lawrence used annually to visit the Indians there, during the summer. These visits, it is understood, are no longer to be made, the Indians being advised to go instead to Mingan, or other posts on the St. Lawrence, to meet the missionaries. All the Indians of the region profess Christianity, and are very careful to keep all the observances of the church, even when far inland, but their beliefs seem to be inextricably mixed up with their older pagan ideas, and often their views on subjects of religion are very curious.

Missionaries.

Indians. The Indians frequenting Northwest River post are probably the most miserable and ill-conditioned in Labrador. Being deer hunters, and consequently depending largely on the caribou, both for food and clothing, they have little inclination to trap fur-bearing animals and thus improve their condition by trade. As their wants are mainly confined to tea, tobacco, powder and shot, and some few articles of clothing, a small amount of hunting only is necessary to provide their price, and beyond this, except for the labour of following the deer, or fishing, they do nothing, spending much of their time lounging about their tents. They will not work, even when offered very high pay, and when asked so to do, simply laugh and say they are not hungry. They are so improvident that they never lay in a stock of fish in the autumn, as the Indians to the westward do, and when during the winter, from some cause or other, they fail to find the caribou, they are soon reduced to starvation, and many die.

These Indians belong in part to both the Montagnais and Nascaupee tribes. The former tribe hunts between Hamilton Inlet and the Gulf of St. Lawrence, the latter to the west and north-west of Hamilton Inlet. No great physical difference can be observed between these tribes; if there is any, the Nascaupees appear to be slightly taller and less robustly built than the Montagnais. They talk different dialects of the Cree language, but the difference is so slight, that they converse freely together, and understand one another quite readily. The name Nascaupee in the Montagnais dialect signifies "the ignorant ones" and is given on account of their lack of knowledge in regard to the works and ways of civilization, owing to their want of communication with the outside world.

Hamilton River.

The Hamilton River is the most important stream of the eastern watershed of the Labrador Peninsula. Its drainage-basin embraces a wide area of the country extending from the head of Hamilton Inlet westward to longitude 68°, or nearly half way across the peninsula. To the northward its tributaries interlock with those of the Northwest River which also flows into Hamilton Inlet, and with the headwaters of the George River and branches of the Koksoak River that empty into Ungava Bay. The southern limit of its large tributaries is very irregular, and may be roughly taken to be near the fifty-second parallel of latitude, where the watershed separating them from streams flowing southward into the St. Lawrence, is extremely sinuous and almost impossible to trace or define. Drainage-basin of Hamilton River.

Westward of the Hamilton basin, the general slope of the country is northward, and the drainage is in that direction from about latitude 52°, the water reaching the ocean by the Koksoak River, which drains a considerable area of the central interior between the head of the Hamilton River and the Big River flowing into Hudson Bay.

Owing to the great difference in physical character between its upper and lower portions, the Hamilton River is naturally divided into two parts at the Grand Falls some 250 miles above its mouth. The lower part occupies a distinct valley, cut out of Archæan rocks, with the present river-level from 500 to 800 feet below the general level of the surrounding country. The valley varies in width from 100 yards to more than two miles, and the river flows down it, between banks of drift, with a strong current broken by rapids in several places, especially along the upper stretches, but only in one place does it fall over an obstruction of rock. Division of river into upper and lower.

This valley is well wooded where unburnt, and the timber is all of fair size and of commercial value, in marked contrast to the small stunted trees found partly covering the rolling country of the table-land, on either side of the valley. The river flows into the head of Hamilton Inlet, on the south side, and a long point of drift material, principally sand, projects out into the bay, separating the river from the head of Goose Bay, which extends several miles west of the mouth of the river on its north side. This point is evidently formed from material transported from the valley above and deposited in the quiet waters at the head of the inlet. The river-valley.

From the mouth of the river to the first fall, the distance is twenty-seven miles, and the direction is S. 80° W. At its mouth, the river is three-quarters of a mile wide, and shortly above widens out to nearly a mile and a half, for ten miles; then a number of flat, sandy shoals bare at low stages of the water, divide it into numerous channels. Man-of-war Island lies on the north side five miles up stream; it is low and about a mile long, and has a few trees growing on it.

On the south side, a mile and a half above the mouth, a channel enters from Mud Lake, a shallow body of water two miles long, extending to the foot of the mountains and separated from the river by two low, wooded islands. About two miles above Man-of-war Island, on the south side, a small stream, called Traverspine River flows in; it rises in the mountains to the southward. Where this stream discharges into the river, there is a small Indian trading establishment, and the proprietor, Jos. Michelin, has made a little clearing about the place, where he grows an abundant crop of potatoes.

Traverspine River.

Three miles and a half above Traverspine, another small stream, called Caroline Brook, comes in from the south. Opposite its entrance, the river narrows to a mile, and its channel continues with this width twelve miles to Muskrat Island, which is low and well-wooded, and a mile and a half long. On the south shore, opposite this island, there is a little clearing with the winter habitation of Thomas Hope, the last permanent residence on the river. For three miles above Muskrat Island, the river narrows to less than a third of a mile, with a narrow island obstructing the channel in the upper mile. Above this narrow, the channel widens out into a nearly circular basin about two miles across, into the west side of which the river pours with a chute of twenty feet called Muskrat Fall. Above this chute is a heavy rapid 400 yards long, with a chute of twenty-five feet at its head, the total fall being seventy feet. At the chutes, where it rushes over ledges of gneiss, the river is only about 100 yards wide. Immediately on the north side of the falls, there is a rounded, rocky hill rising 250 feet above the level of the valley. On the north side of this hill is a wide plain of fine till. Where the edge of the plain has been cut away to form the basin below the chute, a wide section of over 100 feet of fine till is exposed, without any sign of rock in place. The present channel at the falls is of recent origin, and it is probable that previous to the glacial period, the river-channel was filled up with drift material, so that when the river again resumed its course, it was diverted from its old channel by the obstruction, and passed to the south of the hill where the drift deposit was less thick. Having once cut to the rock surface, well below the upper level of the drift on the opposite side, it has continued in its present channel ever since.

Muskrat Island.

Muskrat Fall.

At its mouth, the banks of the river are low and sandy, and have scarped faces from ten to thirty feet high, increasing slowly in height as the river is ascended. Terraces are seen to the south, flanking the mountains up to 300 feet above sea-level. Above Traverspine the banks rise from sixty to one hundred feet and are cut out of coarse, yellowish, stratified sands. Character of river-valley below Musk-rat Fall.

The western extension of the Mealy Mountains forms the southern wall of the valley, and, above the head of the low point separating the river from Goose Bay, rocky hills are seen also on the north side. The valley, as far as the first fall, varies in width from two to five miles, and the river passes close to the foot of the rocky hills on the south side fifteen miles above its outlet. As the valley has been partly filled with drift, out of which the present channel is cut, it is only when the river accidentally passes close to the rocky walls of the valley, that any rock-exposures are seen. The hills on both sides rise from 400 to 600 feet above the river-level, and partly represent the general height of the surrounding plateau, which rises somewhat higher back from the valley on both sides. These hills are wooded to their summits, but as the upper level is approached, the trees become small and stunted, and only a very few species grow on the table-land above. Black spruce forms over ninety per cent of the wood, the remainder being made up of larch, white birch and balsam fir.

In the valley, on the contrary, the growth of timber is very good, considering the position. White spruce trees two feet in diameter and more than seventy feet high are not uncommon, and a large number of ship spars have been taken out about Traverspine. The black spruce does not grow quite as large as the white, but is still large enough to afford good commercial timber, and the same may be said of the larch growing in the valley. Balsam fir, white birch and both aspen and balsam poplar are here met with and grow to fifteen inches in diameter. Timber.

Above the chutes the river soon widens out, and for thirty-five miles flows from the south-west. Its average width for this distance is slightly less than a mile. Fourteen miles above the chutes it narrows to less than a quarter of a mile, and is broken by rapids for two miles above. Below these rapids there is a great sandy shoal, which extends across the course of the river and has forced it to cut a deep bay on the south side out of white sand, that rises in almost perpendicular banks over one hundred feet above the water. This place is called Sandy Banks, and the Hudson's Bay Company formerly maintained a small trading-post on the north side, where the site of their clearing is marked by a new growth of birch. Sandy Banks.

Above Sandy Banks, the stream is again over a mile wide, with a large island dividing it into two channels, and a deep bay runs off to the north-west from the main channel. Above this island the average breadth is half a mile for five miles, when it again widens to a mile for three miles, to the foot of the Porcupine Rapids. These rapids are nearly three miles long, with a deep channel, the river being about 300 yards wide. There is good tracking along the banks, and no portage is necessary to pass this obstruction.

Gull-island Lake.

Above the Porcupine Rapids, the river expands again into Gull-island Lake, which is six miles long, and not over a mile wide. The name is a misnomer, as there is a very perceptible current throughout. Gull Island is a small rocky islet on the south side, about two miles from the head of the lake. From the Muskrat Falls to Gull Island the character of the river and valley is very similar to the portion below. The river-channel is wide and shallow, at ordinary stages of the water, and the current is strong, so that tracking is resorted to in ascending with boats. The hills, as far as Gull Island, remain about four miles apart, and there begin to approach, so that the valley is less than half a mile wide at the head of Gull-island Lake. The height of the hills varies from 500 to 800 feet above the level of the river, and much of their surface is burnt over, with less than half of the north side of the valley wooded, with trees similar to those described along the lower stretch.

Terraces.

There are considerable accumulations of drift in the valley, into which the river has cut its present channel. Terraces are common and well marked, especially about the mouths of small streams flowing down from the table-land, on both sides. As many as seven were seen on the south side, below the Porcupine Rapids, the highest being 200 feet up the flank of the mountains. The river-banks are sandy and steep, and vary from twenty to seventy feet, with a margin of nearly level shore at the water's edge, which affords good ground for tracking. Only two exposures of rock were seen along this course. Several small streams fall into the main river on both sides, but none of them is of any size or importance.

Valley above Gull-island Lake.

From the head of Gull-island Lake, the course of the valley changes more to the northward and the river flows from N. 70° E. for eight miles; the next course is from S. 60° W. for two miles, and is followed by a stretch of nine miles directly from the south. Along all these three courses, the valley is from a quarter to half a mile wide, with almost perpendicular rocky walls that rise abruptly from the water more than 800 feet, with narrow intervals of drift only in a few places. The river varies from 100 to 400 yards in width, and throughout the distance is an almost continuous rapid. Up the stream the Gull Rapid is the first, and extends from the lake upwards for five miles. The water is shallow, and the channel is full of rocky reefs and large boulders, over which it tumbles in foaming masses. Owing to the shallow water, this portion of the river blocks in winter with ice, which is piled up in all directions in great disorder and is quite impassable with loaded sleighs, until after sufficient snow has fallen to cover up and smooth out the smaller inequalities. The second rapid is at the bend and is called the Horse-shoe Rapid; it is also shallow and full of huge boulders. Along the upper stretch, the river only in one place exceeds 100 yards in width, where it passes a small island. The channel is rocky and the water is deep, so that, although the current is very strong, the water is not broken, except by a dead swell, until within a mile of the head of the stretch where a heavy rapid makes it necessary to portage.

Horse-shoe Rapid.

At the head of this rapid, a large branch called Minipi River, enters the main stream from the south, through a deep, narrow valley, down which it rushes with heavy rapids. This stream discharges a large volume of water from its gathering ground on the table-land to the south and south-west of its mouth. It is said to rise in chains of lakes close to the head-waters of the Natashquan and St. Augustine rivers which flow into the Gulf of St. Lawrence.

Minipi River

Between Gull-island Lake and the Minipi River three-fourths of the timber in the valleys and on the hills of both sides has been burned, much of it by a great fire that raged throughout the summer of 1893. In the green woods remaining, many large spruce trees were seen, from twenty to twenty-four inches in diameter, and sufficiently long to furnish three logs each. A few narrow terraces were seen on the hillsides, but owing to the scanty drift deposits there is not much chance for the development of terraces.

Above the Minipi, the main stream bends sharply, and for twenty-five miles flows from N. 80° W. The valley gradually widens out and to the upper end of the course varies from one to two miles across. Its walls continue to rise from 700 to 900 feet above the water, and are nearly everywhere burnt bare. Terraces again become well marked and numerous, and range from 20 to 250 feet in height. The river channel is cut out of the drift, and the banks rise from ten to one hundred feet above the stream. The river, for five miles above the forks, is never more than 300 yards wide, and then widens to about a quarter of a mile, and is broken by a small shallow rapid where it passes four well-wooded islands, three miles up. Beyond the islands, it narrows again for four miles, and from there to the end of the course

River-valley above the Minipi.

it passes what is known as the "slack water," where the width varies from 400 to 600 yards in a deep channel with gentle current. There are three large islands along the upper three miles, with another called Cockatoo Island four miles below. Two large brooks come in from the north near the middle of the course; the lower one issues from a deep cut in the hills. On the south side a small river flows in at the upper end above the islands. Both sides of the valley is almost wholly burnt to within a few miles of the upper end, where the north side is well wooded with somewhat smaller trees than those previously met with.

The valley now bends to the north-west for five miles, and then northward for ten miles to where a small river flows in from the north-east. Along these courses it does not anywhere exceed one mile from side to side, and the hills are particularly high and rugged on the west side, where they rise from 800 to 1000 feet almost perpendicularly from the water. They are well wooded on both sides to within a short distance of the small river, where the eastern limit of an immense area of burnt country crosses the valley. This area, which extends on both sides of the valley almost to Grand Falls, has been traversed by numerous fires during different years, so that, with the exception of isolated patches here and there, all the original forest has been destroyed, and the sides of the valley and adjoining table-land are either destitute of trees, or partly covered with small second-growth timber of no commercial value.

Great area of burnt land.

Along the first or north-west course, the channel is only about 300 yards wide, and is obstructed by a number of small islands of drift. The current is strong, and there is a small river that drops into the valley with a beautiful fall on the west side near the head of the course. Above, the channel widens to a quarter of a mile, and the river is shallow, with small rapids to the upper end of the north course. The stream that here flows in from the north-east, called Câche River, is the largest yet seen on this side, and it has a distinct valley cut down between the rocky hills to a level with that of the main stream. Terraces are not prominently marked along the portion of the river just described.

Câche River.

For the next twelve miles the valley is narrow and very crooked, with sharp bends and a general course north-westward. The rocky walls rise sharply on both sides almost directly from the water, leaving in most places only a narrow margin of steep shore. The hills are nearly all bare and rocky. Terraces are not common, and are best developed at the junction of a small branch from the west about eight miles up, where the terraces are seen rising one above another for 250 feet.

The river varies from 100 to 300 yards across, and is deep and so rapid that in winter ice is formed only along the shores. The Mouni Rapids are two miles long and have three heavy pitches at the upper end. Mouni Rapids.

The valley above straightens, and the river flows S. 80° E. from Lake Winokapau six miles above. The stream continues narrow and rapid to the outlet of the lake, and is joined by a small stream five miles below it. Towards the lake the sides of the valley continue to increase in height, until at its outlet bare rocky precipices tower above it 1000 feet or more, with great masses of broken rock piled up at their base. Only a few small trees grow in cracks on the sides and tops, and the general aspect is wild and grand.

Beyond the valley on both sides, the country is covered with broken chains of rounded hills of gneiss that rise from 200 to 500 feet above the general level of the table-land, which is itself over 700 feet above the surface of the lake. The lower lands are either swampy or covered by small irregular lakes that discharge by streams into the valley, where they often fall perpendicularly 500 feet down the rocky walls. During the winter these streams freeze up, and their positions are marked by masses of ice often attached in fantastic forms to the bare surface of the rocks. In other places where the slope is less, the water wells out from below the already formed ice and congeals on its surface, in this manner forming large ice cones.

The table-land is almost denuded by fire, only small patches of trees being left about the lakes and swamps. These consist of a thick growth of stunted black spruce and larch of no commercial value.

Lake Winokapau fills an expansion of the river-valley, and is thirty-four miles long, its general course being N. 80° W., with two slight bends near its middle. For fifteen miles from its outlet it does not exceed a mile in width. Beyond, to its head, the breadth varies from one and a half to two miles. Lake Winokapau.

From its outlet, the north shore, for six miles, has a narrow margin of drift between the water and the rocky hills. Beyond this, and all along the south side, the rocky walls of the valley rise abruptly from the lake, and there is a marked absence of drift both on the hillsides and in the valley.

The water is remarkably deep; an isolated sounding taken fifteen miles up the lake, and about midway across, gave 427 feet, while another taken by Mr. Bryant* gave 407 feet. A third sounding was Great depth of the lake.

*A journey to the Grand Falls of Labrador, p. 26.

made fifty feet from shore on the south side, opposite the first mentioned, and gave a depth of 80 feet. No other soundings were made, owing to the difficulty experienced in cutting through the ice, which at the time we passed was four feet nine inches thick, and two hours were required to make a hole through it with the implements at hand. Information obtained from Indians shows that the lower three-quarters of the lake are exceedingly deep; the upper quarter has been filled in with drift brought down by the river.

The present bottom of the lake probably nearly represents the level of the river previous to the glacial period, the valley below having been in places filled with drift during that time to levels indicated by the terraces seen along the sides of the valley, rising in places from 200 to 250 feet above the present river-bed. The absence of any rocky ledges in the river-bottom, except at the first falls, where the ancient channel is on the north side of the rocky hill, points to this conclusion. Why the valley should be filled with drift below and above Lake Winokapau, and the portion occupied by the lake should be almost free of it, is a problem in glacial geology to be worked out in the future, but for which there are at present no data.

A small island of drift, covered with willows and a few large white spruce trees, six miles from the head of the lake, marks the beginning of the shallow portion. Above the island there are numerous wide, sandy shoals, bare at low stages of the water, and separated from one another by narrow channels. The main channel passes close to the south bank, and two large, low, wooded islands of drift separates it from a smaller shallow channel on the north side. At the head of the lake, a small branch called the Elizabeth River flows in from the west, down a narrow valley, while the main valley bends to the north-west.

Elizabeth River.

Ancient Hudson's Bay post.

On the south side, at the mouth of the Elizabeth River, there is a wide, sandy plain about twenty-five feet above the river, and on it the Hudson's Bay Company formerly had a post, which was abandoned in 1873, and subsequently destroyed by fire. A small river flows into the lake from the south opposite the lowest island, and the drift on the hillsides is terraced up to 200 feet about its mouth. On the north side, there are three large brooks with deeply cut valleys, and one on the south side; besides these, there are many small streams that fall directly over the precipices, from the table-land above, breaking the monotony of the rocky walls, and adding greatly to the beauty of the scenery.

Character of surrounding country.

The hills that bound the valley on its south side are remarkably regular in outline and have been rounded and scratched by glacier ice.

Those on the north side often rise in perpendicular cliffs from the lake; their faces and tops are angular and rugged, and do not appear to have been glaciated. The walls on both sides are from 700 to 1000 feet high, gradually lowering towards the head of the lake, where the slopes are less abrupt and the hills more rounded. At the head of the lake, the general level of the table-land on the south side is 950 feet above it. The country on top is nearly level, and covered with small lakes. Ten or fifteen miles to the south, a conical hill rises about 500 feet above the table-land. On the north side after an abrupt rise of 400 or 500 feet, the land slopes gradually, and does not attain the elevation of the south side for several miles back from the valley. Only a few small scattered clumps of trees remain of the original forest in the lake-valley; these show that at one time the shores and sloping hillsides were thickly covered with large trees of white and black spruce, up to thirty inches in diameter. At present most of the hills are bare, or covered only with small second-growth spruce and birch. The table-land to the southward is quite bare of trees, only the blackened stumps of the former forest remaining. On the north side, bare patches alternate with scattered second-growth black spruce of small size.

Lake Winokapau is well stocked with fish, the employees of the Hudson's Bay Company when stationed there, depended to a large extent on fish for food. In the old journals* of the post, the catches of the nets are recorded, and show that fish were taken abundantly, especially in the spring. The catch included carp, whitefish, lake and river trout in the order named. Potatoes and turnips were grown at the post, but not very successfully, as after planting in the spring, everybody left the place, and did not return until September, leaving the crops to grow without cultivation. Fish.

From the mouth of the Elizabeth River, the main valley turns N. 40° W., and continues in that direction five miles to the mouth of the Metchin River, a small stream having a deep valley, and used as a canoe route to the north-west interior by the Indians. Along this course the valley is about a mile wide, with the hills more rounded and sloping than below, owing to the great quantities of drift deposited here, through which only the rocky summits protrude. The river is less than half a mile wide, and flows close to the north side to within half a mile of the Metchin, where the deposits brought down by that stream have formed a low plain, and have forced the main stream into a narrow channel close to the south wall. Terraces are common and rise to more than 200 feet above the river. Metchin River.

*Winokapau journals seen at Rigolet.

The course of the valley now changes to N. 70° W., and with a few minor bends, continues in that direction for forty-five miles to the foot of the Bodwoin Cañon below the Grand Falls.

The narrow channel continues for a half mile above the mouth of the Metchin River, where it widens out to an average width of 500 yards, with high rocky walls on the south side, and drift-covered slopes on the north side. Six miles further up, there is a sharp bend to the northward for one mile, when the river again resumes its previous course. At this bend, the walls on both sides exceed 800 feet, and those on the west side rise in perpendicular cliffs directly from the river, which is here 400 yards wide. Above the bend, the character of the valley is unchanged for twelve miles, the valley being from half a mile to a mile wide, with high rugged hills, mostly burnt, on both sides. The channel is cut out of the drift, and is more irregular in width than below, being frequently narrowed by projecting points. The current is swift and the water appears to be deep. Seven miles up, a small branch flows in from the northward, in a gorge cut down to the level of the main valley.

Character of the valley.

After two well-wooded sandy islands are passed, another sharp bend of a mile to the northward, opens out into a wider valley entirely filled by the river, where there is little drift on the hillsides or along shore. The river is very shallow and the current swift. This stretch is seven miles long, and at its head the channel narrows to less than 200 yards, owing to the amount of material brought down by the Portage River, which cuts through a cliff and descends into the valley by a fall of nearly 200 feet, that is almost hidden by the huge blocks of rock heaped up at its bottom. Shortly above the Portage River, the main stream again widens out, filling the valley from wall to wall, and varying from half a mile to one mile in width for eight miles. The portage-route of the Grand Falls, leaves the valley on the north side four miles above the mouth of the Portage River.

Portage River.

Opposite this place and above it, the river is silted up with sand brought down by rapids and deposited in the wider, quieter waters. This sand forms wide flats, covered at high stages of the river, and cut by numerous, deep, winding channels. Four miles above the portage, two large, low, densely wooded islands mark the foot of the rapids that extend almost continuously beyond for twelve miles, to the mouth of the cañon. The channel above the islands soon narrows, and the drift deposits thin out, finally almost wholly disappearing from the sides of the valley, which contracts to less than 300 yards in width and becomes crooked. Three miles above the upper island, the first rocky ledge since leaving the Muskrat Fall, is seen in the river bottom. Here, there is a heavy rapid which continues half a mile to a short bend to the westward. At the foot of the rapid, Messrs. Cole and Cary, of the Bodwoin College Expedition, had the misfortune to burn their boat and supplies, and on this account it has been called Disaster Rapid. The charred remains of the boat was found close to the shore in a small patch of burnt woods. Disaster Rapid.

Two miles above this rapid, at the angle of a small sharp bend, a large branch flows in from the west in a well defined valley. Inquiries made among the Indians who had hunted about here, failed to yield any information concerning this stream, and they were surprised to hear of its existence, as they all were without knowledge of any large stream between the main river and the Elizabeth River, which enters Lake Winokapau. The only explanation given about this unknown stream, was that it must be a deep channel of the Valley River, and must leave that stream some distance above the main forks; but the origin and existence of two deep, well defined valleys such as these, forming an island, is anomalous, and could only be accounted for by the river splitting into two branches before it leaves the table-land. Unknown channels.

Above the junction of this stream, two sharp bends of the narrow main valley lead, after three miles, to a long straight stretch, where the valley widens somewhat, and patches of terraced drift are seen high up its rocky walls. At the upper end of the last bend, a small stream comes in from the north, descending in a succession of beautiful cascades from the table-land 700 feet above. This stream drains a number of lakes, and when the river is swollen by the spring freshets, a small portion of it passes up a narrow bay above the Grand Falls, and from there by a rocky channel into the small lakes, of which the discharge is thus much increased during the early spring.

For five miles above the junction of this stream, the valley continues straight and narrow, with sandy terraces flanking the rocky walls at intervals along both sides. The river varies from fifty to one hundred yards in width, and rushes along in a continuous heavy rapid, from where the main body of water enters the valley by Bodwoin Cañon.

Above the mouth of this cañon the main valley continues in the same direction upwards of ten miles, and then bends slightly northward, its further extension being concealed by the high walls on the north side. As far as seen from the cañon, the valley appears to be from a quarter to half a mile wide, and is partly filled with terraced drift, with a branch flowing with a moderate current down it. This branch has less than a quarter of the volume of the other river, and rises in Lake Main valley above Bodwoin Cañon.

Ossokmanuan on the table-land, thirty miles to the westward. This lake also discharges by another outlet into the main Hamilton River, described later. Eight miles in a straight line north-north-west of the mouth of the cañon, the main branch of the Hamilton River issues from a small lake-expansion, almost on a level with the surrounding surface of the table-land, and begins one of the greatest and wildest descents of any river in eastern America. A large number of barometric readings taken in the vicinity, in conjunction with regular readings at the Hudson's Bay Company's post, at Northwest River, give the height of the river as it issues from the lake as 1660 feet above sea-level. The height of the valley at the mouth of the gorge, determined in the same manner, is very close to 900 feet above sea-level. Consequently, in twelve miles, the total fall is 760 feet. Such a fall would be nothing extraordinary for a small stream, in a mountainous country, but is phenomenal in a great river like the Hamilton, which has been estimated to discharge at this point about 50,000 cubic feet per second, or nearly the mean volume of the Ottawa River, at Ottawa, that stream having a mean volume of 85,000 cubic feet per second at Grenville,* where it includes the waters of the Rideau, Gatineau and Lièvre rivers. The descent includes a sheer fall of 302 feet, the rest being in the form of heavy rapids.

Descent of the river near the Grand Falls.

Volume of water at Grand Falls.

The outlet of the lake is dotted over with small rocky islands, capped with dense thickets of small evergreens. These islands extend downward for a mile and divide the river into a number of narrow channels with a swift current. The stream, flowing southward, then narrows to less than 400 yards, and in the next mile passes over a number of rocky ledges between low wooded banks, falling fifty feet in a continuous heavy rapid. Again it widens out to nearly a mile, and for two miles is obstructed by many small islands, flowing swiftly between them, with short broken rapids. Next, turning south-east, it contracts to less than half its previous width, and rushes along with heavy rapids, in a shallow channel full of huge boulders, with low rocky shores, capped with thin deposit of coarse gravel and sand, and wooded above with small spruce and larch. In this manner the river continues for three miles, gradually narrowing as it descends, with a fall of forty-five feet along the last two courses. The banks and bottom of the river are wholly formed of rock, and as the stream in the next mile has cut a narrow and gradually deepening trough out of the solid rock, at the lower end of the course it flows in a narrow gorge, with sloping rocky walls 110 feet below the level of its upper end. As it descends

*General Report Public Works, Canada, 1867-1882, p. 840.

its width decreases from 150 to 50 yards, and it hurries along with tremendous rapids.

The last 300 yards are down a very steep grade, where the confined waters rush in a swirling mass, thrown into enormous, long surging waves, at least twenty feet from crest to hollow, the deafening noise of which completely drowns the heavy boom of the great falls immeiately below. After a final great wave, the pent up mass of water is shot down a very steep incline of rock for 100 feet, where it breaks into a mass of foam, and plunges into a circular basin below, the momentum acquired during the first part of the fall being sufficient to carry it well out from the perpendicular wall of rock at the bottom, leaving almost a free passage between the foot of the cliff and the falling water. The total fall from the crest of the incline to the basin below is 302 feet. The Indians believe that the space between the falling water and the rocky wall is occupied by the spirits of two maidens who were accidentally carried over the falls, and who now pass their time in dressing and preparing deer skins. On this account, or more probably because of the feelings of awe inspired by the grandeur of the surroundings and the enormous power displayed in this rush of waters, those who hunt in the vicinity cannot be induced to visit the falls or the cañon below. Grand Falls.

The shape and character of this fall resembles closely, though on a gigantic scale that of a small stream flowing down a V-shaped trough, inclined at a high angle, and issuing freely from its lower end. The basin into which the river precipitates itself, is nearly circular and about 200 yards in diameter. It is surrounded on all sides by nearly perpendicular rocky walls 500 feet high, except at the narrow cut at the head of the falls, and where the river issues from the basin. The surface of the basin is violently agitated by the rush of water from above, and its huge lumpy waves break high up the rocky walls. The falls are best seen from the top of the south wall, directly opposite, but the dense columns of vapour that rise out of the basin often interfere with the view, and give a blurred, fogged appearance to photographs taken from that side. The noise of the fall has a stunning effect, and, although deadened because of its inclosed situation, can be heard for more than ten miles away, as a deep, booming sound. The cloud of mist is also visible from any eminence within a radius of twenty miles. Character of the falls.

The river leaves the basin by a narrow cañon at right-angles to the falls. It flows eastward about a third of a mile, and then bends sharply to the south-west for a half mile, next to the east for a like distance, followed by another south-west bend of similar length. Bodwoin Cañon.

In this manner it zigzags until it finally ends in the main valley of the river.

From the falls to the mouth of the cañon the distance in a straight line is not above four miles, but by the river it is over twice as far. This cañon is cut down into solid gneiss, granite and gabbro. Its zigzag course conforms with the direction of two sets of fracture, or cleavage-planes in the rocks, which appear to have caused lines of weakness and aided the eroding action of the water. Except on the inner sides of the bend, where there is a sloping wall of boulders, the walls are nearly perpendicular. At the top, the width rarely exceeds one hundred yards; while at the bottom the river is seldom over one hundred feet wide, and often measures less than half that width. The fall of the river from the basin to the mouth of the cañon is 260 feet, and, as this is accomplished without any heavy drops, the magnitude and grandeur of the rush of water at the bottom of the gorge may be imagined.

The cañon is cut sharply into the surface of the table-land without any appreciable dip of the ground towards it, and there is so little indication of its presence from above, that the gorge is seen only within a few yards of its edge; and its walls are so steep, and the bushes along the top so thick, that in most places it is necessary to hold on to an overhanging tree and lean far out in order to see the narrow white line of broken foaming water that rushes along 500 feet below. As the country slopes gently towards the main valley, the cañon does not deepen with the descent of the river in it, and the walls are everywhere from 500 to 600 feet high, varying with the undulating surface of the table-land.

Origin of Bodwoin Cañon.

There is little doubt that the cañon is a valley of erosion in an unfinished state of formation, and probably previous to the glacial period was the valley of a much smaller stream than the one at present flowing through it. At that time the main stream in all likelihood followed the main valley. There is no evidence that the valley has been cut back, or otherwise eroded since the close of the glacial period, beyond the removal of the drift, which then filled it nearly to the top, as patches of drift still remain on the inner sides of the sharp bends. From the above facts some idea can be had of the great length of time required for the erosion of the main valley of the river, from the falls to the mouth of Hamilton Inlet, which is really a submerged portion of this river-valley.

John McLean.

John McLean, of the Hudson's Bay Company, as before stated, was the first white man to see the fall. In 1839, while on a journey overland from Ungava Bay to Hamilton Inlet, he descended the Hamilton River, visiting the fall in passing, and he has given a short description of it in his book.* The falls are known to the Indians and inhabitants of the Labrador coast as the Grand Falls, but as a recognition of the discoverer, as well as the indefinite character of the above name, it is now proposed to call them the Grand or McLean Falls.

The cañon below the falls was first discovered and partly traced by Messrs. Cary and Cole in the summer of 1891, and was named by them Bodwoin Cañon. Messrs. Bryant and Kenason also visited the fall in 1891, arriving there a few days later than the first party. Among others of the Hudson's Bay Company officers who have seen the fall, may be mentioned a Mr. McPherson, who visited them shortly after their discovery by McLean, Père Babel, O.M.I., a missionary who spent two or three seasons living with the Indians about the head-waters of the Hamilton River about 1870, has also given the writer a most graphic account of his visit to the fall at that time.

Portage-route past the Grand Falls.

The portage-route past the fall and rapids, leaves the main valley on the north side at the foot of the rapids fifteen miles below the mouth of the cañon. The road rises 700 feet in a quarter of a mile as it ascends the steep wall of the valley by a narrow cut beside a small stream. It then passes over undulating wooded country, rising slowly for two miles, to a small lake that lies north-west of the lower end of the portage. Crossing the eastern end of the lake, the route turns northward and passes over four portages of 1000, 200, 200, 300 yards long respectively, that connect as many small lakes or ponds. The last portage ends near the middle of Island Lake, which is about three miles long and a mile wide, with its longest axis running almost east-and-west. This lake discharges from its east end into another large lake that empties into the Portage River. Crossing to the north side of Island Lake, two short portages, with a small swampy lake between, lead into another lake about two miles and a half long, which also discharges into the Portage River. The route now changes to west-north-west, and continues in that direction until it reaches the lake-expansion of the river above the falls. From the western end of the last lake a mile portage through a swamp leads to a narrow lake one mile long, with another mile portage from its west end into a similar narrow lake. The next portage is slightly shorter, and crosses a small watershed, passing close to the foot of a high hill on the south side called Lookout Mountain; it ends in a long narrow bay at the east end of Lookout Lake, the largest body of water along the route. This lake is followed seven miles, to its western end, where a small river enters. The

Lookout Mountain.

*Twenty-five years in the Hudson's Bay Territory. Vol. II., p. 75.

greatest breadth near the east end is less than two miles. The lake is shallow and dotted with small rocky islands. It discharges by the little river that falls into the main valley five miles below the cañon, and which, as already mentioned, forms a discharge of the main river during periods of high water.

The inlet is followed through a number of lake-expansions for five miles, with three short portages past rapids and a final one of a half mile that leads to the head of a deep bay of the main river.

Country about Lookout Mountain.

Lookout Mountain is a long round hill of gabbro, that rises 460 feet above Lookout Lake. Its summit and sides have been burnt over, and from its top a good view of the surrounding country may be obtained. The surface of the table-land is broken by long rocky hills, connected by low ridges of drift, that run west-north-west, or parallel to the direction of the glacial striæ. Between the ridges there are wide valleys filled by long irregular lakes or swamps. Southward from the top of Lookout Mountain, the country is seen sloping towards the river-valley, and it is much more broken and rugged than in other directions. One sharp rugged hill rises well above the rest, and is probably the Mount Hyde of the Bodwoin Expedition.

The position of the river-valley here is well marked, the country sloping towards it on both sides. Beyond the valley, the country appears to be somewhat higher than on the north side. Ranges of burnt hills are seen stretching away to the south-west, and bounding the horizon in that direction. Westward, the position of the Grand Falls is marked by the column of mist that rises high over it. No other feature marks the presence of the cañon, and gently undulating hills extend as far as can be seen. To the north-west, the country is very similar, and in the distance lake-expansions of the river appear. North and north-eastward, the ridges of hills are seen running in regular lines with a higher range bounding the sky-line about twenty miles away. Where any depression occurs in the ridges, a shining patch of water marks the position of a lake, in the valleys beyond. Looking south-east, or parallel to the ridges, a perfect network of small island-dotted lakes are seen, filling each valley, and separated from one another only by low ridges of drift. In the distance are a number of high rounded hills near the discharge of the Portage River.

Trees.

Over half of the surrounding country has been stripped bare by frequent fires. In the swamps and around the shores of the lakes, where the trees are unburnt, black spruce and larch of small size grow thickly together. On the sides of the hills these trees are more stunted, and are separated by open glades. Where the hillsides have been burnt years ago, they are covered with a tangled mass of willows and alders, while the tops are coated with white moss and semi-arctic shrubs and berries. Only on the banks of the river about the falls were trees large enough for commercial purposes seen. Surrounding the basin, white spruce seventy feet high and two feet in diameter at the base, are common, along with large-sized black spruce, balsam fir and white birch. The moisture from the constant column of spray, as well as the warmth from the open water, may account for the better growth of the trees in the neighbourhood. Along the river banks and on the islands above the falls, the trees are larger, and more varied than about the lakes of the portage-route, fair-sized white and black spruce, balsam fir, larch and white birch growing freely.

Upper Hamilton River.

Character of the upper Hamilton River.

Above the Grand Falls, the character of the river changes completely; it no longer flows in a distinct valley cut deep into the surrounding country, but nearly on a level with the surface of the table-land, spreading out so as to fill the valleys between the long, low ridges of hills that are arranged in echelon all over the country. The river in passing around the ridges is often broken into several channels by large islands formed by separate ridges, and in other places, where there are wide valleys between the hills, it fills long, shallow lakes, with deep bays, and often studded with islands. The river is now so divided into channels and so diversified with island-covered lakes, that without a guide it is almost impossible to follow its main channel, and much time is lost tracing its course through the lakes, which often have several channels discharging into, as well as out of them. The current instead of flowing regularly, now alternates between short rapids and long lake stretches.

The banks are often low, and covered with a dense growth of small willows and alders, that form a wide fringe between the water and the conifers of the higher ground behind. In other places, generally at rapids, the stream has cut a channel into the sandy drift that forms the low ridges on one or both sides. The shores of the lakes are very often low, with an interval of flat land between the water and the hills behind. These low shores and those of the islands are generally thickly strewn with boulders, piled up in ridges by the expansion and drift of the ice in the spring. The general direction of the river from the Grand Falls to Lake Petitsikapau, more than 100 miles above, is nearly west-north-west, or parallel to the direction of the glacial striæ, and that of the ridges of drift. All these features give to the upper portion of the river an aspect of newness, and indicate that its present course and conditions have been determined by the post-glacial configuration of the table-land, in marked contrast to the ancient appearance of the deep, rock-walled valley of erosion below the cañon in which the river must have flowed for ages, slowly abrading the hard gneisses and granites and carrying away the results of atmospheric decay brought down from its sides by the rains and small tributary streams.

Post-glacial channels.

Jacopie Lake.

The first expansion of the river above the portage is called Jacopie Lake. It is seven miles long and about two wide, with two deep bays on the east side, and is surrounded by low, rounded, rocky hills, totally burnt over on the east side, and partly so on the west. A chain of low islands of drift extends along the east side, and almost closes off the bays from the main body of the lake. In a few places, bosses of rock are seen rising from beneath the drift of the islands. At the head of the lake, the current is quite strong in the main channel, with a heavy rapid at the inlet, in order to avoid which, when the water is high, a small channel behind a long narrow island is followed by canoes. There are two short portages here past small chutes.

Above the lake, is a stretch of eight miles where the river flows swiftly and is broken by two heavy shallow rapids filled with large boulders. The banks are generally low, and are cut out of drift, the channel averaging half a mile across. Numerous islands divide the stream into different channels, especially towards the upper end, where the river broadens out into the next lake-expansion. This is called Flour Lake, and it is ten miles long and apparently about two miles wide, with deep bays running off on both sides. Its surface is so broken by islands, many of them small and rocky, that it is impossible to determine the shore-line of the lake by passing up its middle. There is distinct evidence of current everywhere, and this grows stronger as the head of the expansion is approached. At the upper end the river splits into two nearly equal channels, that do not again join until Sandgirt Lake is reached, fifteen miles above. The north channel is very rapid, and soon leads into Lobstick Lake, a large and long body of water on the route to Lake Michikamau, described in the part of the report referring to that lake. From Lobstick Lake, a stretch of five miles of river leads into Sandgirt Lake, where the streams again unite.

Flour Lake.

Channel from Lobstick Lake.

The south channel, leading out of Flour Lake, is the ordinary canoe route. The distance by this channel between Flour and Sandgirt lakes is fifteen miles. The stream varies from 100 yards to over a mile in width, and is obstructed by numerous islands. The surrounding country is low and rolling, with long ridges of drift and little rock. The trees are small and are principally black spruce and larch, with white spruce and balsam fir along shore, and white birch on the hill-sides. The current is always strong, and it is broken by seven short heavy rapids, where the stream narrows and is obstructed by islands. The river-bed at these rapids is composed of large, rounded boulders.

Five miles above Flour Lake, the south channel again divides, and the canoe route continues to follow the southern branch, which flows out of a deep bay in the south-east corner of Sandgirt Lake, the other channel flowing out of the next bay a few miles to the northward.

Sandgirt Lake.

Lake Kanikauwinikau or Sandgirt Lake, is an irregular-shaped, shallow body of water, with many islands of drift and with sandy or boulder-strewn shores. It is twelve miles long from the southern outlet to the mouth of the Ashuanipi Branch, on its north-west side, where two deep bays continue on several miles farther to the westward, one on each side of the river, and divided from it by wide low points of drift. From the mouth of the Attikonak Branch, on the south-west side, to the northern outlet, the distance is eight miles. Besides the two bays on the west side already mentioned, there are two others, one to the south and the other to the north; these are only a few miles deep, with small streams flowing in at their heads from wide-spreading series of lakes. The country surrounding the lake is somewhat higher than that along the river below, especially on its south side, where a ridge of rocky hills extends from the east to the shores of the Attikonak Branch. Some twenty miles westward, a wide range of hills is seen rising with barren sides over 800 feet above the general level, and it continues in a north-western direction. The outlines of these hills are sharp and rugged, quite unlike those of the hills of the Archæan area already passed through. Only their lower slopes are wooded, and in the month of August large masses of ice and snow remained in protected gullies on their northern slopes. The name of Ice Mountains was given to these hills. To the north-west, rounded hills from 200 to 500 feet high are seen, separated by wide valleys containing the bays on that side of the lake. To the north and north-east, the country is undulating and lower, with higher, rounded ridges bounding the horizon. To the east, only low ridges of drift break the general level.

Gathering place of Indians.

Sandgirt Lake is an important gathering place for the Indians of the interior, on account of the number of routes that centre here. The Hamilton River divides into two branches, the larger or Ashuanipi Branch flowing in from the north-west and the Attikonak Branch from the south. The main route from the Hamilton River to Lake Michikamau also ends here. The Indians who trade on the lower St. Lawrence and hunt anywhere in this vicinity, always congregate here in the spring, and descend to the coast in company, either by the Romaine or Moisie River.

Returning in the autumn, they travel together to this lake, where they separate into small parties for their winter hunts. The standing poles of their wigwams, scattered everywhere along the shores and on the islands of the lake, show that several families camp here.

On account of its favourable situation, a câche was made on an island in the lake, to store the surplus provisions and outfit, and from here, with lightened canoes, the Ashuanipi Branch was first explored, after which a trip was made to and around Lake Michikamau, before Sandgirt Lake was finally left by the Attikonak Branch.

Ashuanipi Branch.

Ashuanipi River.

The Ashuanipi Branch, as before stated, flows into the lake on its west side. Its course for thirty miles above, to Birch Lake, is nearly north-west. For five miles above Sandgirt Lake, the river flows through a flat, well-wooded country, and then passes close along the southern base of a sharp, rocky hill 300 feet high. This has been burnt over, giving an unobstructed view from its summit. The bay of the lake to the northward comes close to the base of the hill, and extends some miles westward of it, where the continuation of the valley is filled with a large treeless swamp. South-west of the river, a network of large lakes occupies over half of the area between the river and the Ice Mountains, some ten miles distant. From this hill to a small lake-expansion four miles above, the river varies from 100 to 500 yards in width, with sandy banks from ten to sixty feet high, cut out of the roughly parallel ridges of indistinctly stratified drift, between which it flows with a swift current. The lake-expansion is about two miles wide and over three miles long; it is quite shallow, with low, willow-clad banks.

Ice Mountains.

A stretch of five miles of swift water, terminating above in a short rapid, separates the last from the next lake-expansion. A number of high islands of drift obstruct the channel, and the banks are again high and irregular. Occasional white spruce trees are met with along the river bottom, up to fifteen inches in diameter, along with small black spruce, larch, balsam fir, white birch, and a few clumps of small balsam poplar.

Increase in size of trees.

The next lake-expansion is eight miles long; its lower half is crowded with low islands, covered with willows; the shores are also low, with a wide fringe of willows and alders between the water and the trees behind. There is a long ridge on the north side, culminating in a rocky hill 300 feet high at its west end.

The increase in the size of the trees about this lake is very marked, and is probably due to the change in quality of the soil, caused by the disintegration of the Cambrian rocks, which here underlie the surface deposits and form a very large percentage of the drift.

White spruce thirty inches in diameter at the base and forty feet high is not uncommon along the shores, black spruce is often twenty-four inches in diameter at the base, but rapidly lessens above, so that few exceed eighteen inches six feet from the ground. Balsam fir is abundant, but not very large. White birch is also common, and grows up to ten or twelve inches in diameter, but is generally crooked and does not afford good bark for canoe-building. Small clumps of balsam poplar are met with frequently with trees six inches in diameter, but crooked and straggling like the birch.

At the head of the lake-expansion, an island seven miles long divides the river into two channels, with the greater part of river flowing in the northern one. The island is formed by a high ridge of drift into which the river has cut deeply in many places, giving sections of from twenty to sixty feet, and showing that the material is almost wholly sand, with evidence of bedding. In places the banks are cut into small terraces up to a height of sixty feet, in one place to the number of eight.

The north channel varies from 200 to 300 yards in width, is dotted with small islands of drift, and has a swift current with strong eddies behind sharp boulder-strewn points. All these eddies swarm with large brook trout from three to six pounds in weight. Five miles up, the channel widens out and is split by a number of large low islands as Birch Lake is entered. Birch Lake.

The shape and size of this lake are well seen from the summit of a sharp rocky ridge that extends for two miles along its south side near its western end. This ridge is very similar to others that now run south-east and north-west, parallel to one another, with wide valleys between them. The hill consists of stratified Cambrian rocks, highly tilted, and has cliff-faces on both sides with intervals covered with drift resting on the steep slopes. The summit of the ridge is irregular and narrow, so that almost anywhere the foot of the hill can be seen on both sides from the top. The sides, where unburnt, are covered with large white spruce in open glades to within a hundred feet Character of country about Birch Lake.

of the top, where they give place to a thick tangle of willows and alders. On the top the willows are smaller, less matted, and do not interfere greatly with travel. The higher points are only covered with small shrubs, including the cranberry *(Vaccinium Vitis-Idæa)* that grows in great profusion. The highest point of the ridge is about 350 feet above the water.

Birch Lake is ten miles long from the northern outlet to the mouth of its southern inlet, and is less than five miles across in its widest part. Long ridges of drift form deep bays at both ends. The large island already referred to divides the eastern end into two bays, while a long string of islands separates off another portion of the lake on the north. The western end is also deeply indented by three narrow bays that develope into channels of the river at their heads, and thus form two large islands that extend to the next lake to the north-west.

Cambrian ridges.

The north side of Birch Lake is bounded by a sharp ridge extending the whole length of that side. Its height varies from 300 to 400 feet; its top and the greater part of its south side are treeless, the lower parts having been burnt over many years ago, and the conifers have since given place to willows and alders. Fires have devastated much of the country surrounding the lake, and, as the trees once destroyed appear to grow again very slowly, large areas have a barren, desolate appearance; they are covered with small bushes and shrubs, and in many places only with white reindeer moss. This moss, or rather lichen, covers the ground everywhere, even in the thickest woods, and, except in wet weather, is much more agreeable under foot than the tangled masses of Kalmia and Labrador tea met with throughout the country to the southward. On the islands and shores where the forest is unburnt the trees are very similar in size to those last described. To the south of the ridge there is a wide valley stretching far away to the south and south-west, broken only by low ridges of drift and streaked everywhere with water—parts of large irregular lakes—the view from the ridge giving an impression that over one half of the surface in those directions is covered with water.

The southern inlet of Birch Lake appears to be the largest; it varies from 100 yards to nearly a mile in width, and is greatly obstructed by low, sandy islands, with shale beneath. The channels are shallow, and the current strong, with several small rapids, especially along the upper part, the last a heavy one 200 yards long, where the river flows out of Dyke Lake. There are twelve miles of river between the lakes, and several small streams enter by deep bays on both sides. At the foot of the upper rapid two channels separated by two long islands join as the river issues from Dyke Lake.

The shores along the river are low and well wooded, and the general flatness of the surrounding country is broken by a few short rocky ridges of irregular outline on both sides.

Entering Dyke Lake by the right-hand channel, a bay about one mile wide and four miles long is ascended to the end of the large island that extends from Birch Lake. The bay is walled in between steep rocky ridges that rise from 300 to 500 feet above the surface. The ridge on the north side terminates abruptly in a sharp pointed hill 490 feet high and cut transversely to the ridge by a great fault, and on this account called Fault Hill. The southern ridge is wooded, the northern one is mostly burnt. The lower flanks of Fault Hill are covered with groves of white and black spruce for 300 feet up; above this, only willows and alders grow to near the summit, where moss alone partly covers the surface. The trees, as the river is ascended, again become small, and, although large white spruce trees are met with on the lower flanks of the hills, they are stunted in height, and thick branches grow close to the ground, forming great knots in the trunk and rendering the wood practically valueless. Poplar is not seen above Birch Lake. Dyke Lake

The only way in which an idea of the extent and shape of these irregular lakes along the river can be obtained, is by climbing the hills. For this reason Fault Hill was ascended, and from its summit Dyke Lake was seen stretching away far to the north-west. The southern channel extends into a deep bay behind two large islands on the south side. These islands are separated by a narrow channel a short distance above Fault Hill, and from there the upper island continues five miles with a channel nearly half a mile wide, dividing it from a point of the mainland. Looking backwards, the two northern channels, as well as the one ascended, can be traced to Birch Lake. They are all dotted with islands, and the darker water in several places indicates short stretches of rapids. Country about Fault Hill.

The bay on the north side of Fault Hill, is much deeper and wider than that on the south side, and extends seven miles eastward. Its surface is covered with numerous islands, very irregular in shape, and apparently representing ridges of drift, the lower portions of which are submerged. Abreast of Fault Hill, the lake is nearly twelve miles wide, but no idea of its size can be obtained on its surface owing to the number of islands. Westward, the lake gradually narrows, and two large islands almost separate the northern side from the main body. Eight miles further up, the large islands terminate, and the lake narrows to about two miles.

The country about this lake is much rougher than any previously passed through and the north side of the lake is bounded by a continuous ridge that rises from 300 to 500 feet. The larger islands are high and rocky, and consists of broken ridges. Along the south shore, there is an interval of low land extending to within a short distance west of Fault Hill, where a wide ridge commences and extends westward several miles. This is probably one of the highest points in this region; the main hill rises far above the surrounding ridges and the upper half appears quite barren.

Entrance to Lake Petitsikapau.

The lower land to the south is covered with large lakes, and the horizon is bounded by a long, unbroken ridge. From the narrows the lake continues north-west for nine miles to the head of the north bay, were a short, deep, rocky narrow about two hundred yards wide divides it from Lake Petitsikapau. A high rocky ridge bounds the north side of the lake along this part, with an interval of swamp between it and the water, terminating in a low muddy shore. The high land on the south side ends about three miles up, and is replaced by a flat swamp, thickly covered with black spruce and larch. The trees, on the slopes of the northern ridge are larger, and many stout, knotted white spruce are seen on the lower flanks more than two feet in diameter at three feet from the ground. The main river enters with a short rapid on the south side near the head of the lake. At the time this place was reached, the water in Lake Petitsikapau was very high, and a large volume was passing through the deep outlet, which was mistaken for the main river. In consequence, a week was spent carefully examining the western and northern shores of that lake, in search of a large river flowing into it.

Lake Petitsikapau.

Lake Petitsikapau (or Willow-fringed Lake) is the largest body of water in this part of the country. It fills a wide, shallow valley between sharp ridges of rocky hills similar to those already described. Minor ridges cut its ends into a number of deep bays and give to it a very irregular outline. Almost everywhere, the shores are low and swampy and bordered with willows. The greatest length is twenty-five miles from south-east to north-west, and its widest part measures eight miles across. The north-west end is divided into four narrow bays, of which the northern one is the longest. To the southward there are only two bays, the most southern of which is from two to three miles wide, and extends south-east over ten miles, with only a narrow neck of land between it and Dyke Lake. The northern end of the lake is covered with numerous low islands of limestone and shale; these islands are generally long and narrow, running parallel to the strike of the rocks. The water between the islands is very shallow, and in many places difficulty is experienced in finding a passage for light canoes. The southern portion is comparatively free of islands, and those found there consist of drift and are somewhat higher than those of limestone and shale. The whole lake is very shallow, and in its widest part, where islands are absent, it was found not to exceed ten feet in depth. Small streams flow into the heads of all the northern bays, and from the ridges these are seen to drain chains of small lakes in a wide valley that extends many miles beyond the head of the lake, where the waters of Hamilton River interlock with those of a branch of the Koksoak River flowing into Ungava Bay. The largest stream entering the lake flows through a chain of lakes to the eastward and empties into the north-east bay. A rocky ridge from 200 to 300 feet high and less than a half mile wide, extends along the north shore westward of this stream, and divides Petitsikapau from a deep narrow bay of Lake Attikamagen or Deer-spear Lake, at the head of the George River, which also empties into Ungava Bay. This bay runs north-west some eight miles, and joins the main body of the lake, which, from the crest of the ridge, is seen stretching away several miles in that direction; it then bends eastward, where it disappears behind a high ridge. A deep cut in the horizon-line to the east shows where the outlet of the lake passes between the hills.

Shallow water.

Head-waters of Gorge River.

Lake Petitsikapau is on the edge of the barren grounds. The trees still grow in the valleys and on the lower hillsides, but the upper parts of the hills are barren. Northward a succession of high, barren ridges are seen, with an occasional glimpse of a lake, or of a valley wooded with small spruce and larch trees. Total barrens do not occur in Labrador until Ungava Bay is reached, as trees always grow in the river-valleys to the south of it, although the uplands beyond Petitsikapau are covered only with willows and arctic shrubbery.

Fort Nascaupee.

For many years the Hudson's Bay Company had a post called Fort Nascaupee on the second northern bay of Petitsikapau. This post was established about the time of McLean's journeys from Ungava to Hamilton Inlet, in or about the year 1841, and it is mentioned by W. H. A. Davies in an article published in 1843, as having then been lately established.* This post was erected for trade with the Nascaupee Indians of the interior, and was quite successful until after the second establishment of Fort Chimo in 1866, when the Indians began to desert it; those from the north going to Fort Chimo, while the southern Indians traded at Mingan or Seven Islands, on the Gulf of St. Lawrence, or at Northwest River—all of them preferring to undertake the long

*Trans. Lit. and Hist. Soc. Quebec, vol. IV., part I., p. 74.

arduous journey to and from the coast, where they could obtain better prices for their furs, and purchase provisions and other necessities at a much cheaper rate than at the interior post, where the cost of transport and maintenance added several hundred per cent to the original cost of the goods. The post was accordingly abandoned about 1873, and now the only trading posts of the interior are those situated at Nichicun and Mistassini.

Ruins of the fort.

The ruins of Fort Nascaupee stand in a small clearing, close to the shore of the lake, and only a short distance above high-water mark. The houses were built of small, squared logs, with board roofs. When visited, the dwelling-house was in a fair state of repair, with the window sashes and some of the glass still in place. The doors and movables inside had been broken up and used for firewood by Indians; the roof was nearly unbroken, and leaked only in a few places. This building is about twelve by eighteen feet, and has a low room under the attic roof above. Adjoining the main building on each side are two smaller buildings, evidently used for a kitchen and store; the roofs of both have fallen in. Traces about twenty yards to the east of these ruins, probably represent the remains of some outbuilding. About fifty yards behind, the powder-house covered with earth was seen, with broken roof and partly filled up with earth. Adjoining this is a small burying place with a large wooden cross in its centre, but without any marks on the graves, which are probably those of Indians. In the attic a fragment of "The Albion," of March 7th, 1846, was found. Close to the house were several patches of rhubarb eighteen inches high, while a number of introduced plants still flourish in the old door-yard.

River above Dyke Lake.

As previously stated, the main river flows into Dyke Lake, from the south, close to its north-west end. At its entrance the river is obstructed by a number of small rocky islands and large boulders, between which the stream descends in a heavy, shallow rapid about 300 yards long. The lake above the rapid has the general north-west and south-east trend, and is six miles long and two miles wide at its south end, gradually decreasing to a mile at the other end. Both sides are high and rocky. The river flows into the lake from the south almost opposite the outlet. At the entrance a large dyke crosses the stream, forming a number of islands with heavy rapids between them; above the rapid is a short stretch of swift current, and a large island of drift divides it into two equal channels each about 300 yards wide, where the river falls with shallow rapids for a quarter of a mile from Astray Lake, immediately above.

Astray Lake, so called from our wanderings in search of the river, follows the general direction of all the lakes of the vicinity, determined by the course of the rocky ridges. From the head of its longest northern bay to where the river leaves it, the distance is twenty-five miles, and the south-eastern bay extends some distance beyond. In its widest part it is about four miles across. Two rocky ridges, forming long narrow points, divide the northern half into three deep narrow bays ; the southern end, five miles below the outlet, narrows to less than two miles, and passes close to the foot of Red Mountain, the high hill seen from the top of Fault Hill. Two low ridges of limestone extend down the centre of the wide part of the lake, and form chains of rocky islands. The ridges on the south side of the lake are low and broken, and the shore line on that side shows frequent low cliffs of yellowish-white limestone. Quartz Hill is a sharp hill of white quartzite that rises 300 feet above the lake, on the south side, opposite the outlet. This hill is wooded almost to its summit with white and black spruce trees, but on the summit they do not grow more than six inches high. The trees surrounding the lake are very similar to those seen about Dyke Lake, except that they are somewhat smaller. Astray Lake.

A small branch of the river flows into Astray Lake, twenty-four miles from its north end, coming in with a short, shallow rapid from the next lake, called Marble Lake, which is separated from the last only by a narrow ridge of limestone. The other channel of the river flows out of a south bay and joins Astray Lake, a few miles to the east of the first.

Marble Lake stretches north-westward from the outlet, and for four miles is more than three miles wide ; it then contracts to about a mile, and becoming shallow, soon shows current, and thus changes into the river. There is a small rapid two miles above, where a ridge of drift-covered islands extends diagonally out from a long point on the north side causing the stream to flow in a narrow channel on the south side. The shores of the lake are low, and often composed of ledges of white limestone. The surrounding country is also low, apparently swampy, and well wooded with a thick growth of small spruce and larch. Marble Lake.

The river above the narrows continues to flow with a strong current from the north-west for six miles, in a shallow channel over half a mile wide, with low swampy shores. Many sandy shoals obstruct the channel, and huge boulders are scattered everywhere.

The course of the stream now changes to south-west, and in the next six miles is broken by heavy rapids, full of large boulders, as it descends from the next lake above. Flowing in this direction, it crosses the strike of the rock at a right-angle, and the rapids are formed by the river passing over nearly flat beds of limestone. Two miles above the bend, there is a fall of six feet, where the river drops down over the edge of a thick bed of limestone. The channel along this stretch is very irregular in width, and is often split by large islands. The rapids end in a long narrow lake trending north-north-west from its outlet for several miles to where it appears to end against a high range of hills. The west side of this lake is bounded by a continuous range of sharp, barren hills that extends far southward.

Menihek Lakes.

The river now nearly doubles on its former course, and passes directly from the south through three long narrow lakes, called the Menihek Lakes, connected by short river stretches .The lower lake is fifteen miles long from its outlet to its head, and it varies from one to two miles in breadth. The rocky ridge already referred to passes close along the west side, with foot-hills of drift in many places rising directly from the water. The country on the east side is low and swampy, and broken only by small ridges of drift. An invasion of sandy drift forms two long points extending out from the west side of the lake, contracting the channel and causing a wide shallow rapid nearly half a mile long, at the head of the lake. The next lake is twenty-three miles long and its average breadth is slightly greater than the last. The surrounding country is similar to that last described, being flat eastward and having the high, sharp range along the west side. Towards the upper end, the course of the lake and that of the hills diverge slightly, so that at its head the hills are from three to five miles distant, and are lower than to the northward. Twelve miles above the outlet of the lake, a large stream flows through a deep cut in the hills and enters the lake with heavy rapids from the west. Its volume is about equal to one-third of the whole river below.

Middle lake.

The middle lake is separated from the upper by a stretch of river three miles long. The stream is half a mile wide, and the channel is very shallow, with a moderate current. The banks on both sides are formed of drift, and those on the east side are terraced for sixty feet above the present level of the lakes. The upper lake is ten miles long and about two miles wide. It is very shallow and filled with islands of drift, two of which are high, with scarped banks of coarse sand. The range of hills on the west side is now from five to ten miles distant, and appears to be gradually dying away to the southward. In the distance, on the east side, a high range is seen, which is probably the Ice Mountains to the south-west of Sandgirt Lake.

The country on both sides of the lake is higher and more broken than previously noted, the ridges of drift being more pronounced.

This change in the topography is probably due to the change in the underlying rock, the stratified Cambrian beds giving place to Archæan schists.

Above the upper lake the character of the river changes completely, and resemble the stretch between Sandgirt and Birch lakes, becoming narrow and rapid, with an irregular channel filled with many small islands of drift, and with irregular sandy banks cut out of ridges of till. Frequent short rapids, full of boulders, connect longer stretches of swift, unbroken water for the next twenty-four miles, to where the exploration ended at a small conical hill close to the east bank. From the summit of this hill looking southward up the valley, the river was seen to expand into a small lake a few miles above, and beyond that to again contract as it winds with short bends, from side to side. From information subsequently obtained from Indians acquainted with the part above, it was learned that it flows out of Ashuanipi Lake some thirty or forty miles south of the farthest point reached, and that its character remains the same to the outlet of that lake, with swifter water in a narrow, irregular channel, studded with many small islands. The region through which it passes is low and broken by rounded hills and ridges of drift that never rise more than 300 feet above the general level.

Character of the country above the Menihek Lakes.

Ashuanipi Lake.

At the end of the survey the river is seventy-five yards wide with an average depth of six feet, and the current is about four miles an hour, giving a discharge of nearly 8000 cubic feet per second.

Lake Ashuanipi, from descriptions given by the Indians, is situated close to the watershed dividing the Hamilton River from the Moisie River. It is upwards of fifty miles long, very irregular in outline, with deep bays, and is partly covered with many islands, some of which are very large. It is not a deep lake, but its water is very clear and well stocked with fish.

Trees.

The trees along the river and the Menihek Lakes are much smaller than any previously seen. Black spruce forms ninety per cent of the whole, with larch next in abundance, and a few balsam and white birch. Along the lake shores the trees are very stunted, and all bent towards the south by the prevailing northerly winds. The stunted growth of this region is accounted for by the large areas of swamp land along both shores, where deep sphagnum covers the wet ground, which below a depth of eighteen inches from the surface is permanently frozen. The ridge on the west side of the river varies from 300 to 600 feet in height above the water, and is devoid of trees above the level of 200 feet. Much of the lower ground is also treeless, having been burnt over by extensive fires at different periods. After such fires the country is covered only by willows and alders for many years, until the spruce again reproduces itself.

Route to Lake Michikamau.

Having returned from the upper part of the Ashuanipi River to Sandgirt Lake, an exploration was next made from there to and around Lake Michikamau. A description of this portion of the country is introduced here, because the other route leads up the Attikonak Branch to its head, and from there down the Romaine River to the Gulf of St. Lawrence, and it is thought advisable to complete the description of the interior before entering upon that of the southern region.

The route to Michikamau leaves Sandgirt Lake by its northern discharge, which is four miles long, over half a mile wide, and is obstructed with large islands. The channels are shallow with low shores, and the current is strong, terminating in a quarter of a mile of heavy rapids, where the river empties into Lobstick Lake. This is another large body of water, divided into deep bays by long low points and large islands. The surrounding country is nearly flat, and broken only by small rounded hummocks of rock, that seldom rise over 100 feet above the general level. There is also a marked absence of the long parallel ridges of drift, and bare rock shows in almost every elevation, forming the many small islands scattered over the surface of the lakes. There are two deep bays that extend away from the inlet of the lake. One runs directly south-east, with its outlet close to Flour Lake, into which it discharges by the north channel of the river, as has been already mentioned. The other bay runs due east about eighteen miles, and is divided into two portions by two large islands, that extend from the westward of the inlet to within four miles of the head of this bay. There is also a great bay stretching in a north-west direction from the discharge and ending at the foot of a range of rounded hills some twenty-five miles distant, where a small river flows in, which is used by the Indians as a canoe-route to the caribou grounds on the George River, beyond the north end of Lake Michikamau.

Lobstick Lake.

The route to Michikamau follows the east bay, passing along the south shore of the large islands. Four miles from the inlet a narrow is passed, where the water between the low, rocky islands and shore is so shallow that only with difficulty a channel can be found for light canoes between the boulders, which thickly cover the bottom. At the narrow, a slight current is apparent flowing toward the west. Beyond the narrow, the route continues up the bay, passing between many rocky islands for ten miles, to another narrow about fifty yards wide, between the second large island and a long rocky point. Here, the current is strong for 200 yards, when the lake again opens out, but is covered with such a multitude of small rocky islands that no idea of its extent can be obtained by passing through it. For ten miles the route now follows the south shore, passing through narrow channels between the islets. A number of long, rocky points form deep, narrow bays along shore, and complicate the navigation, so that even an Indian guide is often at fault as to the right direction to follow. Two short heavy rapids on a small stream lead upwards into another island-covered lake, with even more crooked and narrower channels through which the route passes to a small bay near the eastern end of the lake, five miles from its outlet.

Island-covered lakes.

A range of rounded hills from 200 to 400 feet high extends along the north and east sides of the lake. At the head of the small bay, there is a gap in the hills about half a mile wide, where at ordinary stages of the water a small stream trickles down from the next lake, a mile beyond, through a series of little rocky pools filled with boulders. When the water is high in Lake Michikamau, which connects with this small lake, a large stream discharges from it through this valley, thus connecting the headwaters of the Hamilton River with those of the Northwest River, which flows out of Lake Michikamau on its north side. A portage of a mile and a half is here ordinarily made. It crosses a rocky hill on the east side of the valley, and then passes over a high drift plain to near its upper end, where it terminates on the wide-bouldery shore of the upper lake. This lake is very shallow and full of small rocky islands and points, with its shores and bottom deeply covered with boulders. It lies in a continuation of the valley, between low rocky hills. Two miles eastward, a rocky narrow occurs, where the water runs in and out, the direction of the flow being determined by that of the wind. Beyond the narrow, the lake widens to over two miles and extends a few degrees south of east, for eleven miles. A long low point separates this bay from a similar one on the north side. The south side is bounded by low, rounded, rocky hills, and the surface of the lake is strewn with small rocky islands, with shallow water between them, where large solitary boulders often rise above the surface. The bay on the north side of the long point, heads nearly opposite the portage, where a small stream enters it from the west. Near the mouth of this stream, the Hudson's Bay Company kept a small outpost called Michikamau during the

Watershed between Hamilton and Northwest rivers.

Hudson's Bay post.

time that Fort Nascaupee was occupied. Nothing can be learned about this outpost from the old Hudson's Bay Company journals at Rigolet or Northwest River, beyond the bare facts that a post was maintained there for a number of years, and was finally abandoned from the same reasons which caused Fort Nascaupee to be given up. This post was not visited, but, from the accounts of the Indians, some of the buildings have been accidentally burnt, and those remaining are in about the same state of decay as Fort Nascaupee.

From the head of the lake, the route turns south-east for nearly six miles, following down a small river that flows close along the west side of a rocky ridge flanked with sandy drift. The channel varies from 100 to 200 feet in width, and is bounded on the west side by a long point of sand, broken into narrow islands towards the south. This point and the islands are merely a ridge thrown up by the river, between it and a large lake to the westward.

The next change in direction is to due east, where the river flows first with a strong current between a number of low rocky islands, and then widening gradually passes, for four miles, between high banks of drift into Lake Michikamau. The hills, on the west side of the river are rounded and irregular, varying from 50 to 200 feet, and covered thickly with boulders. The east side is from 50 to 100 feet high and flat on the top, with traces of terraces from thirty to fifty feet above the present level of the lake.

Lake Michikamau.

Lake Michikamau.

Michikamau, or the Great Lake of the Indians, is the largest in eastern Labrador, being second only in size to Lake Mistassini. Its greatest length from south-east to north-west is about eighty miles, and it is twenty-five miles across in its widest part opposite the discharge. The main body of the lake is sixty miles long, with a long, narrow, unexplored bay extending south-east more than twenty miles, from the south-east corner. The widest part of the lake is in the southern third; in the northern part of the middle third, a long point, and a line of large, high islands of eruptive rock, extend far out from the north-east side, and narrow the lake to six miles. Between this point and the north-west end, the average breadth is eight miles. Islands are numerous along the shore and in the southern part of the lake but elsewhere it is unobstructed. In comparison with Lake Mistassini, this is a much finer body of water, and its size appears much greater, owing to the absence of long points, and chains of islands.

Finer scenery than about Mistassini.

Photo. by A. P. Low, 1894.

VIEW OF SOUTH END OF LAKE MICHIKAMAU.
FROM HILL (450 FT.) NEAR OUTLET OF LAKE.

Lake Michikamau is surrounded by rugged hills which add to the grandeur of the scenery, in marked contrast to the low monotonous shores of Mistassini. The water of the lake is remarkably clear and cold, and according to the Indians, who set lines through the ice in winter, the depth is very great.

Delays caused by wind.

On account of the heavy sea running during the whole time we were engaged in exploring the lake, it was impossible to make soundings from the small canoes, except behind islands and close to the shore. The lake being free from islands, any moderate wind raises such a sea that canoe travel is frequently impossible, and the Indians are often weeks in passing from the discharge to the north end, on their way to the caribou grounds.

The lake occupies a deep basin surrounded by chains of rounded Archæan hills that rise from 200 to 500 feet above its surface. This basin is very ancient, and like that of Lake Mistassini, must have existed previous to the deposition of the Cambrian rocks which are now found lying undisturbed in many places around the lake.

Character of the surrounding country.

The hills surrounding the lake are wooded for only about 200 feet above the water, their tops being covered with white lichens and small arctic shrubs. The outer islands and exposed points are also treeless, and the trees growing on the more protected islands and shores, are small black spruce and larch, with only an occasional clump of straggling white birch on the lower slopes of the hills. From a high barren hill north of the discharge, the view looking northward beyond the lake is exceedingly desolate, and shows a succession of low rocky ridges extending to the horizon. Trees grow only in small patches in the lake-strewn valleys between, and innumerable huge boulders are scattered indiscriminately everywhere. Northward along the west shore, for seven miles from the inlet, the shores are low and boulder-strewn, with many small low islands of drift strung along in a close fringe. The shore-line is irregular, and small ridges of drift form points behind which long, narrow bays run off westward. Some of the islands are flattened at the top, evidently by the action of water, and there are small terraces on the scarped sides up to thirty-five feet above the present level of the lake. Beyond this the shores become higher, with rounded hills of dark-brown rock rising in small hummocks above the drift, and also forming high rocky islands along shore. The country behind is quite rough, rising in irregular hills, from 50 to 250 feet high, and culminating in a sharp cone called Petiscapiskau, more than 350 feet high, which is visible for many miles along the other shore, and forms

Petiscapiskau Hill.

an admirable triangulation point. From Petiscapiskau to the north end of the lake, some six miles, the shores are low and sandy, with boulder-covered points. The land slopes gently up from the water to an even ridge of drift-covered granite about 300 feet high that extends north-west far beyond the north end of the lake.

The north shore is low and sandy, with shoal water extending far out from it. Many boulders of red granite are scattered about, both in and out of the water, and are sometimes arranged in rows along the shore, by the expansion of the ice in the spring before the waters rise.

A little river enters the north end of the lake, with a small rapid full of large boulders, where the channel is about fifty yards wide and too shallow for canoes. This is the discharge of Michikamats or Little Michikamau Lake, which occupies the northern extension of the valley and is separated from the main body of the lake only by a long, narrow interval of drift. This lake is over twenty-five miles long, and extends north-west to and beyond the north side of a high range of hills which is seen in the distance to divide the main valley. From the north end of Michikamats, three portages connecting narrow lakes lead to a branch of the George River, where the Indians of the region assemble in September to spear the caribou, which then cross the river in immense herds in the course of their annual migration from the high barren grounds behind Nain to the wooded region of the interior, where they pass the winter.

Michikamats Lake.

The east shore of Michikamau for twenty miles from the north end, is low, with bouldery points and reefs, and without the fringe of islands. A sharp rocky ridge 300 feet high runs parallel to the shore, and about six miles back from it. The interval between the water and the hills is occupied by small lakes and swamps that lie between low ridges of drift.

Twenty miles up, the highlands come out on the shore of the lake; and from there to the outlet, or for the next thirty miles, the shores are high and rocky, with deep water close in, and only a few small rocky islands along shore. The country behind is exceedingly broken and rough, with bare hills of dark-brown rock, rising in irregular, sharp bosses from 50 to 300 feet above the surface of the lake. Along the lake southward, the gabbro rocks, which form these broken hills, are replaced by granite near the discharge, and then the country becomes more regular, although still very hilly.

Country to the north of Michikamau.

From the summit of a barren granite hill 400 feet high, close by, the discharge or Northwest River is seen to leave the lake between a number of large, flat-topped islands of drift about thirty feet high, that extend outwards from the shore some four miles, and along it for six miles. A long, low point of drift, passing into a ridge, separates the river from the southern part of the lake, and the river is seen extending eastward through a succession of lake-expansions, until it passes behind and is hidden by rocky ridges in that direction. Another chain of lakes extends northward from the river and passes close to the base of a high range on the horizon. By these lakes a second route leads to the caribou grounds, which is used by the Indians when they want to proceed there direct, without the delay usually caused by adverse winds on Michikamau and Michikamats. The river flowing into the Atlantic near Davis Inlet, heads in the high range to the north, and a winter-route from the George River to the coast follows its course closely. Owing to many rapids and falls, entailing several long portages, this stream is never used as a canoe-route by the Indians.

From the discharge to the south-east end of the main body of the lake, some ten miles, the shores are low and sandy, with boulder-covered points and much swampy land behind. There is a deep narrow bay that extends south-east from this corner, where it passes away between rounded, rocky ridges, running parallel to its course. Its entrance is nearly closed by small, low islands; its upper end was not explored, but it is said to be more than twenty-five miles long, with a small river falling in at its head. Southern shores.

The south end of the lake is shallow and is dotted with many small islands of granite. The shore is very irregular and often rocky, and the country behind is broken by several ridges from 200 to 300 feet high. There is another deep bay on the south side, where a couple of small streams discharge.

The country along the west side is broken by low ridges, with a wide interval of swampy land along the shore. The coast-line is indented by deep bays, between wide swampy points, fringed with boulders. From the south end to within five miles of the inlet, there is a wide fringe of large islands of sandy drift, that rise only a few feet above the water.

Attikonak Branch.

The northern channel of the Attikonak Branch flows into Sandgirt Lake on its south side. It is ascended from the lake in an east-south-east direction three miles, to where it is broken by a heavy rapid nearly a mile long, with the channel about 100 yards wide, choked with Attikonak River.

large boulders. A portage of a quarter of a mile, across a boulder-strewn point, ends in a small bay of a lake-expansion above the rapid. From the head of the rapid the river widens to nearly a mile, and for the next three miles flows from south-south-east. Beyond this course the direction changes to north-west, and continues so for five miles, in a narrow, irregular channel, obstructed by numerous islands, and bounded by low, rocky shores in many places, to where a small branch from the base of the Ice Mountains joins the main stream. A chain of small lakes is now entered, connected by short rapids. The general course of the route through these lakes and a larger lake above them is south-south-east; the lower lakes are four miles long, while the large one, called Gabbro Lake, is seven miles from outlet to inlet, with a long bay stretching towards the south-east. Another narrow one mile long, with a slight current, joins Gabbro and Ossokmanuan lakes. The latter is a narrow body of water more than forty miles long, and lying nearly east-south-east. From its northern outlet it trends directly south for eight miles, and in this portion varies from two to four miles in width, being dotted by many small rocky islands, and surrounded by low rounded ridges of drift-covered rocky hills, with rock showing below the drift in many places along the shore. Another bay stretching away more than twenty miles to the north-west now joins the main body. Like the first it is full of islands, many of them composed of coarse drift. The south side of this bay is bounded by a ridge 300 feet high, and at its head a small branch falls in, which drains a number of lakes to the south-westward and forms a canoe-route to Lake Ashuanipi, on the way to the Moisie River. From the junction of the two bays, the main body of the lake extends south-east twenty miles, and then south-south-east fourteen miles. Five miles up the first course, the foot of one of two high, rocky, large islands is reached. This island is six miles, and the other ten miles long, and they practically divide this portion of the lake in two. The part on the south side of the islands averages two miles across, the northern channel being somewhat narrower. On the north side near the head of the upper island a branch called Valley River flows out. This stream is somewhat larger than the northern outlet, and constitutes the river which at present flows down the Hamilton River valley above its junction with Bodwoin Cañon. According to our guide, after passing through two lakes, together about twenty miles long and connected by rapids, it begins to fall rapidly in a succession of low chutes. About these chutes the valley is still wide, with gently sloping walls and not like the cañon on the main river. The guide had never visited the river below the chutes, but had heard that there was a high fall on it, some fifteen or twenty miles above the place at which the main body

Ossokmanuan Lake.

Valley River.

of the Hamilton River enters the valley at the mouth of Bodwoin Cañon.

Besides the large islands already mentioned, there are only a few small ones, formed of drift, in the southern half of the lake. The water is clear, but has a brownish tinge and is never very deep. A continuation of the high ridge on the west side of the north-west bay runs on southward along the west shore of the main body, but gradually dies out towards the southern end. From the lake the land rises slowly upwards to this ridge, leaving a wide interval of flat land and low shores along this portion. On the north-east side the country is lower, and is only broken by a few rounded rocky ridges that have recently been burnt over. The trees about the lake are small, and are chiefly black spruce with larch and balsam fir, but no white spruce. Balsam poplar and mountain ash are seen growing in small straggling clumps on several of the low points on the west shore. Trees.

The river enters the lake on the west side, some ten miles from its south end, where it narrows to less than two miles. Its volume is considerably greater than the channel ascended to Ossokmanuan Lake, being half as large again as the Ashuanipi Branch at the end of the survey, and flows swiftly from the south in a shallow channel from 400 to 1200 yards wide, with low banks and frequent hummocks of gneiss for eight miles, to where it leaves Lake Panchiamitkats. The country on both sides of the river is slightly higher than about the lake below, and much fine drift is seen on the islands and shores arranged in long parallel ridges from thirty to one hundred feet high, running parallel to the glacial striæ or a little east of south.

Lake Panchiamitkats is about twelve miles long and averages two miles in width, with its longer axis running due north-and-south. It is dotted with a few small islands, and has low drift shores. There is a prominent rounded hill on the west side just beyond the entrance of the river, five miles above the outlet. Another hill rises from the east shore opposite the inlet; the remainder of the country is covered with low ridges that run parallel to the lake. Panchiamitkats Lake.

The river above its entrance to this lake, flows from the west for a mile and then from the south, and is separated from the southern end of the lake by a narrow ridge only. It continues from the south for sixteen miles, to where it flows out of Lake Attikonak. Its channel is from 200 to 600 yards wide, obstructed by small rocky islands, while its shores present many rocky points. The current everywhere is strong, and the stream is frequently broken into short rapids between the many small rocky islands. Ten miles up, where the river passes over rocky ledges, there is a chute of four feet, followed by a short heavy rapid that necessitates a portage. Above the chute the current is slack and the river nearly half a mile wide, with low sandy shores, to within two miles of the upper lake, where there are two short rapids, the upper of which is wide and very shallow, as the river issues from Lake Attikonak. The country surrounding this stretch of river continues low, with long, rounded ridges from fifty to one hundred feet high. The timber is similar in kind but perhaps slightly larger than the last described.

Lake Attikonak.

The east shore of Lake Attikonak was followed in a direction a few degrees east of south for thirty-eight miles, to the head of its south-east bay. On account of the great number of islands that everywhere break its surface, no idea of its shape or size can be obtained without a complete exploration of its shore-line, which task, owing to the many deep bays in the lake, would have required more time than could be given to it. From a number of long leads seen between the islands, the lake must be at least twenty miles wide in places, and, according to our guide, its south end is considerably beyond the head of the bay where the route leaves it. A large stream flows in at the south end, which rises in lakes to the south-west of Attikonak, near the head waters of the Magpie River, flowing into the St. Lawrence; and it is used as an alternative route to and from the coast by the Indians of the interior. Many of the islands in Lake Attikonak are large and high, one of them rising into a rounded hill of 300 feet, others seem to be formed wholly of fine sandy drift, with irregular outlines, and scarped banks up to one hundred feet in height. Very little rock is seen except in the south-east bay; elsewhere the shores are generally sandy, with low, boulder-strewn points. The water of the lake is clear, with a brownish colour, and does not appear to be very deep. The eastern side is bounded by low ridges of drift, with a range of hills from 200 to 300 feet high some few miles behind. At the south end of the lake, there is a sharp rugged range of hills, extending away westward, probably more than 400 feet high. The trees continue to increase slightly in size, black spruce predominating, but associated with balsam fir, larch and white birch, the last often occurring on the islands and points in large clumps with many trees up to ten inches in diameter. Near the south end of the lake, two small clumps of dwarfed aspen were seen, the first noted since the Grand Falls were passed.

Large islands.

From the outlet, the lake lies due south for twelve miles and is from one to three miles wide, with several deep bays running off on both sides. A large stream falls into a bay on the east side, immediately above the rapid, while another enters from the west three miles farther south. Above this the course changes to south-south-west, and continues in that direction through a labyrinth of islands for sixteen miles to a short narrow leading into the south-east bay, which was followed for twelve miles, to its head. This bay gradually narrows from two miles to less than a half mile at its head, where a small stream flows in with a short, steep rapid. The shores and islands of the lower half of the bay are formed of sand and boulders, while along the upper half they are steep and rocky, with the country behind higher and more rugged with very little drift, the bare rock rising everywhere in small knolls. Here the trees become much smaller and are wholly black spruce and larch.

Portage to Romaine River.

The route passes up the small stream last mentioned, a short distance to a very narrow shallow lake at its head. A portage of two miles, over and between a number of small rocky hills with swamps between them, joins the last lake with a little stream emptying into the Romaine River. The country about the portage has been recently burnt over, and the standing blackened trunks of the small spruce give a sort of hairy appearance to the otherwise bare rocky hills, from which all the vegetable soil has been removed, and do not add to the beauty of the scenery, which is very rugged and desolate.

Romaine River.

Upper Romaine River.

It is only a quarter of a mile by the little stream from the end of the portage to the Romaine River. The latter where joined varies from fifty to one hundred yards in width, and for two miles passes between low banks, broken by rocky knolls. At the end of this distance there is a short heavy rapid, where the river passes over a rocky ledge between small islands. A portage of fifty yards is necessary here. Below this, for six miles to the upper Burnt Lake, the banks are low and sandy and often overgrown with willows and alders. The river winds backwards and forwards with a moderate current, and has formed a delta of low sandy islands where it enters the lake. On the east side there is a large lake that is separated from the river only by a narrow low point of sand. This lake has a short discharge which joins the main stream three miles below the rapids. The country surrounding the river is slightly rolling on the west side, with rocky hills from 50 to 200 feet high. The water of the river is dark-brown in colour, and carries more suspended matter than the rivers of the eastern watershed.

Headwaters.

According to the guide, about ten miles above the place at which the portage-route joins it, the Romaine River issues from a narrow lake nearly twenty miles long, that extends north-eastward, and is called Tishinakamau Lake.

Beyond the head of this lake the river is very small, and soon breaks up into little branches, the discharges of small lakes near the head-waters of the Elizabeth and Minipi branches of the Hamilton River, and also near the sources of the Natashquan River, that flows southward into the St. Lawrence. Portage-routes connect the heads of all these streams.

The Burnt Lakes.

Upper Burnt Lake is twenty miles long and varies from one to four miles in width. From its head, for six miles, its course is east-south-east, and then changes to south-south-east to the lower end. Twelve miles from the upper end, a deep bay extends south-west for five miles. The middle portion of the lake is for several miles greatly obstructed by long islands of drift. The country surrounding the upper part is low, with long sloping hills quite different from the rounded knolls previously passed; for there is a change in the rocks of which they are composed, the former being granite, the latter gabbro. Towards the south end, the country becomes higher and rougher, with the ridges closer together. Small black spruce and larch predominate, with some white birch on the islands.

A short rapid at the south end of the lake, joins it with the second Burnt Lake, which is four miles long, with a deep bay on the west side. Another short rapid and a mile of river connects this with the third Burnt Lake, which continues southward for two miles, and then turns abruptly north-west for five miles to another short heavy rapid that flows into the lowest Burnt Lake, the south shore of which was followed westward two miles to its outlet. A long bay extends north-ward several miles, and a portage at its head connects with the south bay of the upper lake. The country about the lower lakes is quite rough, with sharp ridges of rocky hills rising from 200 to 400 feet directly from the water. The forest about all these lakes has been devastated by a great fire some ten years ago, and now only small patches of green woods are seen in swamps and in spots along the banks.

Character of the river below Burnt Lakes.

As it passes out of the last Burnt Lake, the river falls twenty-five feet in less than a quarter of a mile, in a heavy rapid, over huge boulders and a few ledges of rock. For seventeen miles from the lake, to where a western branch joins, the general course of the stream is due south. Half a mile below the first rapid, the river again falls twenty feet in one hundred yards, over masses of huge boulders. From here it winds to and fro, with a strong current, between steep banks of stratified sand from ten to fifty feet high, in a valley from two to four miles wide, bounded on both si es by steep rocky hills that rise from 400 to 500 feet above it. About seven miles above the forks, the river is broken by small rapids at intervals for nearly four miles; here the valley is much narrower and the scarped banks are occasionally 150 feet high, with rock coming out from beneath. The west branch has about half the volume of the main stream, and enters it with a heavy rapid from a narrow valley between the hills. The trees are everywhere burnt, except in a few patches here and there, along the river-banks. They are somewhat larger, and white spruce grows on the points and islands. Distinct terraces are seen at intervals, with elevations of 10, 20, 50 and 60 feet above the present river-level, cut out of stratified sand with a large admixture of clay.

Terraced drift banks.

Below the forks, the river is from 100 to 300 yards wide, and flows swiftly in a shallow channel with a sandy bottom and steep banks of the same material from ten to thirty feet high. For eight miles the general course is south-east; it then turns south, and flows in that direction sixteen miles. At the bend there are on the west side several sharp, irregular hills of drift which extend one mile to the foot of the steep rocky hills. One of these hills cut into by the river, shows the sand and gravel to be false-bedded, and, in other places along the river, the bedding of the sands is not horizontal. These hills are thickly strewn with boulders, which do not appear to be scattered through the mass, but only over the upper surface, leading to the belief that the deposition and stratification of the drift took place in ice-water flowing under the glacier, and that the boulders on the surface were left there by the ice on its dissolution.

Character of the valley.

Below the bend, the valley narrows gradually for four miles, to two chutes, where it is less than a mile across, and is filled with sharp hummocks of drift from 50 to 150 feet high, covered with boulders. At the upper chute, the river passes along the base of a granite hill that rises sheer for 500 feet. This fall has a drop of four feet, followed immediately by another of six feet, ending in fifty yards of heavy rapids, where the descent is twenty feet. Fifty yards below is the second chute, twenty feet high, followed by heavy rapids for three miles. The banks immediately below this chute are from 50 to 100 feet high, and sections show them to be composed of re-arranged till, with false bedding; the angle is so high that in places it is impossible to walk along the foot of the cliffs, owing to the displacement and slipping of the sand along the bedding planes. Terraces up to sixty feet are numerous along the sides of the valley.

Below the rapid, for nine miles, to the next bend, the current gradually slackens, until it flows along with an even rate of about three miles an hour. The channel widens from 50 to 200 yards, and the valley also opens to nearly two miles, with sharp rocky hills bounding it on both sides, those to the west presenting high cliff-faces. The sharp hummocks of till gradually die out, leaving low and almost flat stretches to the foot of the hills on either side. The country is wholly burnt. The next bend is to the south-west for ten miles, and for that distance the river preserves the same character as above, but is slightly wider, being now about a quarter of a mile across. Six miles from the bend, a small branch, forty yards wide, comes in from the west. The old burnt woods end near the bend, but a fire of the present season (1894) has passed over all the remaining green woods below, and has practically destroyed all the forest along the river.

Extensive burnt areas.

The river now turns south for six miles to where the portage-route to the St. John River leaves it by a small western tributary. The channel along this stretch varies from a quarter of a mile to half a mile across; the river is very shallow and greatly obstructed by large sandy shoals. The valley is more than two miles wide, and the hills bounding it rise sharply from 600 to 800 feet above it. A small branch joins from the west two miles below the last bend. Below the place at which the portage-route leaves it, the river flows south-east for four or five miles, in a wide shallow channel that slowly contracts as the current increases, and finally breaks into heavy rapids where the river passes into a narrow cut between steep high hills. Nothing is known of the river for over fifty miles below this point, except that it is quite impassable for canoes, probably on account of long rapids with perpendicular rocky walls, where portages are impossible. Nothing but the absolute impossibility of passing up and down this part of the river, would induce the Indians to make use of the present portage-route between the Romaine and St. John rivers, which is the longest and worst of those known to the writer anywhere in north-eastern Canada. Careful inquiries from a score of Indians met coming inland, afforded no information concerning this part of the river, which has never been descended by any one so far as known.

Difficult portage-route to St. John River.

Portage-route between the Romaine and St. John Rivers.

Tributary of the Romaine River.

The small branch previously mentioned, was ascended from the Romaine half a mile, to a portage three-quarters of a mile long, past heavy shallow rapids. The portage passes along the west side, through burnt woods and over sandy hills that rise from 50 to 100 feet above the river on the slopes of the rocky hills bounding the narrow valley. Beyond this the stream is followed for a quarter of a mile to a portage of the same length; after which it is ascended for half a mile to a portage of one mile, followed by a stretch of river one mile long, above which the stream divides. The valley of the south branch is followed with a half mile portage, to a small lake two miles and a half long, from which a portage of a mile and a half leads over the height-of-land between the Romaine and St. John rivers. The branch, as will be seen from the above description, is full of long, shallow rapids, and flows through a narrow valley between steep rocky hills, from 200 to 300 feet high, fronted by lower hills of sandy drift, over which the portages pass. The hills along the small lake are somewhat higher and more rugged. The country travelled through is mostly burnt and the standing trees are small.

Tributaries of the St. John River.

Beyond the height-of-land, the route passes for two miles and a half through two little lakes connected by a short portage. From the discharge of the second lake, a portage of three-quarters of a mile leads up hill to a small pond, and then down hill across the discharge of the last lake to the foot of a high fall. Next follows a short stretch of river, with a three-quarters of a mile portage past heavy rapids, closely followed by three short portages, past chutes. These portages, though short, are exceedingly bad, going straight up and down the rocky walls of a narrow gorge, over great blocks of anorthosite. The last ends in a narrow lake hemmed in by rocky walls that rise sheer from 500 to 800 feet above the water, and often present over-hanging cliffs, the sides being partly wooded with small spruce and birch that form a pleasing contrast to the bare rock elsewhere. In many places great blocks have been detached from the cliffs and are heaped up at their base. A number of small streams fall perpendicularly over the cliffs.

At its discharge, the river falls seventy feet in as many yards, through a narrow pass partly filled with huge angular blocks. The portage is along the side of the cliff, often straight up and down, over blocks and through the water, the whole making the worst possible combination of obstacles. Below the portage, the river is followed for a mile and a half to its junction with a larger stream from the west. Just below the last-mentioned portage a large stream falls in from the east with two chutes over 300 feet high. Lower down, a smaller stream comes in on the same side with a higher fall, which shows that the valley is much below the general level of the surrounding country.

The next portage leaves the river a short distance above the western branch, and in three-quarters of a mile ascends over 300 feet, ending just above a high chute on the west branch, where it falls, down a narrow gorge, to join the other branch below. This stream is then ascended for four miles, with two short portages past rapids on the way, before reaching Cliff Lake, which is eight miles long and from a half to one mile wide. The scenery about this lake is very striking. Both sides are formed of vertical cliffs, often rising sheer from 500 to 600 feet above the water and terminating, in the higher points, in bare, rocky knolls, without a particle of soil. In many places great masses of rock have broken away, and are now piled up in confused masses that extend far out into the lake. At every depression in the walls of the valley, little streams fall into the lake and are fringed by small trees of spruce and birch, which also grow along the edges of the lake and in rocky crevices up the sides of the cliffs.

Cliff Lake.

The small stream that flows in at the head of the lake is ascended for three miles, through two small lake-expansions, to a portage of one mile ending in a very small lake at its head. The next portage is two miles and a half long, and follows a valley between high hills, first ascending to the head-waters of the stream last followed and then down another small brook flowing in the opposite direction. This portage, besides being long, is very rough, leading over broken rock and through swamps. It ends in a small lake, out of which a little river fifty feet wide issues and flows southward with a winding course and strong current, in a deep valley about one mile wide. Its banks are low and generally sandy, and the valley is covered with a thick growth of small black spruce, larch, balsam fir and white birch, somewhat larger than any previously seen on the route from the Romaine River, but still too small to be of any commercial value. This little river was descended for eleven miles to where it is joined by a small western branch, which was ascended for one mile, through a shallow lake. Thence a short portage leads to another very small lake on the same stream, followed by still another portage of a third of a mile into a third small lake at the head of the stream.

Trees.

A portage two-thirds of a mile long next leads up hill to another small lake, from which a portage of three miles follows the stream issuing from it, and descends 600 feet to the next lake below. There is here a general fall in the surface of the country and a change in the outline of the hills, as the route passes from the rugged anorthosite area, with its high knob-like hills, to the lower and more rolling country underlain by gneiss.

The lake at the foot of the portage is a little over two miles long, and its discharge is followed four miles and a half, with five portages past shallow rapids. A portage of a half mile passes up from the stream over a hill 300 feet high to a lake 100 feet above it. This lake and its outlet are followed three miles, with two short portages on the way, to the last portage to the St. John River, which leaves the small stream and passes down a steep gully cut out of drift for about one mile, where it descends 365 feet to the level of the St. John River

Portages to the St. John River.

The total number of portages from the Romaine to the St. John is thirty-one, and their combined length aggregates nineteen miles and a half.

St. John River.

The St. John River, where the portage-route joins it, is about 100 yards wide and pursues a winding course in a valley about one mile wide, bounded by steep hills from 200 to 500 feet high.

St. John River.

There is a great accumulation of drift in the valley, out of which the shallow channel of the stream is cut. The banks are mostly low where the river crosses the valley, and are high only at the bends, where sections from ten to sixty feet deep show stratified sands overlying clay.

A few mil s above the portage, the river is broken by heavy rapids and chutes, and is almost impassable for canoes. Below, the gradient of the valley is steep, and the river in consequence has a strong current, especially at the bends, where it generally falls with short rapids through narrow channels cut out of the shingly shoals that obstruct it. It greatly resembles the rapid-flowing streams of the Gaspé Peninsula. Eight miles below the portage a large branch joins from the east, the head-waters of which form the various streams of the portage-route already described. Below this branch the channel widens somewhat and continues to wind from side to side in the valley for twenty miles; the hills then close in, and the river descends a narrow gorge, with a heavy rapid ending in a fall of twenty feet.

The trees in the valley show a marked improvement both in size and variety. White spruce fifty feet tall and from twelve to eighteen inches in diameter is plentiful, along with larger black spruce, balsam fir, larch, white birch, balsam poplar and aspen. The sides of the valley are more than half burnt.

Trees.

The portage past the chute is nearly a mile long and passes along the almost perpendicular side of the valley some 300 feet above the stream. The ascent and descent at both sides is so steep that the Indians are forced to cut steps out of the soil in order to pass over with loads. In the middle it is close to the rocky wall, and the road has been made by placing logs along narrow parts, which almost overhang the boiling stream far below.

Salmon Branch.

A mile below this portage the Salmon Branch joins from the west. It has a deep valley like the main stream and is considerably smaller. About a mile below this branch there is a salmon fishing camp, with a fine large house situated on a wide bank at the mouth of a small stream, the resort of sportsmen during the summer.

From the chute the general course of the river-valley is almost south for twenty-five miles, to the coast. The valley is narrower than above, and for ten miles does not exceed half a mile, with walls of anorthosite rock rising in nearly perpendicular cliffs from 300 to 600 feet above the water. As the coast is approached, the valley widens and the hills become lower, so that a short distance below Chambers River, or ten miles from the mouth, the rocky hills give place to banks of stratified clay and sand that gradually decrease in height down to the sea.

The country surrounding the river has been over three-quarters burnt, and the remaining forest is very similar to that already described.

The river from the chute to its mouth varies from 200 to 400 yards in width. It is quite shallow and has a very rapid current, with many short rapids, as it winds from side to side in the valley. The limit of tide is eight miles and a half above its mouth.

Manicuagan River.

Position of the mouth.

The Manicuagan River flows into the St. Lawrence about two hundred and forty miles below Quebec. Within ten miles of their mouths, the Manicuagan and Outardes rivers are separated only by a high sand plain, about two miles across. Above and below this place, their courses diverge, so that their mouths are fifteen miles apart, and the land between forms a broad peninsula composed of stratified clay and sand, evidently brought down by the rivers. The channels, thus diverted, instead of passing out into the Gulf of St. Lawrence, hug the shore for several miles with wide sandy shoals outside. The Outardes water flows westward, and that of the Manicuagan River towards the east. Owing to the channels being in-shore and to their broadening as they leave the mouths of the rivers, it is impossible to approach within ten miles of either stream with large vessels, while anchorage is dangerous outside on account of insufficient holding ground, the bottom being sandy.

From the mouth of the Manicuagan River, where the stream is about three miles wide and greatly obstructed with shoals bare at low water, the course is directly west for four miles, to where the rocky point projecting from the north side narrows the stream to less than half a mile. Above this, the west course continues two miles, with rocky banks and, towards the upper end, with a number of small rocky islands, between which the river flows with a rapid current. A sharp bend to the north now leads to a succession of heavy chutes that obstruct navigation for the next two miles. The river, while passing the chutes, rushes through a narrow gorge from 200 to 300 feet wide, with low rocky walls. The highest direct fall is about 30 feet, while the total descent is 110 feet. The volume of water passing down is very great, being over half that of the Ottawa at the Chaudière Falls. The portage is divided into two parts, the upper half being only used during high water; at other times short portages are made up or down this part of the gorge. Volume of water.

A short distance above the upper portage, a road climbs a high bank of modified drift, and leads to the Outardes River, some three miles distant. This route is frequently used by the Indians, to avoid the long coast journey, from the mouth of the Manicuagan River to Bersimis, where they reside during the summer months.

Above the portage the river widens to about 500 yards, and continues from the north for five miles, after which the valley bends to the north-east, for a similar distance, to the next portage. Several long islands of drift occur in the upper half of the stretch between the portages. The valley is about one mile wide, bounded by rounded, rocky hills, 600 feet high and flanked by thick deposits of stratified clay overlain by sand. These superficial deposits are terraced at frequent intervals up to an elevation of 350 feet above the water-level. The clay deposits do not rise more than 100 feet above the river and are horizontally bedded. The banks and hills are well wooded with large trees of the following species, arranged in their order of abundance:—White birch, white spruce, aspen, black spruce, balsam poplar, balsam fir, yellow birch, Banksian pine, white pine and black ash. Many of the spruce trees are sufficiently large to afford good commercial timber. The current along this stretch gradually increases from two to four miles per hour as the stream is ascended. Timber.

The next portage is about two miles long, and, for the greater part of its length, passes over a sandy plain 320 feet above the river at its lower end. Steep hills of clay and sand are found at either end, and, being constantly wetted by small streams, are very difficult to ascend or descend with heavy loads. The river here again passes, with heavy rapids and chutes, through a low rocky gorge; the fall is 165 feet.

Above the portage the valley again widens and the next portage is thirty miles farther up. The course of the valley for the first nine miles is due north; its walls are from half a mile to one mile apart, rising in abrupt rocky cliffs from 600 to 1000 feet, the river flowing close to the western wall, with a wide interval of sandy bottom-land intervening on the east side. The stream varies from a third of a mile to half a mile in width, and its channel is broken in many places by sandy shoals. The current is even and averages about three miles an hour.

Toolnustook River.

The valley next bends to the north east for four miles, and again to the north for six miles, where a large branch called the Toolnustook or Elbow River, joins the main stream. This branch comes in through a deep valley from the north-east, and takes its rise in the same lake out of which the Godbout River flows. Along the lower bend of the stream, the mountains forming the western wall of the valley are greatly broken and rise in detached rounded hills more than 1000 feet above the river. One of these mountains, immediately at the bend, towers upwards, with bare rocky walls, directly from the water, and is named by the Indians the "Manitou Pulpit." Above the bend the valley widens to more than two miles, and continues so to the mouth of the Toolnustook. Wide terraces occupy both sides between the hills and the water, and are covered with a fine growth of trees similar to those named above. The current quickens as the fork is approached, and there flows steadily at a rate between three and four miles an hour, in a shallow, sandy channel. Above the forks, the main valley changes its direction to nearly north-west, and for the next twelve miles averages a mile wide, with high rugged hills of anorthosite forming its walls. The river here varies from 200 to 300 yards in width, and flows with a very strong current, as it winds from side to side down the valley. At each bend it reaches the rocky walls, while elsewhere it has high banks cut out of the heavy deposits of stratified clay and sand, which partly fill the valley in the form of terraces, of which the highest is 150 feet above the river.

Chesniup Portage.

At the end of this stretch a high bank of terraced drift extends almost across the valley, apparently filling the old river-channel and forcing the stream through a narrow rocky gorge on the east side, where it descends 115 feet, in a succession of five chutes in about half a mile. The portage, named the Chesniup Portage, passes along the side of the west bank, where the terraced drift rises 250 feet above the water.

For thirteen miles above, the river continues narrow, crooked and swift, with frequent short rapids and a couple of dangerous whirlpools, in a valley from a quarter to half a mile wide, surrounded by irregular, rounded hills from 400 to 500 feet high. Down every depression between the hills on both sides, small streams fall in beautiful cascades from the higher lands surrounding the valley. The drift, along the lower half of this stretch, is not heavy, and narrow terraces are cut into it up to about one hundred feet above the present level of the river. As the upper half of the distance is ascended, the valley widens, and the rocky walls are somewhat lower and more regular. With the increased width of the valley the channel also widens to a quarter of a mile and the current slackens. The valley now straightens, and for twenty miles runs slightly east of north, widening to nearly two miles, with regular rocky walls on either side. The river along this portion averages half a mile in breadth ; it is very shallow, and is broken by a number of low, sandy islands and shoals. The current is even and moderate, and the banks are low, rising in wide terraces to the rocky walls. About six miles up this stretch a burnt area is entered, which extends up both sides of the valley, leaving only a narrow fringe of green woods at intervals along the river-margin. The timber in the valley and on the hillsides is all of fair size, and much of the white spruce is of good quality and in sufficient quantity for profitable lumbering. Black spruce predominates, followed in decreasing order by white birch, aspen, white spruce, balsam fir, larch and Banksian pine. The northern limit, in this valley, of white pine, yellow birch and black ash appears to be along the crooked stretches close to the Chesniup Portage.

Character of the river valley.

About half way up the last described stretch, a portage-route leaves the river on its west side, and, after passing over the wide, sandy plain, ascends a gulley in the hills to a small lake on the table-land, some 500 feet above. Thence two or three other small lakes are passed to a larger one, called Tetiskouskua, the outlet of which is descended to the Outardes River. This is the route followed by the Indians who hunt along that stream, in order to avoid the many long portages along its lower part.

Portage-route to the Outardes River.

The valley next again turns more to the eastward, and then bends to the north for twenty-four miles, to the next portage. It narrows, and the river becomes deep with a rapid current. The lower part of the valley contains much drift, which is in part terraced to a height of 200 feet above the river. Clay is no longer seen ; the stratified sands extend downward to the water's edge, and are often capped with thin beds of fine gravel. In most places the bedding is nearly horizontal, but in a few places the angle of bedding is considerably inclined and the drift appears to have been, at least in part, deposited under or in cracks of the glacier. The walls of the valley are still rocky, and vary from 500 to 800 feet in height. Much of the forest has been destroyed by fires at different times, the latest having occurred about fifteen years ago. The older burnt areas are grown up with thickets of small white birch, aspen, black spruce and Banksian pine. On the unburnt portions the trees are considerably smaller than those already noted, and the quantity of white spruce is much less, black spruce predominating.

Branch Portage.

The next portage crosses the neck of a small peninsula, formed by the main stream and a branch which comes in from the east. The portage is about half a mile long and passes over a level plain of sand 250 feet above the river at its lower end. The upper end of the portage comes out on the small branch, about fifty feet wide and very deep, which winds with a sluggish current between high sandy banks, for nearly two miles, to where it joins the main stream. The river just below passes into a very narrow, rocky gorge, where it descends 175 feet in less than two miles.

From the mouth of the small branch to the next portage, the dis tance is five miles and the course of the valley about north-west. The valley is narrow, and the hills on either side rise in almost perpendicular cliffs, directly from the water, to heights ranging from 500 to 1000 feet. A little drift is seen, terraced to 100 feet, and through this deep, narrow valley the river rushes in a deep channel, with many stretches of broken water.

Kikaskuatagan Portage.

The next portage is called Kikaskuatagan, and is nearly a mile long. It starts from a steep, rocky ledge, where, owing to the constant heavy swell, unloading is very dangerous. The road leads up a narrow gully filled with rough broken rock, and ascends almost perpendicularly for a hundred feet to a sandy terrace, which it follows to the head of the portage, where a steep drift hill is descended. The river at this place falls about twenty feet, with heavy rapids, where the channel is obstructed by numerous boulders. During high water the lower end of the portage cannot be approached, and at such times a gully more than half a mile lower down, is used to reach the terrace. Above this portage the direction of the valley changes to north-north-east for eleven miles. For the lower six miles the river averages 100 yards in width, and flows in a deep channel at the base of the western wall, which here rises in perpendicular cliffs from 300 to 600 feet high, with numerous small streams falling in narrow white ribbons of spray into the river. The eastern hills are less abrupt and are flanked by a good deal of sandy drift, terraced to one hundred feet above the river. Along the upper five miles of this course, the valley widens and contains much drift; the grade of the river is here very heavy and, as the bed widens, it becomes divided into numerous channels by low shingle bars, over and between which the stream rushes at a rate of five or six miles an hour, so that it is exceedingly difficult to ascend with loaded canoes.

The course of the valley next changes to north-west and continues in that direction seven miles. A short distance above the bend, the walls again approach and, two miles above, are less than a quarter of a mile apart. As the stream is ascended, its channel narrows and deepens, and it flows very rapidly between steep banks of boulders or rock for four miles, to where the Long Portage leaves it. Above the lower end of this portage the stream is still more contracted, and is walled in by steep rocky cliffs on both sides, where it is impossible to enter or leave the valley with canoes for the next three miles. In this distance the river is interrupted by a number of low chutes, which at low stages of water can be passed with canoes in descending. The portage leaves the valley on its east side, at the mouth of a small tributary. A sharp ascent of 250 feet leads to a terrace of coarse sand and gravel, formed along the flank of a rocky hill. This terrace is followed about one mile, and then a sharp bend to the north carries the road, in the next half mile, over the shoulder of the hill, to a small lake 560 feet above the river. A short portage leads from this lake to a slightly larger one, from the north side of which another portage one mile and a half long again leads down to the river, after first passing over a flat drift plain between the hills. The trees surrounding the lakes are mostly small black spruce, with a few fir, larch and white spruce, none of which are of commercial value.

Long Portage.

Above the Long Portage, the still contracted valley stretches due north for three miles, when it changes to north-north-east for eight miles, to the next portage. The river, along the lower half of these distances, is deep, narrow and very swift, with steep banks of rock or large boulders. Along the upper half it alternates between long stretches of quiet water, and short rapids, where heavy banks of coarse drift project out from the sides, contracting the channel.

Character of valley above the Long Portage.

The portage, at the head of these courses, is about 100 yards long, and passes a heavy rapid full of large boulders, where the stream falls over a low ledge of rock. From here, to the outlet of Lake Ichimanicuagan, six miles above, the valley continues in the same direction as the last course, and gradually widens to about one mile. The hills forming its sides rise very abruptly from 600 to 1000 feet, and in most places their sides are bare rock, with straggling spruce and birch trees growing here and there in crevices. The river gradually widens, and after a short rapid, about two miles above the portage, its current slackens, and it passes imperceptibly into the lake. The rocky walls are flanked on both sides with some quantity of drift, cut into terraces at various heights, up to 150 feet above the water, these terraces being well wooded with spruce, aspen and birch. Numerous large trees of white spruce grow on the lower terraces, many of them more than thirty inches in diameter three feet from the ground.

Lake Ichimanicuagan.

The view at the outlet of Lake Ichimanicuagan is one of great beauty and grandeur, the quiet water of the lake contrasting in colour with the bright sandy shores, backed by the dark green of the spruce and the lighter-coloured birches and aspen, while the rocky walls of the valley rise abruptly on both sides, bold and bare, with a fringe of small trees crowning their summits. Out of every depression in the hills above a stream issues, falling in most places directly down the rocky walls from 300 to 800 feet. One stream in particular, on the east side, is of considerable volume and has a sheer fall of upwards of 500 feet. In its descent it dashes against the almost perpendicular wall, and, by the time it reaches the lower level, is completely broken into spray.

Lake Ichimanicuagan is the lower of the two great natural reservoirs which collect the waters of the upper portion of the Manicuagan River. The lake lies in a deep narrow valley, a continuation of that of the river lower down. The water surface is 685 feet above sea-level, and nearly as many feet below the level of the surrounding country. This lake was not examined by us, but was surveyed in 1872 by John Bignell, P.L.S., and was found by him to be sixty-three miles long, while its breadth varies from half a mile to two miles, giving an average breadth of one mile, the southern half being the narrower. The lake is crescent-shaped, so that a line drawn from the two ends runs nearly north-and-south, while the convexity of the curve is towards the east. The principal river flowing into the lake, enters it on the west side, about four miles above the outlet, and forms the discharge of Lake Mouchalagan, the upper large lake. The other large streams entering the lake are three in number, but they do not compare in volume with the last mentioned. Two come in on the east side: the lower, called Gabriel River, enters about half way up; the other, called Wachaogamau River, flows in about ten miles from the north end, and is used by the Indians as a route crossing to the head-

Previous surveys.

Tributaries.

waters of the Ste. Marguerite River. The third river flows into the north end, and is exceedingly rapid, as it descends quickly from the table-land to the level of the lake. It rises some forty or fifty miles to the north and north-east, in a number of lakes, of which the waters interlock with those of the main stream on the west, the Ste. Marguerite on the east, and tributaries of the Koksoak River on the north.

Mouchalagan River.

As stated above, the main stream, flowing into Lake Ichimanicuagan, comes in from the west about four miles from the outlet, This river, which equals at least three-quarters of the volume of the outlet, enters the lake through a deep narrow gorge, nearly at right-angles to the main valley, and also cuts almost directly across the strike of the rocks. For three miles above the lake, the valley is not over 200 yards wide and is walled in by rocky hills, which on the north side rise in perpendicular cliffs from 800 to 1000 feet; the south wall is equally high, but less abrupt, and is about one half wooded with small spruce and birch. The river has an average breadth of one hundred yards, and flows swiftly in its deep narrow channel, which is frequently partly blocked with huge masses of angular rock, fallen from the overhanging cliffs of the north side. Several small streams tumble in from the high lands on the south side, in series of beautiful waterfalls. After three miles, the valley curves gently towards the north for four miles, widening in so doing, and thus allowing for a narrow interval of terraced drift between the river and the walls of the valley. The east wall continues abrupt, but farther up the stream it gradually decreases in height, and the scenery loses much of its wild grandeur. The course of the valley next changes to nearly north-east; here it widens, and its walls become lower and much less rugged, so that in the upper part, the surrounding hills do not rise more than 500 feet above the stream, and have well wooded, rounded outlines. The current throughout is swift, and two miles up this course, a large ledge of rock, crossing the stream, causes a low chute and heavy rapid, passed by a portage of one hundred yards on the east side.

Upper rapids.

At the upper end of the course, the stream bends quickly to the north-west, and for more than a mile is broken into broad low chutes and heavy rapids. This obstruction is passed by a portage nearly a mile long, of which the lower end is found a short distance up a small stream which flows in on the west side at the foot of the rapids. The portage rises rapidly 170 feet, to the level of a flat sandy terrace, and then crosses northward, on the level, to the river, where a sharp scarped bank of sand is descended.

From the upper end of the portage, the stream gradually bends to the westward for the next five miles, to where it flows out of Lake Mouchalagan. Along this portion the banks are not high, and the rounded rocky hills are quite distant, so that the country on either side of the river is low and flat, and is thickly wooded with spruce, Banksian pine, fir and birch, somewhat smaller than before noted.

Lake Mouchalagan.

Lake Mouchalagan is not as long or as large as the lower lake, but, notwithstanding, contains a great volume of water. Its greatest length is forty-one miles, and its average breadth about one mile, being least in its southern half, and varying from one mile and a half to two miles in the northern part. In shape this lake also resembles an irregular arc, but with the convexity towards the west ; on account of the opposite bends in these long lakes, their northern ends approach within fifteen miles of each other, and the interval there is occupied by low lands covered with lakes.

Height above sea.

The level of the lake is 830 feet above the sea, and its water is remarkably deep. Soundings made off Partridge-tail Hill, on the west side, about fifteen miles from the north end of the lake, give a depth of 466 feet, at one hundred yards from shore ; while at a distance of 500 yards the depth is 655 feet, the greatest known depth of any lake in the Labrador Peninsula. The water is clear, with a brownish tinge.

Fish.

Owing to the great depth, but few places are suitable for the setting of nets, and consequently the fisheries are not well known to the Indians except in the northern part, where the sand brought down by the principal tributary has silted up the bottom and produced shallow water over a considerable area. Here large quantities of lake trout, whitefish, land-locked salmon, pike and suckers are taken in nets during the spring and autumn.

The shores of the lake alternate between wide rocky points and sandy bays, and the banks in most places rise in terraces cut out of thick deposits of drift that flank the rocky hills on both sides. The highest terrace is about 150 feet above the present level of the lake, and it is seen on both sides in all favourable localities.

The hills are, for the most part, well rounded, but broken by deep valleys, those on the west side rising from 200 to 500 feet above the water. On the east side they are low and regular until the middle of the lake is reached, where a range of high irregular-shaped hills of rusty garnet-diorite occupies the country back from the shore for more than ten miles, when they again die away in the low lands at the head of the lake. To the north of the lake a low flat country extends for some ten miles, to the foot of a high irregular range of hills, which, from their outline and white colour are believed to be formed of crystalline limestone—an extension of the hills seen along the river above the lake and described later. Over three-quarters of the country surrounding the lake has, within the last three years, been devastated by fire, and in consequence only blackened trunks are seen in most places. The timber remaining is chiefly black spruce, seldom exceeding twelve inches in diameter, together with white birch, balsam fir, aspen, Banksian pine and a few larch, all growing thickly, but small in size.

Tributaries.

A number of small rivers enter the lake, generally with falls close to their mouth. Most of them come in on the west side, and one of them, which enters a few miles south of the Partridge-trail, forms with its connected lakes, a route to Outardes River. The main stream, or Mouchalagan River, flows through a wide, flat valley on the west side, about five miles from the north end of the lake.

As before stated, wide shoals extend for more than a mile into the lake, dividing the stream into narrow channels, which render an approach difficult during low stages of water. For the first four miles from its mouth, the stream flows from the north-north-west in a channel more than a quarter of a mile wide, with low scarped shores and sandy shallow bottom, with a moderate current. At the head of this course, a large branch, called the Kawikwanipinis River, joins from the north-east. Its volume appears to be about one-quarter of the main stream below its junction. It is about 100 yards wide and averages six feet in depth, with a current of two miles an hour.

Kawikwanipinis River.

This river, a short distance above its mouth, passes in a deep narrow valley, between high rugged hills of white crystalline limestone. From information obtained from the Indians, who hunt along the stream for many miles above its mouth, it is a succession of long heavy rapids and quite unnavigable, until near its head, where it flows out of a large lake called Mishinik, some fifty miles to the north-east of its mouth and close to the northern watershed. From the north end of this lake, portage-routes through small lakes lead north and north-east into the headwaters of streams flowing north into the Koksoak River, and eastward into the Moisie River. The portage-route to Lake Mishinik and past the rapid lower part of the river, is by a small tributary which joins the main stream fourteen miles above the Kawikwanipinis. This route is exceedingly long and rough, and quite impassable during the summer months for heavily loaded canoes, owing to the shallow streams and lakes connected by more than fifty portages, many of which are long and pass through deep swamps. The Indians wait at Lake Mouchalagan until winter sets in, and then haul their canoes and outfit over the portage-route, returning in the spring in their canoes. At this time they carry out only the furs caught during the winter, and in conseqnence pass over the portages in one trip.

Above the Kawikwanipinis, the main stream, for the next fourteen miles up to the small tributary above mentioned, has a general direction from the north-west, with a number of minor bends on both sides of the course. It now enters a distinct valley, which narrows from a mile to less than half a mile across as the stream is ascended, with rocky walls from 300 to 500 feet high, often with perpendicular cliff-faces, especially along the upper half of the distance, where white crystalline limestone and rusty, decomposed gneiss are the prevalent rocks.

High cliffs.

For five miles above the forks, the channel averages 200 yards in width, and a steady current flows over the sandy shallow bottom; farther up, the stream is broken into numerous channels by long islands of drift, often well wooded with medium-sized white spruce and white birch. The current here becomes swift with short shallow rapids, and poling is necessary in ascending with canoes. In many places thick sections of false-bedded sands and gravels are exposed in the scarped banks, and well-marked terraces were noted at 10, 20, 40, 60, 70, and 100 feet above the stream. The lower terraces are thickly wooded with trees similar to those found on the islands, along with black spruce, which predominates on the upper terraces and on the rocky sides of the valley. About one-half of the forest in the valley has been recently burnt.

The valley now turns due west for two miles and a half, and then nearly north for three miles and a half. Throughout these distances the river passes through a narrow rocky gorge with walls rising from 200 to 500 feet. The channel, in ascending, first narrows to about fifty yards and continues so for more than a mile. The current is very strong, and increases into a heavy rapid, with a low chute where the stream passes over a ledge of limestone. Above the chute the stream widens to 300 yards and is broken into numerous shallow channels by gravel bars and masses of coarse blocks and boulders. The stream here descends with heavy rapids. At the bend, the valley and river again narrow, and the latter varies from ten to 100 yards in width as it passes down over a number of short chutes connected by heavy rapids. With this character the stream continues to the head of the gorge, where the valley gradually opens up, and as it widens it becomes free from rocky ledges. This portion of the river can be navigated with canoes only at low stages of water, as then only can portages be made over the rocky margins between the steep walls and the water at the chutes.

Gorge.

The Indians never use this part of the stream; they pass it by a portage-route of which the lower end leaves the main stream on its east bank a few yards above the mouth of the already-mentioned tributary. The portage is short and ends on this stream, which is followed northward for a mile and a half in a direct line, but, owing to the stream winding from side to side in a valley about half a mile wide, the distance by water is more than four miles. The direction of the route now changes to north-west and continues nearly so to the head of the gorge. From the stream a portage of a mile and a half leads to a small lake 450 feet above the river. The route next passes through three small lakes connected by short portages, for two miles, and then by a portage of a mile and a half down hill to the river. The country surrounding the lakes is characterized by rounded, rolling hills partly covered with small black spruce and larch, with a few birch trees. Portage past the gorge.

From the head of the portage, the valley runs nearly due north, and quickly widens out to nearly one mile, with its bordering hills rising gradually on both sides to heights varying from 300 to 600 feet. The river has an average width of 400 yards for the next five miles, up to where the main portage-route leaves it. The channel is shallow and greatly broken by drift bars and low wooded islands, with a very swift current that averages five miles an hour and is occasionally broken into short rapids. Between the hills and the water there are wide intervals of terraced drift, the highest terraces being about 100 feet above the water. Scarped banks show the drift to be chiefly fine sand, with occasional beds of small gravel near the top, all showing signs of bedding at various angles to the horizontal. The trees in the valley continue to be of fair size and are chiefly black spruce, with white spruce, balsam fir, white birch, aspen, larch and Banksian pine.

The main stream, a few miles above where the portage-route leaves it at the head of this stretch, becomes very rapid, and flows in a deep, narrow gorge, with high, steep, rocky banks, where it is impossible to ascend with canoes, and very dangerous to descend. On this account, the Indians make use of a long and difficult portage-route, in order to reach the upper waters of the river. This route was passed over in ascending to the watershed, and will be described further on. Portage-route to head of river.

Above this portage-route, the valley continues northward for seven miles. Along the lower part it is somewhat wider than the portion last described, and the river is also broader, with high drift banks, from beneath which rounded masses of rock outcrop at intervals.

Along the upper three miles, the valley gradually narrows and the drift on the banks of the stream give place to rock, which hems it in and, as the grade is heavy, causes it to form wild rapids in a channel less than 100 yards wide.

Pepechekau River.

On the east side, about one mile below the upper end of the course, a large branch called the Pepechekau River, enters the valley with a beautiful fall of fifty feet. This stream heads in the neighbourhood of Mishinik Lake, to the north-eastward.

Dangerous rapids.

The valley, for the next twenty miles, runs almost straight north-north-west, with only a few minor bends. For the whole distance it never exceeds 400 yards in width in the bottom, and for many long stretches is less than one hundred yards across, with high, rocky banks rising abruptly from 300 to 600 feet, to the level of the irregular table-land above. The grade of the valley is steep, and down it the river, much confined, rushes in wild, heavy rapids, broken occasionally by short, low chutes. The shore is rocky, and broken with small, irregular points, past which the water rushes with great velocity and thus forms dangerous whirlpools. This portion of the river is exceedingly dangerous to travel, owing to the impossibility of making portages in most places, on account of the high, perpendicular walls of the valley and of the absence of any beach between their foot and the water. During the descent of this portion of the river it was only with the greatest difficulty and danger that the frequent landings necessary for the survey were made, and disaster was avoided in a number of places only by good luck. At a rapid pitch about half way down, one canoe was accidentally upset, and Paul Bacon, an Indian guide, was most unfortunately drowned in the whirlpools. Although the river was carefully searched below, no trace was found of the body of the unfortunate young man, nor of the canoe or its contents, which must have been caught in some of the eddies and sunk out of sight beneath the deeply-eroded, rocky banks.

Along the upper mile of this course, where the river first passes into the cañon, it falls 140 feet, in a succession of chutes over rocky ledges, the stream being broken into a multitude of channels by small rocky islands. The trees along the walls of the cañon are chiefly black spruce and a few white birch, with an occasional tree of white spruce along the lower portion.

Above the head of this gorge, the hills on both sides fall away, leaving a valley several miles across, bounded by broken ridges of rounded hills from 100 to 500 feet high. The valley is filled with a great accumulation of drift arranged in low ranges of drumlin-like hills, covered with boulders. The river now spreads out, and is broken into numerous channels by the detached drift ridges, so that for the next fourteen miles it assumes a lake-like character, although everywhere the current is perceptible and in many places strong. This portion is called Natokapau. The stream continues to flow from north-north-west for eight miles, to where a large branch called the Attikopi River joins it from the westward. The main stream, or Itomami Branch, then changes its direction and flows almost due south. Several large streams from the surrounding country join the main river in this neighbourhood. On the west side two flow in below the Attikopi River, and drain small chains of lakes on the high lands, through which a portage-route passes to join the Attikopi River. Two other streams enter on the east side, within a short distance of the commencement of the cañon, while at the upper end of Natokapau a large branch called the Mossy-pine River, joins from the north-east, where it is said to head in several long lakes on the watershed, one of which, at least, also discharges northward into the Koksoak River.

Notakapau.

Branches.

Above the Attikopi, the main stream flows in short crooked courses down a valley from one to four miles wide, bounded by rounded hills from 200 to 500 feet high, that run in broken ranges parallel to the direction of the valley, or north-east and south-west. The lower lands surrounding the river are covered with ridges of drift, often largely formed of coarse boulders and angular blocks of rock. The summits of all the higher hills rise above the tree-line and are covered only with low arctic willows and shrubs. The trees growing on the low lands are small and stunted; over ninety per cent are black spruce, with a few larch and Banksian pines, and an occasional clump of small straggling white birch. The aspen is not found above the mouth of the Attikopi River.

The valley continues in a north-east direction for forty miles, up to the watershed, beyond which it was seen holding the same course for at least thirty miles farther.

Character of the upper river.

Above the Mossy-pine River, the main stream is about one hundred feet wide in rapids, where the average depth is under two feet. Immediately above its junction there is a short heavy rapid leading from a small lake-expansion connected by short rapids with three others in the next seven miles. Above these, for twelve miles the river is narrow and blocked with small islands and huge boulders, past and over which it pours in continuous heavy rapids. It then flows out of the lower of a series of lake-expansions that almost fill the bottom of the valley, and are only separated from one another by short heavy rapids. These continue for ten miles, until the outlet of Lake Itomamis is reached. This lake is five miles long, and from one to two

Itomamis Lake.

miles wide, with several small irregular bays stretching away from the main body. It is surrounded by barren-topped hills that rise from 200 to 500 feet above it. Low shores, backed by drift ridges, intervene in many places between the water and the surrounding hills, and they are covered by patches of stunted black spruce and a few larches. The lake is fed by two large and a number of small streams. The largest flows in on the west side, near the south end, and forms the outlet of a chain of lakes on a portage-route to the head of the Attikopi River as described further on.

The second large stream flows into the north end of the lake, and, by two short rapids and a small lake-expansion, connects this lake with Itomami or Summit Lake, so called on account of its waters discharging in opposite directions; the southern outlet forming the head of the main branch of the Manicuagan River, the northern flowing into Lake Kaniapiskau, and thence into Ungava Bay. The streams flowing out are about equal in size and volume, being about ten feet wide in the rapids of both discharges.

Summit Lake.

Summit Lake is cut by the 53rd parallel of north latitude. It is six miles long, and averages about one mile in width, with two lateral bays, which increase the width in the centre to three miles. It is estimated to be 1940 feet above sea-level. Like the lower lake, it is surrounded by rugged, rocky hills, arranged in roughly parallel ridges. These hills are all barren on the top; on the low lands surrounding the lake small black spruce grows, but only in open groves. A great part of the timber has been destroyed by fire, and the landscape has a most desolate, barren appearance.

Country about the watershed.

From the summit of a hill that rises 565 feet above the water, situated on the east side of the lake near its north end, a fine view was obtained of the country about the watershed. The valley of Itomami is seen continuing in a north-north-east direction for more than twenty-five miles; beyond, it appears to bend towards the north, and a chain of long narrow lakes partly fills the valley, down which they discharge into Lake Kaniapiskau. Another wide valley stretches off towards the north, with two large lakes, the upper of which appears to be about 200 feet above the level of Summit Lake, into which it drains. To the westward are two more lakes, the lower separated only by a narrow strip of sand from Summit Lake. To the south, there is a narrow valley containing a chain of small lakes. With these exceptions, nothing is seen in all directions but rounded, barren-topped mountains, apparently considerably higher to the east, north-east, and north than about the lake, and the elevation of these mountains may vary from 300 to 600 feet above the lake, or from 2000 to 2500 feet above sea-level.

Attikopi Branch.

This stream, as before mentioned, joins the main river in a small bay at Natokapau. At its mouth there is a short rapid where the river passes down a channel about one hundred feet wide, over and between large boulders. For ten miles it flows in an irregular channel between low ridges of drift, thickly strewn with boulders and angular blocks of rock, on its way down from Lake Attikopi. The stream is greatly broken by rapids and chutes, and descends over 250 feet in the ten miles. The grade of the upper half is the heavier, and low ledges of rock along this portion cause frequent chutes. In all six portages, aggregating four miles in length, are necessary to pass these obstructions. Besides the low boulder-strewn ridges, occasional low hills of rock rise above the general level, and become more marked as Lake Attikopi is approached. Junction with main river.

This lake is very irregular in shape, and its surface is broken by many rocky islands. A long point, stretching out from the south side, divides it into two bays, with a third trending towards the north-east. From the discharge, at the south-east end, to its north-east inlet, the distance is about five miles, and its greatest breadth is about four miles. It is surrounded by broken ranges of rocky hills, from 200 to 400 feet high, the wide valleys between being characterized by low ridges of drift. Over one half of the forest has been destroyed by fire, and the remainder is chiefly small black spruce and larch, with a few Banksian pines and birches. Here the river divides into two branches of about equal volume. That flowing into the south-west bay is called the Kiche-wapistoakan River, while the one entering the north-west angle of the lake, is called the Attikopis River. The former flows from the south-west, where it rises some forty miles away from Lake Attikopi, in a number of small lakes whose discharges interlock streams flowing into the Peribonka and Outardes rivers, with the head-waters of the Manicuagan River. This stream was explored for twenty miles above its outlet, to where a small tributary passes into Lake Kitchewapistoakan, on the portage-route past the unnavigable portion of the Mouchalagan River. For this distance the stream flows in a channel about one hundred feet wide, generally with a sluggish current, except at short rapids which occur at frequent intervals. The channel is very crooked, and the banks seldom show solid rock, being for the most part composed of sand and generally low. The main direction of the stream is determined by sharp irregular ridges of sand, which bound its western side. These ridges are nearly continuous and where they are cut by the river, show the false-bedded structure of an esker, or deposit Lake Attikopi. South-west branch. Great esker ridge.

formed by a river flowing in or under the ice-sheet. This great esker was traced for more than twenty-five miles beyond Lake Attikopi toward the north-east, while in the opposite direction, according to the Indians, it extends almost to Lake Pletipi on the Outardes River, or a total distance of nearly one hundred miles. It is a marked physical feature in its south-western half, where it traverses wide swamps, and is used as a highway by the Indians in their winter travel. On the east side of the river, the country is covered with low, drumlin ridges of coarse till.

Highest area of central Labrador.

From the above description, the general surface of the country surrounding the river will be seen to be low and nearly flat, and it is only broken by occasional isolated rocky hills that rise from 200 to 400 feet above the general level. According to the Indian guide, the upper, unexplored portion of the river preserves the same character, flowing nearly on the surface of a wide swampy plain broken only by the esker ridge and by a few low drumlins. This plain extends northwards about ten miles to the foot of a high range of barren hills that rises 500 to 1000 feet above its level, and constitutes the highest area of central Labrador, being about 2400 feet above sea-level, forming the watershed between the Big River of Hudson Bay and the rivers flowing into the St. Lawrence.

Attikopis Branch.

The Attikopis Branch flows from the north-east, where it takes its rise in Lake Attikopis, or Little Attikopi, some twenty miles from the larger lake. The smaller lake is less than three miles long, and is divided by two narrows; it is chiefly of importance on account of two portage-routes which join here. One, from the westward leads to Nichicun, the other to Summit Lake. The Attikopis River, below the lake, flows in crooked courses in a wide valley bounded by rounded, rocky, isolated hills on the east side and by the higher range of granite hills on the west. Two spurs of this range rise close to the river. The valley is broken by low boulder ridges, with extensive swamps and small lakes between them. This country is partly covered with small, stunted black spruce and a few larches, while the hills are almost wholly barren. The river-channel is very irregular and occupies the depressions between the drift ridges. It practically consists of narrow lakes, connected by short rapids, where the channel is lined with boulders. Before reaching Lake Attikopi, it passes through a lake three miles long and about one mile wide, below which a mile of rapids and strong current leads to the large lake. Little Attikopi Lake is fed by two large brooks, both of which head in the mountainous country westward of Summit Lake. The portage-route follows the the eastern stream, almost due east, for six miles by its winding channel, to a lake about two miles across, surrounded by high, rugged, barren hills. Above this lake the stream is too small for canoes, and portages are made along it between the three small lakes at its head; these portages are respectively one-half, two, and one mile long. The portage over the watershed, between this stream and one flowing into the main branch, is about a mile and a half long and passes over a ridge between high, rugged hills, which surround the route. These hills are semi-barren, and the country has a very rough, desolate character.

Four small ponds, connected by a little stream, lead into a larger lake, about four miles long, the discharge of which is navigable with canoes, and, in a mile and a half to the next lake, it is broken by several rapids. This lake is a mile long and empties by a short rapid into Spruce Mountain Lake, which is four miles across to its southern angle, where it discharges. A narrow bay runs up a deep valley to the northward, and the lake is filled with islands and surrounded by high hills. The discharge is characterized by heavy rapids for two miles, to where it enters Itomamis Lake.

Portage-route between Lake Attikopis and Nichicun.

Route to Nichicun.

The portage-route to Nichicun leaves Lake Attikopis by its western tributary, which is ascended for about one mile; then a portage of over a mile leads to a little lake that empties into the small river. From this little lake two portages of a mile and a half mile respectively, with a small pond between them, end in a narrow lake, one mile long, connected by a short portage with a larger irregular lake, nearly three miles long. The general direction of this portion of the route is almost due west, and is through a wide valley surrounded by barren, rocky hills, from 300 to 600 feet high. The only trees seen skirt the lakes or grow in the swamps, the remainder having been destroyed by fire, leaving exposed low hummocks of drift thickly strewn with boulders. A portage of a quarter of a mile crosses the watershed and ends in a small lake drained by a tributary of the Big River. The direction of the route now changes to nearly south-west, for nine miles, as it passes first through a lake two miles long, connected with the next by a river stretch of one mile, with three portages past rapids, followed by a lake for five miles and another river stretch of a mile, with several rapids. A change of direction next occurs to west-north-west for the next twenty-four miles, along which course the stream passes through seven small lakes, and is greatly augmented by the junction of small branches from the lakes that partly fill the surrounding valleys.

Between each lake there are heavy rapids, so that the large lake, called Naokokan, into which the river empties, is some 200 feet below the level of the lake at the watershed, or nearly 1800 feet above the sea. The country surrounding the river is rough, but the rocky hills near the valley die away to the south and west as Naokokan is approached. Recent fires have destroyed the greater part of the small stunted, black spruce and larch, which partly covered the lower lands.

Lake Naokokan.

Naokokan is a large, irregular lake, nearly covered with islands and deeply indented with bays. Its greatest length, of thirty miles, is from east to west, while its width appears to be nearly twenty miles. From an elevation of 300 feet, near the mouth of the river, the lake had the appearance of a wide plain covered with numerous small lakes, and it was found only on passing into the lake that these numerous small lakes were really connected by straits and passages. Three days were spent in examining the southern shore of the lake in search of its outlet, and in that time only one of the deep western bays was explored. Owing to unfavourable weather—heavy south-west gales, accompanied by rain and fog,—and failing supplies, the exploration was ended here, without the outlet being found and descended to Nichicun. It has since been learned that the outlet is somewhere near the north-east angle of the lake, and that along it the distance to Nichicun is not more than twenty-five miles.

A large branch was discovered, falling with heavy rapids into the south side of the lake. This is the main stream of the Nichicun River, and takes its rise in a number of small lakes to the south, along the northern slopes of the mountains forming the watershed between it and the Manicuagan, Outardes and Peribonka rivers. South and west of Lake Naokokan, there is a wide, flat plain, broken only by small isolated hills, and covered with innumerable lakes; to the north and north-east, the high mountains of the vicinity of Nichicun are seen with their rugged barren tops.

Portage-route used in Ascending the Mouchalagan River.

As previously stated, a portage-route leaves the west bank of the Mouchalagan River, about twenty-five miles above Mouchalagan Lake. A description of this route is intelligible only by reference to the map, as it follows a succession of portages joining little lakes and streams that lie in small valleys between the hills of the table-land, high above the level of the river-valley. The first portage is a mile and a quarter long. It leaves the river immediately above the mouth of a small stream and follows up its valley to a little lake on the table-land 620 feet above the river. There is a very marked change in the size and variety of forest trees between the ends of the portage. At the river there is a dense growth of medium-sized, black and white spruce, balsam fir, Banksian pine, larch, white birch and aspen, while, about the small lake above, only stunted black spruce and Banksian pine separated by open glades, are found together with a few larch about the swampy margin of the lake.

Crooked courses for two miles lead to the west end of the lake, whence a portage of half a mile, then a pond, followed by a portage of a mile, lead to a chain of very small lakes, on the head-waters of the stream, at a level 200 feet above that of the lower lake. Three small lakes joined by rapids follow, to a portage one-third of a mile long, through a swamp, ending in a narrow, crooked stream which is ascended about a mile and then left by another swampy portage half a mile long, crossing the watershed between tributaries of the Manicuagan and Outardes rivers at an elevation of 1680 feet above sea-level, or 770 feet above the river at the commencement of the portage-route. The country surrounding the route is rolling, being broken by short, isolated ridges of rounded hills, that rise from 100 to 400 feet above the water level. Wide valleys lie between the hills, covered either with small lakes or swamps, and with frequent low ridges of boulders rising above the level. The soil is scanty, and everywhere boulders and large angular fragments of rock are scattered in profusion, so that there is no difficulty in walking in any direction over the higher ground without stepping off these, while in the swamps the portage roads frequently lead along ridges of packed fragments, without any fine material between, and only partly covered with a deep coating of sphagnum, or white moss. The trees growing on this poor soil are small and stunted, and over ninety per cent are black spruce, with only a few groves of Banksian pine and small larch in the swamps.

Character of the country.

From the height-of-land portage, the route for five miles follows a small stream connecting four little lakes, with short portages between them, and so reaches Little Matonipi Lake, about four miles long and a mile and a half wide, studded with many small, rocky islands. A portage of a mile and a half leads from near the discharge, at the north-west corner of the lake, to the eastern bay of Matonipi Lake. This bay is about two miles long, and from its mouth a northern bay extends four miles to its head, where the portage-route leaves it. Another long bay extends southward several miles, with a small river flowing out of its head, to join the Outardes River some twenty miles below the outlet of Lake Pletipi. The lake averages a mile in width, and is surrounded by rocky hills that rise

Matonipi Lake.

in rounded outline from 200 to 500 feet, those on the west side being the highest. This western ridge is only a few miles across, and an old portage-route leads over it to Lake Pletipi, some fifteen miles away.

The direction of the portage-route to Lake Matonipi has been nearly due west. It now changes to north, and continues near that course until it reaches the south-west branch of the Attikopi River. The surface of the lake is 1640 feet above sea-level. The next lake at the upper end of the portage is two miles distant from the north end of Matonipi; it is about three-quarters of a mile across, and 270 feet above Matonipi.

From this lake another portage of two miles leads over a barren, rocky ridge thickly strewn with boulders, into a narrow gully filled with small ponds, connected by a brook which discharges into Lake Matonipi. The rise on this portage is 350 feet. The route continues up the gully, and passes in the next four miles through five ponds, with intervening portages, to the height-of-land between the waters of the Outardes River and a small branch of the Mouchalagan River, at a height of 2390 feet above sea-level, and one of the highest water summits of the Labrador peninsula.

Highest level.

The portage over the summit is more than a mile long, and passes between low, rounded, rocky hills, covered with blocks and boulders, and ends in a small swampy lake, out of which issues a stream too small to be descended by canoes.

Two miles of portage, over boulders and through swamp, lead to the junction of this stream with a somewhat larger one. The portage here crosses to the west bank, and for two miles and a half farther, follows down stream, on the summit of a narrow esker of stratified sand.

At the lower end of the portage, the stream is about twenty-five feet wide, but soon increases to fifty feet, below a small north branch, where it has a shallow channel, sandy bottom and sluggish current. This stream was followed for three miles and a half, and then left by a short portage to a pond, followed by another portage of half a mile to a small lake without any outlet. From this lake a three-mile portage leads northward to another pond connected with a small lake by a portage of half a mile. A similar portage leads from this to a larger lake, which is followed northward three miles to its end. This lake empties by another branch into the main river. The next three miles are occupied by five portages, which pass up a shallow valley, surrounded by drumlin hills of coarse drift, and containing five small ponds. The next lake is two and a quarter miles long, and is left by a half-mile portage, ending in a small lake-expansion of the discharge of that lake. The discharge is followed for a couple of miles, and then a small branch is ascended a short distance, to a portage of a quarter of a mile, past rapids, to a small lake above. Five portages connecting ponds occupy the next three miles; then a small stream is reached and descended for about one mile, after which a two-mile portage leads to a pond connected by a short portage with a lake nearly two miles long, from which a portage of a half-mile leads to Lake Kichewapistoakan on a small stream flowing into the south-west branch of the Attikopi River already described. This lake is of no great size, and is broken into deep irregular bays by low points of drift and rock. It is chiefly remarkable, on account of its possessing two discharges, both of which enter the valley of the main river within a short distance of each other. In the spring, when the Attikopi branch is in freshet, its water backs into the lake, and flows out by the second outlet, which at ordinary times is nearly dry.

South-west Branch, Attikopi River.

The country and timber from the watershed to this place is similar to that already described. The only difference being the increase of drift on the northern slope, in the form of till and sand or esker-like deposits. The only trees are black spruce along with a very few larch, and all are stunted and confined to the valleys.

GEOLOGY.

Source of information.

The following notes on the various geological formations of the Labrador Peninsula are the result of observations made along widely separated lines of exploration in that great territory, and the time given to the work was very limited. It will thus be understood that they afford only the means of making a rough estimation of the distribution and extent of the areas of the different rocks, with some general remarks on their relations, modes of occurrence and age, together with a more or less detailed statement of the various exposures of rock actually examined along the routes followed.

The descriptions of the different rocks are from observations made in the field, together with a microscopic examination of the hand specimens brought back. It is to be regretted that circumstances prevented more than a small number of microscopic sections being made. These have been examined by Mr. W. F. Ferrier and described in Appendix V.

Geological Formations.

Laurentian.

The term Laurentian is employed to designate the complex mass of highly crystalline Archæan rocks of which the greater part of the

Labrador Peninsula is composed. These do not differ in any essential particulars from those similarly designated in other parts of Canada. They consist chiefly of gneisses and schists, some of which are believed to be highly metamorphosed materials of clastic origin, while others are regarded as foliated eruptives. As it is not possible, except in limited areas, to separate these rocks on the map, they are necessarily treated together.

The rocks of clastic origin are in nearly all cases the most ancient. The age of the areas of irruptive rocks is not known definitely, but many of them are very ancient, as fragments from them are included in the conglomerates of the Huronian. Others closely resemble the basic irruptives found cutting the Cambrian strata, and possibly are newer than that bedded series. These basic irruptives are in turn cut by later intrusions of granite, so that if the former are post-Cambrian some of the latter may be high up in Palæozoic time. Where the age of these rocks can be determined by their intrusion into the bedded series of the Huronian or Cambrian, they have been separated from the rest of the complex, and the remainder grouped under the name Laurentian until more evidence is obtained as to their exact age. It may be taken for granted, however, that by far the greater portion of the irruptive rocks included in the Laurentian are extremely ancient, and that the areas of those supposed to be post-Cambrian are unimportant compared with the areas of rocks long antedating that formation.

Huronian.

Under the name Huronian are included several widely separated areas of clastic and volcanic rocks, together with many basic eruptives; these are represented by various schists, conglomerates, breccias, diorites and other rocks more or less interfolded with the Laurentian.

Cambrian.

The Cambrian rocks rest unconformably upon the Laurentian and Huronian, and are made up of bedded sandstones, argillites, shales and limestones, along with bedded traps and other basic intrusive or volcanic rocks. More detailed descriptions of the Huronian and Cambrian rocks are given under their respective headings.

Great lapse of time between Huronian and Cambrian.

The Laurentian and Huronian gneisses and schists are intensely folded. This folding took place long previous to the deposition of the sedimentary beds of Cambrian age; and a sufficiently long time had elapsed between the period of folding and the Cambrian submergence, to allow for great removal of material by denudation and for the main sculpturing of the peninsula. The Cambrian rocks are found flat-bedded in the valley of Hamilton Inlet, and extend fifty miles up the Hamilton River; they are also found resting almost undisturbed in the great basins of Mistassini and Michikamau lakes. These examples show that the chief physical features of the Labrador Peninsula due to erosion, existed previous to the deposition of the Cambrian, and the enormous lapse of time requisite for the formation of the Hamilton inlet and river-valley can hardly be conceived, if the denudation was not much greater than that under present conditions.

LAURENTIAN.

The Laurentian rocks occupy more than nine-tenths of the area of the peninsula, the remainder being underlain by scattered areas of Huronian and Cambrian. Area

Nearly all these rocks are more or less foliated, the general directions of the foliation being roughly as follows: On the lower East Main River, near the coast, the general direction is east-south-east; farther inland, along the river, it is about east-north-east; along the upper part of the river, it varies from east to south-east. Between the East Main River and Lake Kaniapiskau the direction of foliation varies from east to east-north-east. Along the Koksoak River, above Cambrian Lake, it is from east-south-east to south-east, while, along the lower part of the same river, it is from north to north-east, showing a considerable change in the direction of the line of pressure, which here seems to have acted from the eastward, while elsewhere it appears to have been from the southward. Along the lower Hamilton River, the strike is from east to north-east, and above the Grand Falls, along the main stream, it is the same; but northward, towards Lake Michikamau, it ranges from east-north-east to north, the direction here being parallel to the Atlantic coast. On the Attikonak branch, where there are several large areas of basic irruptives, the strikes are more divergent, and range from east to south-south-east. Along the Romaine River, they vary from east to east-north-east, or are roughly parallel to the direction of the Gulf of St. Lawrence. Direction of foliation.

Of course the directions of foliation given above are merely general ones, subject to many minor changes, especially in the neighbourhood of intrusive areas, of both acidic and basic crystalline rocks. In such cases, the older foliated rocks appear to bend round these masses, and are often greatly contorted, both on the strike and dip.

By far the greatest area of the peninsula is underlain by medium to coarse-textured hornblende-granite-gneiss, corresponding to the Fundamental Gneiss of Logan. This gneiss varies in colour from red to light-gray, a pink variety being most abundant. It is made up chiefly of orthoclase, abundant quartz, together with hornblende, Fundamental Gneiss.

and commonly mica. It nearly always has a gneissic foliation, and at times an augen structure, due to the orthoclase collecting in bead-like masses, between laminæ of hornblende and mica. Sometimes over large areas the foliation is obscure, and the rock then approaches a true hornblende-granite.

Between Lake St. John and Lake Mistassini, along the routes examined, gneissic rocks of the above kind occupy over nine-tenths of the area. Northward, from Lake Mistassini to the East Main River, with the exception of a few bands of mica-gneiss, these are the only rocks met with. Large areas are found inland from the east coast of Hudson Bay, along the Big, Great Whale and Clearwater rivers.* Along the East Main River, rocks of this kind are met with at intervals; they are most abundant along the upper parts of the river, where, in places, being unfoliated, they pass into hornblende-granite, and as such form the great area passed through, from the head of the river to Lake Kaniapiskau. On the Koksoak River, an area of mica-schist and gneiss extends from Lake Kaniapiskau to the first gorge, below which the hornblende-granites, more or less foliated, again appear in association with mica-granite-gneiss, and continue along the river until the gneisses pass under the Cambrian rocks. On the Lower Koksoak River, the hornblende-granite-gneiss is less abundant. The same kind of rock is met with on the George River, at Port Burwell, Nachvak and along Hamilton Inlet. On the lower Hamilton River, it is found along with mica-gneisses, the latter being most abundant. Above the Grand Falls, hornblende-granite is the principal rock seen along the routes travelled, in the country stretching from Lake Michikamau on the north to the Gulf of St. Lawrence.

Differences in age.

From field study, the hornblende-granites do not appear to be all of the same age, some of the areas having an older and more altered look than others. The exact difference cannot be explained, but is quite noticeable when the areas are traversed. To one of these newer-looking masses, large dykes or veins of pegmatite were directly traced. These dykes were found cutting the rocks of Huronian age on the East Main River.

Pegmatite veins.

Pegmatite dykes or veins are very numerous everywhere in the Archæan rocks of the peninsula. They are found cutting the Huronian schists and basic eruptives, the anorthosite areas, the mica-gneisses, as well as the hornblende-granites, to which they appear to be genetically related. The most abundant mineral of these veins is orthoclase in coarsely crystalline masses, quartz in irregular crystalline lumps is next

*Annual Report, Geol. Surv. Can., vol. III. (N.S.), part J.

in abundance and hornblende is nearly always present, together with mica (biotite or muscovite) often in large plates, but usually much bent and twisted. Black tourmaline and red garnet are often found, the latter being most abundant. The colour of the orthoclase varies from red to white, and depends on the colour of the granite or granitite area, from which the pegmatite is derived. The width and direction of these veins are not nearly so constant as those of the basic dykes found throughout the region. They are often lenticular, and appear to have been injected into fractures and fissures, filling even very small cracks. Some of the veins are of great size, like those met with above the Great Bend of the East Main River, where the pegmatite is often more abundant than the mica-gneiss and schists constituting the original country-rock. The larger veins often hold angular fragments of the well foliated gneiss and schists, and some of these fragments are of great size. Although differing in appearance from the basic dykes, it is believed that these veins of pegmatite, from their character above described. and from the fact of their cutting all varieties of rocks of the Archæan, must be of irruptive origin, as has been clearly shown to be the case with similar veins met with in Sweden, and ably described by Prof. W. C. Brögger,* who believes that the pegmatite veins were formed during the later stages of irruption of the granite, when the main mass was in part solidified, and that the veins cutting the surrounding rocks were injected in a molten state; also that the materials of the veins were not deposited from highly heated aqueous solutions.

The rocks next in importance as regards area, are the mica-gneisses and mica-schists, that occur in wide persistent bands throughout the Labrador peninsula, and are taken to be the representatives of the Grenville Series of Logan, lately so well described by Dr. F. Adams.† Grenville Series.

Mica-gneiss greatly predominates over all the other members of this group, and it varies from coarse-grained, well crystallized gneiss, through all gradations of texture and composition to mica-schist. Pink or white orthoclase, quartz and mica (generally biotite) are always present, and hornblende is often found in small quantities. Garnetiferous bands are frequently met with, especially in the great areas along the Manicuagan River. The gneisses are usually very quartzose, and in many places shade into an impure, garnetiferous quartzite. All are well foliated or stratified, and in many places the dip of the foliation approaches the horizontal, giving the rocks the appearance of flat-bedded, altered clastic rocks. In many places these gneisses and schists are associated with bands of crystalline limestone. On the upper

* Can. Rec. Science, vol. VI, No. 1-2. "On the formation of Pegmatite Veins.'
†Am. Journ. Sci., vol. L., July, 1895.

Crystalline limestone.

Manicuàgan River, the limestones are extensively developed and are found in thick beds, always associated with a rusty-weathering mica-gneiss that contains both pyrites and graphite. Several smaller bands of limestone occur along the rivers north of Lake St. John, in conjunction with the garnetiferous mica-gneiss, also in the valley of the Hamilton River, below Lake Winokapau, and at Lake Attikonak. On the East Main River, a couple of small bands were noted a few miles above its mouth, and along the coast of James Bay in the vicinity of that river. These limestones, when the bands are thin, are sometimes greatly broken and very irregular. They then often enclose broken masses of the surrounding gneiss, and apparently pass between different strata of the gneiss, so that they often resemble veins parallel to the bedding rather than true beds. In other places they closely follow the bedding or foliation of the adjoining gneiss, being quite persistent for considerable distances, and having all the characters of true beds.

Supposed bedded structure.

The well marked foliation of this series of gneisses and schists, the developement of garnet in most of them, together with the graphite in the beds adjoining the limestone, and the apparently great bedded masses of limestone and iron ore of the Manicuagan River, all point to a former clastic origin and bedded structure for this series; and in many places where the limestones, quartzites and iron-bearing gneisses are present, the lines of foliation appear to coincide with those of the bedding planes. An originally bedded structure would also account for the nearly horizontal position of the gneisses noted in many places. The association of altered hornblendic and chloritic schists, probably of volcanic origin, and bearing a close resemblance to similar rocks of Huronian age, with the mica-schists and garnet-mica-gneisses of this series, as seen along the upper gorge of the Mouchalagan River, points to a connection between the Grenville series of the Laurentian and the Huronian.

Associated eruptives.

Along with the mica-gneisses occur bands of hornblende-schist, often broken and at times stretched out into lenticular masses. From the field relations, these hornblende-schists in most cases appear to have been ancient basic dykes, which were folded up, broken, and contorted by the same pressure that produced the changes in the surrounding gneisses. This is well shown at the whirlpool at the Great Bend of the East Main River, where a dyke of hornblende-schist is seen inclosing a large mass of the gneiss. Where it runs transverse to the foliation of the gneiss, the schistose structure of the dyke remains parallel to that of the gneiss, or transverse to the walls of the dyke.

The minor areas of acidic irruptive rocks include some of syenite, generally with a little quartz; others of quartz-porphyry and granite, holding considerable plagioclase. The basic irruptives are represented by great areas of anorthosite, gabbro, diabase and diorite. The anorthosite areas are the largest and most common. They occur on both sides of Lake Michikamau, along Lake Ossokmanuan, about the south end of Lake Attikonak, on the upper part of the Romaine River, as well as along the portage-route between that stream and the St. John River, and extending down the last-named river to within a few miles of the Gulf of St. Lawrence. This last-mentioned area probably extends westward to the Moisie River, and forms part of the great mass of this rock found by H. Y. Hind* on that stream. A probable continuation of this area was also met with along the Manicuagan River, where it has a breadth of more than twenty-five miles, its southern limit being within twenty-five miles of the coast.

Anorthosite areas.

Along the Atlantic coast, anorthosite is found in a number of places southward from Nain to Hamilton Inlet, and areas are said to occur on Grand Lake of the Northwest River, in the Mealy Mountains, south of Hamilton Inlet, and, according to A. S. Packard,† at Tub Island, within a hundred miles of the Strait of Belle Isle.

The anorthosite is a variety of gabbro, made up of labradorite holding isolated masses of hypersthene or rhombic pyroxene, ilmenite and mica. In texture it varies from exceedingly coarse, with crystalline faces sometimes nine by six inches, to a fine-grained saccharoidal form. The colour is generally a shade of violet, and is mostly dark, especially in the coarser varieties, which sometimes have a green tinge. The fine-grained granular variety is always light-coloured, varying from white to light shades of pink and violet. Along the north shore of Michikamau Lake, where the rock is very coarse-grained, many of the crystal faces show a beautiful irridescent play of colour, in shades of green, blue and bronze-yellow. The crystals having this property are not confined to veins or dykes in the rock, but pervade the whole mass, and were seen for more than ten miles along the shore of the lake. This property of the rock was seen to a less degree in large crystalline surfaces included in the granular variety on the upper Romaine River.

Precious anorthosite.

The coarse crystallization of these rocks is probably due to the slow cooling of the enormous masses in which they are found. Dr. F. D. Adams,‡ from his microscopic study of the Morin and Saguenay anorthosites, has shown that the light-coloured varieties were originally coarse in texture and dark in colour, like the massive areas, and that their present structure and colour was induced by pressure. The light-

*Explorations in Labrador, vol. I.

†Coast of Labrador.

‡Canadian Record of Science, vol. VI., p. 277, Jan, 1895.

coloured anorthosite is often found foliated, and passes into a gneiss, from the presence of mica in small scales, or from small grains of ilmenite arranged in bands. Dark red garnets were found in some of the gneissic areas. As before stated, large, isolated, crystalline masses are found in the granular rock, being evidently uncrushed parts of the former mass. Near the head of Lake Attikonak, a contact between the massive rock and a gneissic granular variety was seen. The two rocks are here found separated by a sharp, distinct fault-line that runs nearly at right-angles to the direction of foliation, or parallel to the line of pressure. On one side of the fault the rock is coarse-grained, dark-violet anorthosite, without any signs of gneissic structure or pressure disturbance; on the other, the rock is whitish, with a granular texture, resembling coarse loaf sugar, and in places it has a distinct banded structure, from the presence of small plates of mica, grains of ilmenite and some red garnet. It would appear that a strong force from a south-eastern direction had acted upon this area of anorthosite, causing first the fault, and, subsequently, the crushing to the gneissic mass.

Contact of coarse and fine anorthosite.

The light-coloured, granular anorthosites predominate on the upper Romaine River and in the great area between that stream and the St. John River, showing apparently that the crushing of the anorthosite areas was greater to the south, along the St. Lawrence coast, than in the interior, where the crushed rock is very rare. It is not found about Lake Michikamau.

Associated minerals.

The anorthosite areas of the interior generally weather to a dark brown, while towards the coast the decomposed surface is usually white. The hypersthene found in these rocks occurs generally in large crystalline masses, often a foot in diameter, exhibiting, at times, zig-zag structure in section, due probably to crushing. It is of a brown colour and generally has a metallic lustre. The ilmenite, or titanic iron ore, is mostly found in irregular, crystalline masses, varying from small grains to lumps several tons in weight. Sometimes the ilmenite is in small crystals scattered through the mass of the labradorite. Mica is not common, except in the foliated varieties, where it occurs in small plates, and much more rarely in the massive rock. In the area about Ossokmanuan Lake especially, the labradorite is considerably decomposed, into large, irregular patches of dark green saussurite. On the south side of Lake Michikamau, the anorthosite passes into a dark green gabbro along the east side of the mass.

Diabase.

Gabbro and diabase, having to all appearance the same or a similar origin to the great anorthosite areas, are met with along the Hamilton River, especially in the neighbourhood of the Grand Falls, where these rocks form all the higher hills about the portage-route. These areas are small, and are separated from one another by belts of orthoclase gneiss. The texture is generally moderately coarse, but at times it is fine-grained. The colour is greenish to black, while the weathered surface is commonly brown. These masses of gabbro and diabase closely resemble those found cutting the Cambrian rocks of the upper Hamilton River, and may be of the same age, as they appear to have been intruded into the old gneisses after the latter had become foliated. The great diabase dykes found everywhere throughout the peninsula, where they cut rocks of all ages, up to and including the Cambrian, are directly associated with these diabase or gabbro masses in the district, and probably represent the latest great irruption of igneous matter to be found in the Archæan of Labrador.

Diorite.

Diorites are not commonly found along the routes traversed, and the small areas noted may be in part, at least, only altered diabase. Sometimes they shade into quartz-diorite, which, with the basic granites above referred to, form several comparatively small areas on the Chamouchouan River, and along the Koksoak and Lower Hamilton rivers.

Details of Rock Exposures along Routes.

Chamouchouan River.

J. Richardson

The rocks along the Chamouchouan River, from its mouth at Lake St. John, to its head-waters, have been described by Jas. Richardson,* who examined the river and the route beyond to Lake Mistassini, in 1870, and it only remains to add such information as has been obtained later, from a closer examination of certain areas along these routes and at other places not visited by Richardson. Before doing so, it is right that mention should be made of the careful work done by that observer, and it is only our more extended knowledge of the country that enables changes to be made in a few of his determinations.

Little Bear Portage.

From the first rapid to the quiet stretch of water above the Little Bear Portage, the rocks show frequently from below the overlying, stratified drift along the river-valley. They are fine to coarse-grained red and gray mica-gneiss and mica-hornblende-gneiss, accompanied by thin bands of hornblende-schist. Strike N. to N.E.

. Can., 1870-71.

Thirty-five miles above its mouth, the river enters a narrow valley between steep rocky walls that afford almost continuous rock-exposure to the Chaudière Falls, twenty-one miles farther up stream. At the foot of the valley, on the west side of the river, dark red and gray mica-gneiss occurs, along with coarser, grayish-green hornblende-gneiss, holding small grains of magnetite. Dip E. $<$ 60°-70°. From here to the mouth of the Mouchipon River, seven miles above, the rocks are mostly a coarse-grained, dark-greenish, basic gneiss, composed of dark, grayish-green orthoclase and plagioclase, dark-green hornblende and quartz. The rock in mass greatly resembles the crushed basic granite, microscopically examined by Mr. Ferrier,* that occurs along the upper Jacques Cartier River, in Portneuf County, and other similar areas met with throughout the region between the St. Lawrence and Lake St. John. Along with these basic rocks are bands and veins of coarse, red pegmatite, and also bands of finer-grained, gray and pink mica-gneiss, and fine-grained, flesh-coloured hornblende-gneiss, the hornblende of which is light-green and much decomposed.

Basic granite

From the Mouchipon River to the foot of the White Spruce Rapid, some seven miles above, the rocks seen are all dark-greenish basic granite, containing much dark plagioclase and specks of pyrites; they are not well foliated, and have the appearance of an intrusive mass. Large veins of red and white pegmatite are commonly seen penetrating the granite.

At the foot of the White Spruce Rapid, there is an exposure of medium-grained, pink mica-hornblende-gneiss. Dip S. $<$ 45°. At the Chaudière Falls, the rocks are chiefly fine-grained, thin-banded, gray and pink mica-gneiss and mica-hornblende-gneiss, interbanded with thin bands of dark greenish-gray mica-diorite-gneiss, that often approaches a hornblende-schist. Average strike N. These rocks are much contorted and are penetrated by large veins of pegmatite that hold much dark green hornblende. Richardson found, below the falls, a thin band of pink crystalline limestone, but it was not seen by the writer, being probably covered by the high water.

Chaudière Falls.

At the Little Chaudière Fall, the rocks are the same, only the amount of basic gneiss is less. Another thin bed of limestone occurs in the gneiss just above the last-mentioned fall. Mica-gneiss and mica-hornblende-gneisses are met with along the main stream to its junction with the Chief River. At the sixty-sixth mile, thin bands of gray crystalline limestone, holding scales of mica, are interbanded with coarse mica-gneiss and dark mica-schists. These bands are seen almost

Crystalline limestone.

*Annual Report, Geol. Surv. Can., vol. V. (N. S.), p. 75 L.

continuously along the west bank of the river for the next two miles, to the mouth of Pike River. The thin bands of limestone and associated gneiss are not above fifty feet thick, and none of the limestone bands exceed a foot in thickness. Above, at the bend of the river, the beds appear to thicken, and may be twice the width mentioned. Dip N. 75 E. < 40°. Limestone is not again seen in the Laurentian rocks northward up to Lake Mistassini.

Chief River.

No rock in place is seen along the Chief River from the forks to the first chute, about fifteen miles up. Here the river passes over a ledge of dark-gray medium-grained hornblende-gneiss, composed chiefly of black hornblende, with white orthoclase and little quartz. Dark red garnets are generally present, at times in crushed crystals an inch in diameter. The gneiss is cut by a number of pink pegmatite veins. Dip S. 40° E < 60°. These gneisses continue along the river-banks for more than half a mile, to the foot of the next chute. They are here interbanded with fine-grained, highly felspathic, pink hornblende-gneiss.

At the head of the second chute, medium fine-grained, light-gray hornblende-mica-gneiss is seen, along with finer bands of a pinkish tinge. Dip S. 40° E. < 50°. Above this to the fourth portage, eight miles farther up, frequent exposures of hornblende gneiss and hornblende-mica-gneiss occur along the river. The rocks are everywhere evenly bedded, and are not contorted along the strike. At the fourth portage the strike is S. 45° E. < 45°-60°.

Sapin-crôche River.

The same rocks are seen, at long intervals, in the next eight miles, to the mouth of the Sapin-crôche River. The banks of this stream are low, and are formed of drift for eleven miles above its junction with the Chief River, and no rock is seen in place until the long portage past a heavy rapid is reached, where light-gray, highly felspathic, medium to fine-grained hornblende-mica-gneiss occurs. Strike N. 45° E.

These light-gray hornblende-gneisses are seen at intervals, everywhere along the route, up to the head of the river. In places about Canoe and File-axe lakes they have a granitic structure, and then resemble a true hornblende-granite. Small garnets are often present in these rocks. Beyond the watershed, they again show foliation and at times change to a hornblende-schist. Ten miles up the Perch River, which flows into the south-west bay of Lake Mistassini, these schistose gneisses are seen, overlain by the Cambrian limestones of Mistassini without the intervention of the Huronian rocks found to the south-west of Lake Mistassini, and which, if they extend in a north-west direction, pass under and are concealed by the newer limestones about the lake.

Chegobich Branch.

Chegobich River.

The Chegobich River, which joins the Chamouchouan a short distance above the Chaudière Falls, flows from the north-west, where it heads in Chegobich Lake, close to Lake Ashoupmouchouan. Owing to its more direct course and fewer rapids, it is used as a portage-route to the last-named lake, in the spring time, when its volume is sufficient to float loaded canoes.

The Laurentian gneisses are exposed along its course at frequent intervals, and as the general strike of the rocks is nearly north-and-south, the stream crosses it diagonally. For the first nine miles from the mouth of this branch, the rocks met with are gray and pink mica-gneiss, that varies from medium-coarse to fine-textured; the pink-coloured variety predominates, and all are very felspathic.

Along the next twelve miles, to Lake Chegobich, these mica-gneisses are interbanded with medium-grained, gray mica-hornblende-gneiss, together with a few bands of white quartzite, holding garnets, and also bands of rusty-weathering mica-gneiss.

On the sides of Chegobich Mountain, near the discharge of the lake, the yellowish-pink mica bands predominate, along with a few gray bands; their texture varies from medium to fine-grained, and orthoclase is the predominant constituent, with mica and quartz, and in some bands hornblende. Pegmatite veins are common here as well as lower down the river. The shores of the lake are low, and the country between it and Ashoupmouchouan Lake is swampy, without any rock in place.

Lake Nikaubau.

From Lake Ashoupmouchouan to the head of the river, exposures of rock are met with but rarely, and where seen they were made up of red and gray mica-gneiss, along with bands of dark hornblende-gneiss and hornblende-mica-gneiss. On an island in Lake Nikaubau the gneisses are cut by a dyke over fifteen feet wide, of dark brownish-green diabase of fine texture, containing a quantity of brown, translucent mineral.

Lake Mistassini to East Main River.

The rocks underlying the country from the north-west shore of Lake Mistassini almost to the East Main River, are all referable to the Laurentian. From the numerous exposures examined, it would appear that hornblende-mica-gneisses and hornblende-gneisses, alone, characterize this area, with only one large dyke of diabase cutting them. These gneisses are often only obscurely foliated and approach closely to the

Hornblende-granite-gneiss.

structure of hornblende-granites. To all appearance this great area is, like those between Lake Nichicun and Lake Kaniapiscau, along the Koksoak River and also on the Big and Great Whale rivers, referable in type to the fundamental gneiss of Logan's Trembling Mountain section.

Leaving Lake Mistassini, coarse to medium-grained, pink and red, hornblende-mica-gneiss is met with in several places along the low banks and small islands of the northern channel of the Rupert River, before the first portage is reached. In these gneisses hornblende appears to be always more plentiful than mica. Scattered throughout the mass of the gneiss, are lenticular patches of dark hornblende-schists and often finer bands of hornblende-schists and hornblende-mica-schists. General strike N. 50° W. The same kinds of rock are constantly met with to the portage past the fall, where the river enters Pinched-neck Lake. Below the portage, great angular masses of dark-green amphibolite are seen in which the hornblende is arranged in large sheaf-like masses of long, narrow, secondary crystals, some of the masses being six inches in diameter. On the islands of Pinched-neck Lake, the exposures are small and few, and show pink granite-gneiss, with inclusions and broken bands of dark hornblende-schist, much contorted. Strike N. 10° E. to N. 40° E.

Amphibolite

At the narrows leading from Lake No. 7 to Lake No. 8 of the portage-route between the Rupert and East Main rivers, there is exposed a portion of a large diabase dyke. The rock is of a dark greenish-gray colour with more or less rounded, yellowish-green masses of plagioclase. The size and direction of the dyke is unknown, as its contacts with the surrounding gneisses are concealed. This rock has been microscopically examined by Mr. A. E. Barlow, and his description of it is to be found in Appendix V. The few exposures along the portage-route to the East Main River, show that the underlying rock is all hornblende-mica-gneiss, with its associated bands of hornblende-schist, as far as the outlet of Clearwater Lake. Only two or three small rock-outcrops are seen along the discharge of this lake, and they are all fine to medium-grained mica-gneiss like that found along the East Main River in the immediate vicinity of the mouth of that stream. General strike N. 10° E.

Huronite dyke.

Lower East Main River.

The land surrounding the mouth of the East Main River is low, and the river-banks consist of stratified clay. On Governor Island, at the entrance of the river, there is a large exposure of light-gray, medium-

Mouth of East Main River.

grained granite-gneiss, cut by masses and dykes of a dark-red hornblende-granite. The gray gneiss is much contorted and has a general strike of N. 80° E.

The next exposure seen along the river, is on a small island close to the south shore, two miles above the Hudson's Bay post, where coarse, gray mica-gneiss appears, holding patches and veins of fine-grained, pink hornblende-granite. Strike N. 75° E. No Laurentian rocks are again met with along the river for 125 miles, or to within twenty miles of the lower end of the Great Bend. The river, in this part of its length, follows closely the strike of a band or bands of Huronian rocks, described under their proper heading.

Contact of Laurentian and Huronian below the Great Bend.

The gneiss below the Great Bend, varies from fine to medium texture, and is either pink or light-gray in colour. It is very felspathic, and as a rule holds little quartz. Hornblende and mica are present, the former being always most abundant. In places, the foliation is indistinct, and the gneiss then approaches a hornblende-granite. The general strike varies from N. 70° E. to N. 85° E. The foliation of this mass apparently took place previous to the deposition of the Huronian schists, as blocks of the gneiss are inclosed in these, with the gneissic structure sometimes transverse to the structure of the schists. At the lower end of the Great Bend, these hornblende-gneisses are associated with small areas of light-gray rock, composed chiefly of white orthoclase, with crystalline grains of opalescent quartz, and scattered porphyritic crystals of orthoclase. This appears to be an intrusion of quartz-porphyry into the granites. Along the next two miles, the granite-gneisses are mixed up with diorites and hornblende and chlorite-schists, that are taken to represent intrusive masses of Huronian age, as they clearly cut the gneisses. These gradually thin out, and only a few narrow bands of dark-green hornblende-schist are seen penetrating the gneiss for a mile above, to the chutes.

Contact at the Great Bend.

The river above the chutes flows in a shallow channel between rocky banks overlain with drift. For twenty-one miles, only Laurentian gneisses are met with, until they are again cut off by an area of basic irruptives. The gneisses are light-gray and pink in colour. For the lower half of the distance, a coarse-grained hornblende-granite predominates. It often has an augen structure, but in other places is almost unfoliated, and then holds large porphyritic crystals of orthoclase. Segregations of hornblende are common, often large, and always lenticular in shape. The rock has the appearance of an irruptive mass. Associated with it, are bands of finer-grained mica-gneiss, with a more marked foliation. Along the upper half of the distance, the hornblende-gneiss is much finer and very felspathic, while the accompanying mica-

Augen gneiss.

gneiss is more abundant. The strike throughout is very regular and is almost directly E. and W.

The basic intrusives first appear about two miles below the Broken-paddle River. From here to the mouth of that stream, the main river passes close to the contact between the Laurentian gneisses and the Huronian rocks. Contacts were seen in several places, and at all of them the Huronian dykes were undoubtedly intruded into the older Laurentian gneisses. Contact of Laurentian and Huronian at Broken-paddle River.

Gneisses are not again seen along the river for seventeen miles ; they re-appear five miles above the last exposure of Huronian, the rocks in the interval being concealed beneath the drift.

For the succeeding twenty-five miles, to beyond the next sharp northern bend of the river, the rock is chiefly a mica-gneiss. It varies from a mica-schist to a medium-grained gneiss, and its general colour changes with that of the constituent minerals, from dark-gray to light-gray or pink. The rocks have a general dip to the northward < 15°–70°. They are cut by numerous dykes or veins of coarse pegmatite, either white or light-pink in colour. These dykes are very irregular in size, and along their direction pinch out and come in again, so that they have a lenticular appearance in most places. They clearly cut the gneisses, and often enclose angular masses of the gneiss, which when so situated is generally schistose. Farther up the river the pegmatite becomes more abundant, and at the upper end of this course greatly exceeds the gneiss and forms high rocky walls showing large enclosed fragments of the schist. The pegmatite is composed chiefly of coarsely crystalline orthoclase, with large masses of quartz and little mica or hornblende. Large dark-red garnets are not uncommonly scattered through the mass, and in some places large crystals of black tourmaline are seen. Pegmatite veins.

For the next ten miles, to the lake portages, the same rocks are seen, along with a medium-grained red hornblende-mica-gneiss. Here the pegmatite dykes are not so large and are less abundant. The red hornblende-mica-gneiss is interbanded with the gray mica-gneisses, but their relations to one another could not be studied. The general dip is N. 10 E. < 15°–80°.

At the upper end of Prosper Gorge, the rock is chiefly a medium- to coarse-grained, pink hornblende-mica-gneiss, in which the hornblende predominates over the mica. It holds a few fine-grained dark-gray schistose bands. Dip N. 35 E. < 15°. This rock has the appearance of an irruptive and is associated with a gray and more micaceous gneiss, holding grains of magnetite. Prosper Gorge.

A mile above the portage, there is a large exposure of coarse, red, highly felspathic gneiss, containing small quantities of light-green decomposed hornblende. Dip N. 50° E. < 30°.

Medium- to fine-grained hornblende-mica-gneiss, along with thin bands of gray mica-gneiss, outcrop at intervals for the next six miles, to a small chute. Above the chute, and from there to the foot of Ross Gorge, the gneisses become darker and more schistose, and are cut by dykes of red pegmatite that carry much hornblende. The schists are mica-hornblendic and micaceous. The strike of these rocks along here shows that there has been a great bend in the foliation, which assumes a direction N. 60° W. Three miles above the chute, there is a large dyke of coarse diabase, holding much pyrites, and running N. 30° W., or diagonally across the strike of the foliated rocks. The composition of this dyke is similar to the newer dykes previously described as of post-Huronian age.

Large diabase dyke.

The few exposures met with on the portage past Ross Gorge, show pink mica-hornblende-gneiss, full of small red garnets, and cut by coarse pink pegmatite.

Between the head of Ross Gorge and Lake Nesaskauso, there is only one small exposure of pink mica-gneiss. About this lake, the rock is to all appearance an altered, intrusive hornblende-granite. It is generally red in colour and coarse-grained, with frequent bands of dark mica-hornblende-schists. These bands are long lenticular masses lying parallel to the foliation, and when followed along the strike are soon found to pinch out.

From the lake to the foot of Grand Island, the rocks along the river are mostly light-coloured mica-gneiss, with a few bands of mica-hornblende-schist, both of which are cut by large masses of white and pink pegmatite. Garnets are common both in the pegmatites and gneisses. The strike of the foliation here is again nearly parallel to that below Prosper Gorge, or N. 80° E.

The exposures along the northern channel past the Grand Island, are few, and everywhere show coarse, light-pink or white pegmatite, in great dykes, cutting mica-schists and enclosing broken bands of mica schists and mica-hornblende-schists. The pegmatites are much more plentiful than the foliated rocks. In the pegmatites garnet is common, in large dark-red or black crystals, and dark-green hornblende and greenish muscovite are frequently met with, along with much quartz. Two miles above the foot of the island, there is a large mass of dark-green amphibolite, which is probably the decomposition-product of a diorite dyke ; its contact with the gneisses is concealed.

The rock is made up of dark-green hornblende arranged in stellar masses of needle-like secondary crystals. These masses vary from half an inch to one inch in diameter, and give to the rock a beautiful spotted appearance on its smooth glaciated surfaces. Large blocks of the same rock are found at the rapid on the south channel, about a mile and a half above the foot of the island, and probably represent an extension of the dyke in this direction. Diorite dyke.

About Tide Lake, along the south channel, the pegmatite dykes are fewer and smaller, and, in consequence, more of the foliated gneisses are seen. These are mostly mica-gneisses, that vary in texture from medium to fine, and in colour from light-gray to light-red. Along with these are a few bands of red hornblende-mica-gneiss. Above Tide Lake no rock is seen along the south channel until within two miles of the head of Grand Island, where a low exposure of light-green serpentine appears on the north side. The mass seen is about thirty feet wide, and is bounded on the east side by green chlorite schists, containing small blotches of white plagioclase. The serpentine contains pearly hydromica in radiating flakes, and whitish hornblende in secondary radiating crystals. It is probably a highly decomposed dyke cutting the pegmatite and mica-gneisses that are seen a short distance above. Serpentine.

From the head of Grand Island to the end of the survey of 1892, a distance of about ten miles, the rocks are all mica-gneisses cut by pegmatite dykes. The gneiss varies from a fine dark-gray mica-schist to a medium-grained light-gray gneiss. The pegmatite is always white, and as the river is ascended the dykes gradually die out.

Upper East Main River.

At the starting point of the survey of 1893, the rocks are medium to fine-grained, dark greenish-gray mica-schist, and dark-gray mica-gneiss, cut by large, irregular masses of white or light-pink pegmatite. Both pegmatite and gneisses are cut by small dykes of fine-grained, compact, dark-green diabase. In the next three miles, small exposures of fine-grained, light-gray, highly felspathic granite-gneiss, cut by pegmatite, are seen on both banks of the river. Strike N. 80° E. with northerly dip. Mica-gneisses.

At the lower end of the large island immediately above the mouth of the Kawatstakau River, the rock is finely banded gray and pink granite-gneiss, cut by pegmatite. Strike N. 65° W. Fine-grained, dark-gray, highly micaceous gneiss, associated with coarse white pegmatite, is seen at the small rapid one mile and a half above the last. From here to Sunday Portage very few exposures are seen, and all consist of gray and pink mica-gneiss along with pegmatite. Some of the gneissic bands are garnetiferous. Strike N. 80° W.

At the foot of the next rapid, two miles above, there are exposures of dark-gray granite-gneiss, cut by gray pegmatite. Half a mile above this rapid, low cliffs occupy both shores for a short distance, the rock being chiefly coarse, white pegmatite, with broken bands of fine-grained, dark-gray hornblende-granite-gneiss, often weathering greenish from the presence of decomposed hornblende. Some of the bands are highly hornblendic. Strike N. 80° W. Two other exposures occur on the south side, before the Pond Portage, both showing the same dark greenish-gray hornblende-granite-gneiss, cut by pegmatite, and at the upper exposure the rock is nearly horizontal. Mica is the principal constituent, the hornblende forming but a small percentage of the mass. At the foot of Pond Portage, similar schistose gneisses, cut by pink pegmatite, are seen, dipping N. 5° W. < 15°; while at the small lake on the portage, these are found interbanded with coarser highly felspathic, light-gray granite-gneiss, both cut by pegmatite. Strike S. 85° E. At the short rapid on the north-west bend, three miles above the Pond Portage, the rock is mostly a dark greenish-gray mica-schist, with coarser, more felspathic bands, and pegmatite. Dip N. 80° W. < 25. A mile and a half above, on the west side, is an exposure of medium-grained, light-gray granite-gneiss, cut by pegmatite; while half a mile farther on the same side, there is a sharp rocky point where dark, greenish gray mica-schist is interbanded with lighter-gray granite-gneiss, and is cut by a yellow-weathering, red pegmatite. Strike N. 10° W.

Pond Portage.

At the islands, a mile and a half above the north-west bend, the rock is a dark-red, highly quartzose granite-gneiss, holding little hornblende. One mile above, and on the south side, light-gray, medium-grained granite-gneiss is seen, with a few bands of dark mica-schist. Strike N. 80° W. No exposures now occur along the river for over three miles, until the foot of the high hill is reached on the north side. There the rock is a coarse pink pegmatite, at times a coarse syenite, and holds a few broken bands of mica-schist. The mountain mass appears to be formed of coarse pink and red hornblende-granite. On the opposite shore are seen dark greenish-gray mica-hornblende-schists.

Hornblende-granite.

A quarter of a mile above, where the river bends abruptly south, away from the mountain, the rock is a coarse, red hornblende-granite, and is followed a mile and a half beyond by medium-coarse flesh-red hornblende-granite, with a light-green serpentine, or chloritic mineral, filling small cracks and veins in it. The hornblende is dark-green in colour. The quartz, at times, is stained dark-red, and small red garnets are also present. The granite often shows signs of foliation, and so becomes a hornblende-granite-gneiss.

Huronian schists at Sharp Rock Portage.

At Sharp Rock Portage a continuous section of schists is exposed for a quarter of a mile. At the lower end of the portage, dark-gray mica-schists are interbedded with more felspathic, fine-grained, light-gray gneisses, and are conformably followed by a considerable thickness of dark hornblendic and altered hornblende-schists, on edge, their strike being S. 85° W., and very regular, except where they fold around lenticular masses of dark-green hornblende. The schists are arranged in narrow, dark-green, light-green, white and brown bands. The white bands are highly felspathic, while the colour of the brown ones is due to the decomposition of pyrites, which mineral, along with quartz, is also found in small irregular veins, cutting the schists. A few small bands of white pegmatite also cut the schists. These schists closely resemble the hornblende-schists associated with irruptive rocks, found in several large areas along the lower parts of the river, and are supposed to be of the same or Huronian age. The pegmatites and the masses of hornblende-granite from which they are derived, must be post-Huronian, as they distinctly cut these rocks.

One mile above the portage, on the south side of the river, bands of greenish-gray mica-schists and mica-hornblende-schists are seen, interfoliated with thin felspathic bands of a light-gray colour, and the whole is cut by pegmatite. Strike S. 85° W.

A mile above the last, on the same side, is a large exposure of coarse white pegmatite. At the chute, a short distance farther up along the north side, the dark-gray schists are much contorted and broken by masses of pegmatite.

Upper contact.

At and below the islands at the narrows, two miles above the chute, the dark greenish-gray mica-schists and mica-hornblende-schists are partly interfoliated with a medium-grained, pink, highly quartzose hornblende-gneiss, which appears to have broken up between the bedding planes of the schists, and in places forms great masses wholly displacing them. The granite has in many places a porphyritic appearance, due to large perfect crystals of orthoclase, generally parallel to the plane of foliation. At the upper end of the island the schists are found only in broken bands and fragments imbedded in the granite. On the south shore, opposite the head of the island, the schists are, however, well developed, and only a little granite is seen.

Three-quarters of a mile beyond, and for nearly half a mile along the north shore, red hornblende-granite and gneiss are found holding a few broken bands of mica-schists and hornblende-mica-schists. The same rocks are again seen coming out at the head of a small island half a mile above; dip N. 5° W. $<$ 30°. At the foot of the hills, three-quarters of a mile farther up, on both sides, are hornblende-granites cutting mica-schist, interbanded with medium-grained, highly felspathic hornblende-granite-gneiss; dip N. 5° E. $<$ 40°. For the next four miles there are three small exposures, all of medium-grained, pink hornblende-granite and gneiss.

Hornblende-granite.

At and below Mink Portage and at the chute immediately above, there are a few bands of mica-schist along with a great thickness of medium to coarse-grained, light-gray hornblende-granite, at times showing signs of foliation parallel to that of the schists. Dip N. 30° W. $<$ 45°. Both schist and granite are cut by white pegmatite. From here to above the islands of Channel Portage, a distance of over four miles, on both sides of the river there are many exposures of medium-grained, light to dark-gray hornblende-granite-gneiss, associated with, and apparently cut by pink to red granite, also medium-coarse in texture. The granites are most abundant, and both rocks show frequently signs of foliation. Strike N. 50° E.

Diabase dyke.

For the next four miles upward, the river flows between low sandy banks, the rocks again appearing on the small islands in the rapid at the end of that distance, where part of a great diabase dyke is seen cutting a flesh-red, medium-grained hornblende-granite. The same dyke is probably seen on the north side, a quarter of a mile above the islands, where it cuts a medium-grained, pink hornblende-gneiss. Strike N. 60° E. The dyke is here thirty-five feet wide, and runs N. 20° W. In structure it is fine-grained, and it splits into sharp, angular fragments, along two principal cleavage-planes, arranged at an acute angle to one another. The colour is dark-green, and only a few blotches of dull, white felspar are coarser than the general texture.

Exposures of pink and red, medium to coarse hornblende-gneiss, are frequent along both banks of the river for the next two miles, and are followed by a great exposure of dark-greenish hornblende-schist, which forms the mass of a high hill on the south side. The hornblende-schist, towards the upper end of the exposure, takes up mica and gradually passes into a dark-green mica-hornblende-schist, closely resembling the rock met with along the river below the granites. It is also cut by white pegmatite.

Above this, for two miles, the shores are composed of till, and then again become rocky, forming an almost continuous exposure for the next two miles, with frequent exposures in the following ten miles. Red and pink hornblende-gneiss forms the mass of the rock, and often holds broken bands and lenticular patches of dark-green hornblende-schist. General strike N. 60° E. In places the bedding, or plane of fracture, is nearly horizontal. Some bands are composed largely of felspar, and are then light pinkish-gray in colour and fine-grained in texture.

Cascade Portage.

Four miles above the Cascade Portage, a large diabase dyke is seen at intervals for nearly half a mile along the north shore. As its contact with the surrounding granite could not be seen, its width and direction could not be determined, but its course is roughly parallel to the river, or about N. 45° E. This dyke is medium-grained in texture, dark-green in colour, and holds numerous small, porphyritic crystals of greenish-white plagioclase.

Exposures of hornblende-granite are very frequent to the mouth of the Misask River. Two miles and a half below that place, the rock is a medium fine-grained, light-gray, highly felspathic hornblende-gneiss. Dip S. 60° E. < 20°.

On the islands in the rapid immediately below that river, the same light, pink and gray hornblende-gneiss occurs, and here holds a few broken bands of dark-green hornblende-schist; while small fractures and cracks in the pink hornblende gneiss are filled with light-green serpentine. At the first portage above, an abundance of the same rock is seen, and here dips S, 60° E. < 5°–40°.

Beyond this point only angular blocks are seen, until the last portage before Long Portage Creek is reached, where similar fine-grained, light-gray and pink, highly felspathic, hornblende-gneiss occurs, holding broken bands of hornblende-schist. Strike N. 65° E.

Absence of rock exposures

No further exposures are seen along the route until the rocky portage on Long Portage Creek is reached, where there is a mountain formed of medium to coarse, red hornblende-granite, at times showing signs of foliation. Although no exposures of rock in place are seen in this long interval, yet, from the number of large angular blocks scattered about the river-bed and apparently not far-travelled, the rock underlying this section of country must be wholly hornblende-granite and gneiss. Above this to the second small lake beyond the Long Portage, loose blocks of granite are common, but no rocks are seen in place until they come out on the north side of that lake, where they are dark-pink, medium-grained hornblende-granite. The next exposure is seen at the small rapid at the entrance of Opemiska Lake, where the same granitic gneiss is seen lying nearly flat. Strike N. 80° E.

Opemiska Lake.

On a small rocky island on the north side, half a mile from the eastern end of this lake, coarse, pink pegmatite-gneiss holding broken bands of hornblende-mica schist is again met with. Strike N. 80° E. At the lowest rapid on the river between Opemiska and Wahemen lakes, there are large exposures of medium-grained, pink, highly quartzose, hornblende-gneiss. Strike N. 80° E. It is associated with coarse pegmatite, the contact of which with the gneiss is covered, and above, in the rapid, there is a large development of dark-gray mica-hornblende-schist.

Half a mile farther up, at the short portage over a small island, there is a considerable thickness of dark-gray mica-hornblende-schist. Dip N. 30° W. < 50°. These beds are sharply cut by large dykes of pegmatite that hold considerable quantities of hornblende. Between this and the last exposures, on both sides of the river, the hills are formed of coarse, red hornblende-granite, from which the pegmatite runs out as dykes. Granite is seen on the shores and islands along the river to Lake Wahemen. These granites are often foliated, but commonly show no signs of structure. No exposures were seen along the shores of Lake Wahemen or of the small lakes between it and Patamisk Lake : but from the large angular blocks of granite it may be taken that this kind of rock underlies the drift of this region. Dark-gray mica-schists cut by pegmatite are seen on some of the islands in Patamisk Lake. Strike N. 80° E.

Hornblende-granite.

At the west end of the first small lake beyond Patamisk Lake, there are immense angular blocks of dark-gray mica and hornblende-mica-schist. On the south side of the same lake, half a mile from the portage, there is a large exposure of fine-banded, highly contorted hornblende and altered hornblende-schists. The bands are of various colours, being yellowish, white, light-green, dark-green and reddish-brown. Dip N. 70° E. < 50°. On the other side of the lake, and half a mile beyond, similar banded schists are seen. Dip N. < 60°. Some of the bands contain finely divided pyrites and weather brown. They closely resemble the rocks seen at Sharp Rock Portage on the East Main River. From here no rocks are seen in place until the Big River is reached, but the angular blocks on the next two portages are nearly all mica-schist, or a fine light gray mica-gneiss.

Green schists.

Upper Big River.

Great hornblende-granite area.

A great area of hornblende-granite is now entered, that extends from the Big River north-eastward to Lake Kaniapiskau, a distance of over one hundred miles. Throughout this distance, the rocks met with consist almost wholly of pink or red hornblende-granite, at times associated with hornblende-mica-granite and rarely including fragments of the bedded series of mica-gneisses. These granites are generally massive, and do not show signs of foliation, except in the segregated masses of hornblende that frequently occur with them. The segregations have commonly a schistose structure induced by pressure. Where the segregations are large and numerous, the remainder of the rock contains a very small proportion of hornblende, it apparently having been nearly all collected into dark-coloured masses. Some of the segregations contain a small amount of mica. Along the Big River above Nichicun Lake, the coarse, red granites are seen in two places; the lower being at the Sharp Hill, where the river enters Back Lake. Both exposures show no signs of foliation, are coarse in structure, and contain a very small percentage of mica.

The islands of Lake Nichicun are often rocky, and wherever examined the rock was found to be coarse-grained, pink and red hornblende-granite and mica-hornblende-granite, the former predominating. On the first portage below Nichicun Lake, a considerable exposure of medium-grained highly felspathic mica-hornblende-gneiss was seen, along with thin bands of dark-gray micaceous schist. Strike N. 80° E. For several miles below, rock-exposures are frequent along the river, and where examined show coarse-grained, pink and red hornblende-granite. At the lake-expansion below the third portage, the bedded series of micaceous gneiss is again seen. From here to beyond Lake Kiaswachigastook, the rocks are all granite. On Eagle Lake the granite in places shows signs of foliation. Strike N. 75° E. On both sides of the long bay of Snipe Lake there are numerous broken bands of mica-schists and mica-hornblende-schists inclosed in the granite, and this development of the bedded schists continues across the portage to Long Lake, where the granites again come in, holding many segregations of hornblende-schist inclosed in a magma of almost pure orthoclase.

Lake Nichicun.

Koksoak River.

No rock in place was seen from here until the height-of-land was passed, but from the immense number of blocks and boulders scattered about, the underlying rock is taken to be hornblende-granite. From the height-of-land to Lake Kaniapiskau, a number of exposures were examined, and all were found to be hornblende-granite, sometimes including hornblende segregations, and rarely showing signs of foliation.

Lake Kaniapiskau.

On an island, off the discharge of Lake Kaniapiskau, the bedded series of gneisses is again seen as fine-grained rusty-weathering dark-gray mica-hornblende-schist. Strike 10° S. The first exposure on the

Change from granite to mica-gneiss.

river is three miles below the lake, where an outcrop of dark-gray, schistose mica-gneiss occurs at a heavy rapid. Strike S. 85° E. No other exposures are seen for several miles, but from the many large blocks scattered about in the drift, the underlying rock is supposed to belong to the bedded series of gneisses.

The next exposure on the river is eight miles below the last, where the rock is a dark-gray mica-schist, with numerous thin bands of light-gray felspathic gneiss. Below this, there is an interval of twenty-two miles to the next rock-outcrop, which occurs at a rapid below the lake-expansions. Here the rock is a very coarse, pink

Pegmatite.

pegmatite, some of the orthoclase faces being eight by ten inches. The rock contains a considerable amount of quartz in large rounded masses, and is singularly free of mica or hornblende. It resembles a great dyke over 300 yards wide, and appears to run N. 70° E. The same kind of rock is met with at the next rapid, one mile below the last. Similar rocks occur frequently for two miles below, when very coarse, pink and gray granite-gneiss appears. Dip N. 15° E. $<$ 50°. Some of it has an augen structure, and there are also finer-grained bands. These rocks do not resemble the bedded mica-gneisses, and may represent irruptive granites, with the pegmatite dykes derived from the granite mass.

Rocks at the first gorge.

From here, along the east channel past the large islands, the river flows over many rocky ledges to the head of the first gorge thirteen miles below. These exposures show a great development of coarse to medium-grained gray granite, often with porphyritic crystals of white orthoclase, and charged with a considerable quantity of mica. Along with these are broken bands of finer, and often darker, mica-schist and granite-gneiss, that perhaps represent the bedded series. All these rocks are cut by dykes of coarse pink pegmatite. Along the gorge these rocks are continuously exposed for eight miles. The coarse red pegmatite here developes into a hornblende-granite, from the presence of dark-green hornblende, and it carries in cracks small veins of light green chlorite. These rocks cut the coarse-grained light-gray basic syenites or granites,* which in places contain well formed crystals of brown orthorhombic pyroxene. Associated with, and cut by both the granites, are large masses of mica-schist and fine-grained mica-gneiss, in the form

Basic granite.

of broken bands. These schists and gneisses are often highly charged with dark-red garnets, some of the crystals being nearly two inches in diameter. The general strike of the foliation is S. 75° E.

For several miles below the gorge the valley continues narrow, with high rocky walls that afford an almost continuous exposure on both

*See No. 6, Appendix V.

Hornblende segregations.

sides of the stream. Owing to the heavy rapids in the river, the rock could only be examined at favourable landing places. Where examined the light-gray basic granites were found to predominate; they are at times garnetiferous and sometimes change to a mica-hornblende-granite from the presence of small quantities of dark hornblende. They then hold segregations of hornblende with a schistose structure. The rocks are often foliated, but still the general appearance and the well developed crystallization point to their irruptive origin. They continue to hold large fragments of the finer-grained, less metamorphosed, bedded series. The hornblende-granites and pegmatite dykes cut both of these rocks.

Eight miles below the gorge, and along the stretch of three miles where the river runs east, the mica-hornblende-granites are very abundant and hold many segregations of hornblende. The direction of the foliation is S. 75° E. They are penetrated by many large red pegmatite dykes, and cut by small veins of serpentine and steatite. Three miles below, where the river bends to the north-west, there is much fine-grained schistose hornblende-granite of a dark-green colour. Strike S. 55° E.

Garnets.

For the next eighteen miles, the rocks were examined at intervals, and were found to be similar to those already described. Garnets were often seen plentifully scattered through the mica-schists as well as through the granites, the former being found more largely developed as the river was descended. The general strike is S. 80° E.

For the next five miles the river banks are sandy, but farther down stream the same varieties of rock are seen, the granite changing to a mica-hornblende-granite from a free admixture of hornblende with the mica. Strike S. 75° E.

At the foot of the next long rapid, twelve miles below the last exposure, the rock is a medium-grained, greenish-gray, basic mica-hornblende-gneiss. It is composed chiefly of a yellow-weathering plagioclase, and holds a good deal of dark-green hornblende along with mica. It changes into the light-gray gneiss, and the rusty colour is probably due to decomposition. Strike S. 80° E.

Seven miles farther down, at a heavy rapid, a large diabase dyke was seen, but could not be examined, as it was impossible to land near it.

Sandy River.

The next exposure examined was three miles above the mouth of Sandy River, where medium-grained, light gray mica-hornblende-gneiss was seen. Strike S. 60° E. Similar exposures were seen at the low chute a mile below, where the rock was found to be contorted on the strike, and holds a number of shattered bands of hornblende-schist. General dip N. $<$ 25°

At the second gorge, four miles below Sandy River, medium-grained, light-gray and pink mica gneisses and mica-hornblende-gneisses were seen in nearly flat layers. There are large masses of dark-green hornblende-schist in places, and these appear to be the remains of old dykes, foliated by pressure. The same rock is seen at the small chute one mile below, and there the dip is N. 15° E. < 20°-50°.

Eaton Cañon. At the head of Eaton Cañon, the same flat-bedded gneisses are seen, cut by large dykes of dark-red pegmatite, holding large decomposed crystals of green hornblende. The cañon proper is cut out of a medium-grained, dark-red hornblende-granite, from the mass of which the pegmatite dykes appear to be given off. The granite is extremely brittle and is much fractured along two sets of cleavage-planes; it is so minutely broken that it is next to impossible to obtain an ordinary hand specimen. These is a large dyke of fine-grained, compact diabase 125 feet wide, running N. 55° E. along the south side of the river. This dyke appears to have been the cause of the shattered condition of the granite, as the latter is more broken and friable near the contact than elsewhere. At the foot of the cañon, the granite is again displaced by the medium-grained, light-gray mica-hornblende-gneiss, that forms the steep rocky walls of the river-valley to the mouth of the Goodwood River.

Below the Goodwood, the walls continue high and rocky for many miles. Five miles down, the rocks, where examined, consist of coarse to fine-grained, gray and pink mica-hornblende-gneiss. Strike S. 75° E. Six miles farther down the same gray and pink granite-gneisses are seen, cut by red hornblende-granite. Strike E. Two miles above

Granite Fall. the Granite Fall, only coarse-grained, hornblende-gneiss with light-green hornblende is seen. Strike S. 45° E. At the fall the rock is also coarse, pink and red hornblende-gneiss, including lenticular masses of dark hornblende-schist, often much broken. The gneiss is considerably contorted, but the general dip is N. 45° E. < 40°.

For seven miles below the falls, the river has banks cut out of drift, which conceals the underlying rock; then the rocks are seen at the bends of the river, where the heavy rapids occur, and where a landing cannot be made. In consequence, no exposure was examined for twelve miles below the falls, where a highly contorted, coarse-grained, gray and red hornblende-gneiss was seen.

The valley now widens out, and there is a considerable interval of drift between the river and the rocky hills. In a few places low hummocks of red hornblende-gneiss are found along the shores. At times the gneisses are massive, but they generally shew signs of foliation, and have a general dip of N. 45° E. < 20°-70°. These characters continue till the crystalline rocks are replaced by the overlying Cambrian strata. Sixteen miles below the Stillwater River, the Laurentian rocks are again found rising from below those of Cambrian age, although the latter still form the summits of the hills on both sides of the valley. The first exposure on the south side of the river shows finely banded, pearly-gray schists, somewhat calcareous, with plates of silvery hydromica, and in some of the bands green hornblende and chlorite. The hornblendic bands are full of dark-red garnet, some of the crystals being nearly two inches across. These bands are vertical, and the strike is S. 45° E. A curious coincidence is that, on the Hamilton River, near the eastern contact of the Laurentian and Cambrian rock, similar beds of hydromica-schists are met with. Three miles below, on the same bank, the Laurentian rocks are again seen, and are here fine-grained, gray mica-gneiss, cut by large masses of red pegmatite. Dip N. 55° W. < 40°.

Contact of Laurentian and Cambrian

Garnet schists.

On the summit and side of the hill in rear of the last exposure, the rock is a fine-grained, dark mica-schist, interbanded with coarse-grained pink mica-gneiss. Dip N. 75° W. < 10°-40°. On the north bank at the Head-of-tide Rapid, medium-grained pink mica-gneiss is met with. Dip S. 35° E. < 40°. Below this there appears to be only patches of the Cambrian rocks on the tops of the hills on the north side of the valley, and these soon disappear.

From five miles below the rapid, there is an almost continuous exposure along the south shore for nearly four miles. Along the upper part the rock is largely fine-grained, light-gray mica-gneiss. Dip S. 75° E. < 40°. A mile below, a section of 400 feet of banded, light and dark-coloured mica-schists is seen, along with thin bands of dark-green, hornblende-schist. Dip S. 65° E. < 10°-30°. Some of the dark micaceous bands are full of small, dark-red garnets.

Fort Chimo.

Similar schistose rocks, cut by large veins of pegmatite, appear on the high rocky islands, above the Hudson's Bay post. Immediately behind the post, is fine-grained, gray and light-pink mica-gneiss, cut by large dykes of pegmatite. Strike N. 45° E. Similar rocks now bound the river on both sides to its mouth, and they all appear to belong to the bedded series of dark gneisses, except the pegmatites, which may represent dykes from some irruptive masses in the vicinity, not seen along the river.

George River.

About George River, the country is high and rocky, and near the Hudson's Bay post the rocks are contorted, gray mica-gneiss, cut by fine to coarse-grained red hornblende-granites. The high country eastward of the Hudson's Bay post is mostly bare rock, and shows gray and pink granite-gneiss, cut by large masses of red hornblende-granite.

Near Port Burwell, the rock is a highly contorted, fine to medium-grained, red hornblende-gneiss cut by large dykes of dark-green diabase.

Lower Hamilton River.

Muskrat Falls.

The first rock seen in place along the Lower Hamilton River, is at the Muskrat Falls, where the river passes over a number of ledges of dark grayish-green, diorite-gneiss,* along with medium-grained, light-gray and pink mica, and mica-hornblende gneiss. These rocks are greatly contorted along their strike, which appears to be about N. 80° E. About five miles above the falls, a rocky spur projects from the south wall of the valley, giving an exposure a quarter of a mile long on the bank of the river, where contorted, medium-grained, pink and gray mica-gneisses and mica-hornblende-gneisses are seen.

Cambrian rocks.

On the north shore at Sandy-banks Rapid, there is a low cliff of coarse, light-red sandstone along with bands of fine conglomerate of irregular thickness and of Cambrian age. No other exposures are met with until the second bend of the Horse-shoe Rapids is reached, where there is a high cliff of fine-grained, dark-gray mica-gneiss with coarse, light-gray and pink augen-mica-gneiss. Dip S. 65° E. $< 70°$.

Along the south shore of the river, from here to the mouth of the Minipi River, there is an almost continuous exposure of gneiss and granite, which could not be examined, owing to the river being open along this part, and to the impossibility of travel on the ice along that shore. Immediately above the Minipi River, there is a large exposure of dark-red hornblende-granite, with gray and pink mica-hornblende-gneisses and mica-gneisses. Dip S. 75° E. $< 50°$.

Pyroxenite.

Five miles above the Minipi River, a large dyke of very coarse-grained pyroxenite† crosses the valley and narrows the river-channel to less than one hundred yards, with an island on the south side. On this island the rock is well exposed. It has a brownish colour, and is much rotted on the surface, where it is broken into great rounded masses. It is formed of a jumble of large crystals of rhombic pyroxene and holds a good deal of black mica in small scales. The direction of the dyke is S. 5° E., and it exceeds seventy feet in width.

No rock is seen in place in the river-valley for thirty-five miles above this dyke, and until the valley again becomes quite narrow about three miles above Squirrel River. But an examination of

*No. 11, Appendix V. †No. 13, Appendix V.

scattered angular blocks shows that the underlying rocks are largely mica-gneisses. Above this, up to Lake Winokapau, exposures are frequently met with on both sides of the river. The first is on the north side and shows a band of coarsely crystalline limestone, enclosed in coarse, highly felspathic augen-gneiss, associated with finer gray mica-gneiss. The limestone band is very irregular and varies from one to four feet in thickness only. In colour it ranges from pure white to a beautiful cobalt-blue and contains no associated minerals. Strike N. 75° E. The next exposure examined was on the south shore, three miles higher up, where the rock was found to be medium to fine, dark and light-gray mica-gneiss, along with apparently broken dykes of dark-green schistose hornblende. Strike N. 35° E.

Limestone.

A mile above the last, medium-grained, gray and pink augen-mica-gneiss was seen, together with fine-grained mica-gneiss, in broken bands. Strike N. 35° E. The orthoclase of the augen-gneiss has often a beautiful pearly lustre.

Augen-mica gneiss.

From here to Lake Winokapau, all the rocks met with were coarse, highly felspathic augen-mica-gneiss, varying in colour with the felspar, from white through yellow and pink to red. At the entrance of the lake, the rocky walls rise 1000 feet sheer, and huge angular blocks, fallen from above, are piled up at the base of the cliffs. On the surface of one of these large blocks is a beautiful example of the secondary crystallization of hornblende, which is nearly always present in small quantities in these rocks. The needle-like crystals vary from one-tenth to one-fortieth of an inch in diameter, and from a half to two inches in length; they are arranged so as to radiate from centres, thus forming dark-green stars.

Lake Winokapau.

The next exposures of rock, on the north shore of Lake Winokapau, twelve miles above its outlet, are schistose to medium-coarse, pink mica-gneiss. Strike N. 80° E. Exposures of mica-gneiss and mica-hornblende-gneiss continue for three miles along this shore, and these are cut by a dyke of dark-brown, coarse-grained pyroxenite similar to that already described. This dyke is more than one hundred feet wide. On the south side, sixteen miles above the outlet, and for four miles beyond its first appearance, the shore is high and rocky. The rock is mostly gray, fine to medium-grained mica-gneiss, cut by small veins of white pegmatite. Dip N. 10° W. $<$ 45°.

The north shore, for three miles below the lower island, at the head of the lake, rises in perpendicular cliffs of contorted, micaceous gneisses mostly pink in colour. There appear to be two series of rocks represented, the most abundant being a coarse augen-gneiss or granite, which in places holds large, almost perfectly developed crystals of orthoclase. The other is made up of fine to medium-grained mica-gneiss, sometimes schistose, and probably an altered clastic rock; whereas the first series has every appearance of an igneous origin, and encloses broken bands of the schistose rock. At the small point on the north side, opposite the lower island, there is a large dyke of very coarse, red pegmatite, formed of large crystals of red orthoclase (9x12 inches), and holding much brown mica in crystals, up to four inches in diameter. Masses of translucent quartz in the pegmatite hold large crystals of black hornblende. At the bend one mile below the mouth of the Metchin River, there is a low cliff of fine-grained mica-gneiss, the dip being N. 60° E. < 20°–50°. Opposite the mouth of this river, dark-gray mica-gneiss is seen holding large quantities of dark-red garnets; these are mostly small, but some crystals are half an inch in diameter. Dip S. 80° W. < 40°.

Mica.

No rock is now seen for six miles, to the next sharp bend of the valley to the northward. Here, on the east side, are two or three small exposures of fine-grained gray and pink mica-gneiss. Dip S. 20° W. At the upper end of the bend, and on the opposite side of the valley, a prominent hill rises vertically from the water. The rock here is a dark-green, medium-grained quartz-diorite, made up chiefly of dark-green hornblende, with irregular spots of plagioclase and a small amount of quartz. The relation of this rock to the mica-gneisses, which again outcrop on the east side above the bend, is unknown.

Quartz-diorite

The valley from here is free from rock for sixteen miles, to where a point projecting from the north shore, shows highly contorted, mica-gneisses, associated with red hornblende-mica-gneiss. Strike E. to S. Large, angular blocks fallen from the cliff, opposite the mouth of Portage River, are all composed of mica-gneiss.

The next exposure is one mile above the Big Hill Portage, where dark-red hornblende-gneiss is seen. Rock in place is again seen in the river bed at Disaster Rapid, six miles above the portage, and from here to the mouth of Bowdoin Cañon exposures are of frequent occurrence. Only the north bank of the river was examined owing to the stream being open.

Disaster Rapid.

At Disaster Rapid, the rock is a medium-grained, light and dark gray and pink mica-gneiss. Strike N. 80° E. One mile above, the same rocks were seen with highly felspathic, pink bands. This is followed, half a mile above, by an exposure, a quarter mile long, of red mica-gneiss and mica-hornblende-gneiss, in which the hornblende is much decomposed. These rocks are distinct from the banded mica-gneisses, and are associated with coarse augen-gneiss. A quarter of a mile above, the augen-gneiss is found along with broken bands of fine-grained mica-gneiss. Dip S. 60° W. < 40°.

These are followed, two miles beyond, by light-gray mica-gneisses, cut by broken bands of dark hornblende-schist, that are apparently formed from ancient diorite dykes. Along with these gneisses, and seemingly interbanded with them, are gray hornblende-gneiss and a very felspathic, pink hornblende-gneiss. Strike S. 5° W. The next exposure is half a mile above, and consists of medium-grained, dark and light-gray mica-hornblende-augen-gneiss, with a few bands of pink hornblende-gneiss. A short distance above the last, coarse hornblende-mica-gneiss and hornblende-augen-gneiss are again seen, not well foliated. Strike S. 65° E. This rock is more basic than any yet passed, and has the characters of an intrusive mass cutting or displacing the banded mica-gneiss.

Hornblende-gneiss.

No exposure is now met with for three miles, or to within a half mile of the mouth of the cañon, where a medium-grained schistose hornblende-gneiss is found, associated with a dark-red, compact hornblende-gneiss, holding very little quartz, as well as similar bands with both hornblende and mica. These rocks are highly felspathic and are very brittle, splitting along several jointage-planes. They have been greatly shattered and have been recemented by veins of chlorite and serpentine. Dip S. 60° E. < 40°-80°. The Bodwoin Cañon, for the greater part of its length, is cut out of this kind of rock, and its shattered condition and friable nature must have greatly aided the erosive action of the water.

Grand Falls.

At the Grand Falls, the rock forming the walls of the basin and the ca on to below the first bend, is a coarse-grained augen-mica-gneiss. Strike S. 50° W. The foliation planes dip at a high angle, but the rock splits up into great blocks along several planes, one of which is nearly horizontal, and there appear to be two other principal planes, one running nearly east and the other south-west. The direction of these principal lines of jointage corresponds to and probably determined those of the reaches of the cañon immediately below the falls. Similar rocks, above the falls, are cut by bands of coarse hornblende-mica-augen-gneiss, and both are cut by large dykes of dark-green, medium-grained diorite.

Upper Hamilton River.

One mile above the falls, these rocks are exposed along the shore for a quarter of a mile, and here they appear to change gradually into mica-schists and mica-hornblende-schists by the reduction in amount of felspar.* Several bands of dark-green hornblende-schist are seen interbanded with the gray schists, but are found on close examination to cut the latter, and are in all probability squeezed diorite dykes. On the east bank, one mile farther up stream, is a very felspathic, red gneiss, with thin partings of mica, and at times chlorite ; this rock is interbanded with ordinary, gray mica-schists. Dip S. 10° W. < 70°.

Gabbro.

On the islands, at the outlet of Jacopie Lake, two miles and a half above the last exposure, are large masses of unstratified uralitic gabbro† enclosing broken bands of mica-gneiss.

On another island, half a mile eastward of the outlet, bluish-gray augen-mica-hornblende-gneiss is seen ; strike E. The same rock was also seen, on the low hills, along the south-east shore of the lake.

The rocks underlying the portage-route past the Grand Falls, appear to be coarse augen-mica-gneisses and mica-hornblende-gneisses, cut by large masses of uralitic gabbro, which, owing to its superior hardness and weathering qualities, now rise as rounded hills from 100 to 500 feet above the general level of the surrounding country. Four of these hills were ascended, and each was found to be composed of medium-grained gabbro, in some places very felspathic. There are also several exposures of gabbro seen on the islands of Jacopie Lake. The rock varies from fine to coarse-grained, and often holds considerable mica. At the entrance to the narrow east channel at the head of the lake, thin bands of coarse-grained, red hornblende-granite are met with, cutting the gabbro.

A small exposure of medium-grained, gray and pink hornblende-granite-gneiss outcrops on the east bank nearly two miles above the head of the channel. This rock carries much bluish-white translucent quartz, and is somewhat contorted, with a general strike S. 60° W.

No rock was seen in place for several miles until the small hill on the west side near the outlet of Flour Lake was examined, where the rock was found to be dark-gray mica-gneiss.

Rocks of Flour Lake.

The islands of Flour Lake appear to be all formed of hummocks of fine to very coarse-grained, dark-brownish and greenish gabbro, made up largely of coarsely crystalline plagioclase, with irregular masses of augite or hornblende, hypersthene and mica, and also holding small grains of ilmenite. The coarser masses are badly weathered and decayed on the surface, the rock resembling a typical anorthosite, while the finer-grained rocks are similar to the gabbros of Jacopie Lake and Lookout Mountain, and all may have come from the same or nearly contemporaneous outbursts of igneous matter.

* No. 19, Appendix V. † No. 12 Appendix V.

At the head of Flour Lake coarse-grained, red, very felspathic hornblende-gneiss crosses the river, with its strike N. 50° W. Similar rock, only finer grained, is met with three miles up the river, where it is much contorted and encloses masses of hornblende-schist. Beyond, no rocks are seen in place along the south channel of the river for ten miles to Sandgirt Lake. There are great numbers of angular blocks of hornblende-granite scattered everywhere along this interval, and this rock probably underlies the drift here. At the outlet of Sandgirt Lake there is a small island of coarse, red hornblende-granite, cut by small veins of finer-grained, similar rock.

Sandgirt Lake.

There are very few rock exposures about the shores or on the islands of Sandgirt Lake, but on two small islands near the middle of the lake are huge angular blocks of light-gray and pink mica-gneiss, much contorted and holding inclusions and broken bands of hornblende-schist. On an island at the northern outlet of the lake is a ledge of fine-grained red hornblende-mica-gneiss; dip N. < 45°.

Ashuanipi Branch.

The first exposures along the shores of the Ashuanipi Branch occur at the foot of the hill on the north side, four miles above Sandgirt Lake. The rock on the top of the hill is an unfoliated gabbro like that of Lookout Mountain, which changes to a gabbro-gneiss on the eastern flank. The same rock comes out on the river at the south-west end of the hill, and here, as also on an island immediately above, shows obscure foliation striking S. 40° E. There is much broken fine-grained red hornblende-gneiss along the southern flank of the hill, which appears to have been baked by the intrusion of the gabbro and is very brittle.

After this no rock in place is seen along the river for ten miles, when a long exposure occurs on the north bank, consisting of evenly banded light-gray and greenish sericite and talc-schists, with a few narrow bands of a fine-grained slaty, altered hornblende-rock holding pyrites; dip N. 65° E. < 25°–60°.

Rocks like those on Koksoak River.

These rocks closely resemble those met with on the Koksoak River immediately after leaving the Cambrian area, and those here noted are again immediately followed by rocks of the Cambrian series to the westward. This is probably only a coincidence, and does not show that the Cambrian has an altered series attached to its base, as the Cambrian strata found a few miles farther up-stream are of detrital sand-rock and bear no resemblance to the schists, which resemble the Huronian lithologically.

At a point a short distance above the exposure of schist, a portion of a large dyke is seen, made up of very fine-grained dark-green altered hornblende and plagioclase, with a considerable amount of pyrites disseminated through it.

In the small lake-expansion, six miles above, the bedded sandstones of the Cambrian appear on several small low islands, and from here to the upper end of Menihek Lake the country passed through is underlain by rocks of this age. A description of these rocks is given farther on.

Above Menihek Lake.

Along the river, above Menihek Lake, to the end of the exploration on the Ashuanipi Branch, there is only one exposure of rock in place, and that is near the end of the survey, where dark pearly-gray hydromica-schists are found with thin layers of white orthoclase and quartz, associated with dark-greenish chloritic schists; dip, S. 10° W. < 35°. Below this place, in the river-valley, to the Menihek lakes, large angular blocks of dark schist are met with frequently, and these rocks probably underlie the drift of this area. They resemble rocks of volcanic origin and are possibly plutonics of the same period as the Huronian rocks of the East Main River; they may be better correlated with these than with the Laurentian gneisses.

The small rounded hill at the end of the survey, is formed from a mass of medium-grained dark-green diabase.

Route to Lake Michikamau.

North of Sandgirt Lake

At the northern outlet of Sandgirt Lake, medium-grained, red hornblende-mica-gneiss occurs on several small islands. Dip N. 60° E. < 45° This rock is composed chiefly of red orthoclase and hornblende, and breaks up into angular fragments, along different jointage-planes, like similar rock at the outlet of Bodwoin Cañon. At the rapid, where the channel discharges into Lob-stick Lake, there is a coarse-grained, greenish-gray hornblende-mica-gneiss, holding small broken dykes now converted into hornblende-schist. At the foot of the rapid, the rock is a well-banded, light-gray and pink mica-gneiss. Strike N. 10° W.

Lob-stick Lake to Michikamau.

The geology of Lob-stick Lake and the country beyond, to the head of the eastern bay of Lake Michikamau, is very complicated, and would require much more study and examination to work it out than it was possible to give it on a hurried trip through the lakes. This area is remarkably free from drift, and in consequence the rocks are everywhere exposed along the shores, and on the myriads of small islands of the lakes. From the hasty examination made, it would appear that the route passes close to the contact of a great area of coarse-grained, red hornblende-granite, like that about Lake Nichicun, with an older series of foliated mica-gneisses and mica-hornblende-gneisses. The contact of these rocks was examined in a number of places, and everywhere the hornblende-granites cut the gneisses. The latter, near the contact are much contorted, and at the contact become darker and change from mica-gneiss to mica-hornblende-gneiss, from an admixture of hornblende, perhaps absorbed from the hornblende-granite. Both series are full of broken masses, or bands of hornblende-schist, the probable remains of old diorite dykes that cut the rocks previous to the final squeezing and folding, when they were broken up and changed to their present condition. All these rocks are cut by several large diabase dykes, which are undoubtedly of much later age.

Michikamau Lake.

At the head of the east bay of Lake Michikamau, the hornblende-granites give place to light-gray, talcose and hydromica-schists, holding small garnets, with partings of white orthoclase and quartz, closely resembling the rocks of the Ashuanipi Branch, at the contact between the Laurentian and Cambrian. Strike N. 25° W.

No exposures are seen along the shores of the east bay, or on the west side of Lake Michikamau for eight miles northward, up to where low rounded bosses of anorthosite come out along shore and on the small islands fringing it. These rocks continue along this side of the lake for thirty miles, or up to within four miles of the north end. The rock is everywhere very constant in its physical characters. It is almost wholly formed of coarsely crystalline masses of dark-purple anorthosite, or labradorite, holding masses of dark brown hypersthene, and ilmenite, and at times mica. The rock is badly weathered to a depth of several inches below the surface, and disintegrates, leaving rounded cores. The labradorite, where weathered, has a dark, greenish-brown colour. It is so coarse that cleavage faces six inches across are not uncommon. Anorthosite

The mass of dark-purple anorthosite includes large patches, or rather bands, of a lighter coloured and finer grained variety, due to the segregation of the almost white plagioclase from the darker.

The hypersthene is present in crystalline masses from one to eight inches in diameter. The ilmenite has no definite crystallization, but occurs as irregular masses, generally small, although sometimes measuring more than a foot through.

Hornblende-granite.

About four miles from the north end of the lake, the anorthosites give place to a coarse, red hornblende-granite, which occupies the shore for a couple of miles and then passes under the drift, at the head of the lake. The contact of the anorthosite and granite is concealed and their relations are consequently unknown.

Labradorite.

The north end of the lake is low, and the shores are formed of sand and boulders; the western side is also low for twenty-two miles from the north end, to where a ridge of anorthosite hills projects into the lake, forming a prominent point and large high islands. From here, anorthosite is found on every point along the shore for nearly twenty miles. In physical characters this rock closely resembles that of the opposite side of the lake, except that the felspar has the peculiar opalescent character of labradorite, with a play of colours showing dark-blue, light-blue, green and bronze-yellow. Some of the crystals are six inches by eight inches, and at times the outline of the crystal and lines of growth are beautifully marked by the different colouring. The precious variety of the rock is not confined to veins or dykes, but includes the whole mass. Owing to the badly weathered condition of the rock, good specimens could not be obtained above water without blasting. The beauty of the rock was best seen along the shore below the water-level, where the surface protected by the water was fresher and had been smoothed and polished by glacier-ice. Here, looking down through the clear water, the play of colour from the numerous large crystal faces is most beautiful.

Hornblende-granite resumes.

About eight miles north of the outlet of the lake, hornblende-granite replaces the anorthosite and again the contact is concealed. Exposures of granite are frequently met with up to the high hill just north of the discharge. This hill is granite with patches of bluish-gray Cambrian limestone. At the base of the hill is a large exposure of pink and gray hornblende-granite, with an obscure foliation in the direction N. 30° W. From here, for fourteen miles, to the south end of the lake, the western shore is low and formed of sandy drift, strewn with large angular blocks of Cambrian sandstone. The south end of the lake is shallow and filled with small rocky islands of coarse, red hornblende-granite, that are often thickly strewn with huge, angular blocks of Cambrian limestones and sandstones. The west shore of the lake is also low and drift-covered from the south end to the entrance of the eastern bay.

Attikonak Branch.

From Sandgirt Lake to the first lake expansion, the Attikonak River passes through an area of red hornblende-granite and hornblende-mica-gneiss, evidently of igneous origin. The first exposure, about one mile up the river, shews fine, pink hornblende-mica-gneiss, interbanded with darker hornblende-schists. Strike N. The gneiss has partings and small cracks filled with light-green chlorite and serpentine. The second exposure is about five miles farther up, and is formed of well banded, medium-grained, red and dark greenish-gray hornblende-gneiss. Strike N. 20° W. There are numerous exposures along the ten miles of river below the lake-expansion, and they are all medium-grained, red hornblende-granite with green hornblende and partings of chlorite, the orthoclase at times being developed into small porphyritic crystals. Strike N. 10° W. Hornblende-granite and gneiss.

With the south bend of the stream, as it passes through the small lake-expansions after leaving Lake Ossokmanowan, there is a distinct change in the underlying rocks, which now apparently become bedded argillites, altered grauwackes, and chloritic schists, cut by large diabase dykes. These rocks are frequently exposed, until they are seemingly cut off by a great area of gabbro, near the north end of Ossokmanuan Lake. Up the stream, the first exposure of these rocks is seen on a long point opposite the discharge of the first lake, where the rock is a fine-grained, dark-green chlorite, somewhat schistose in character, and probably the remains of an ancient dyke. Strike S. 80° W. The next exposure is nearly a mile above, where a large dyke of medium-grained, greenish-gray diabase is seen giving a beautiful example of the phrenocrysts of plagioclase. The contact of this dyke with the adjacent rocks was not seen, so that its width and direction are unknown. On the next point, half a mile above, dark-green chlorite-schists are found, interbanded with a very siliceous grauwacke holding small scales of secondary mica and evidently highly altered. Black slates are also interbanded with the last. On the opposite side, and a mile farther up stream, are light-gray sericite-schists, together with altered grauwacke. Strike W. The last two exposures are on islands in the north end of Ossokmanuan Lake, where exposures of dark anorthosite are seen along the west shore. The rock on the islands is light-gray in colour, very siliceous, and is probably an altered grauwacke. Strike N. 50° W. The above-described rocks, taken together, resemble strongly certain aspects of the Huronian, and are probably an extension of the Huronian area met with on the upper part of the Ashuanipi River, the strike of the

Rocks probably of Huronian age.

Ossokmanuan Lake.

rocks being such that, if continued, they would cross that stream at this place.

Large area of anorthosite.

The anorthosite area appears to be largely developed to the south-west of Ossokmanuan Lake, and its characteristic rounded knobs are seen frequently along the west shore and islands of the lake for ten miles, to the mouth of the large south-west bay. The eastern side of this part of the lake seems to lie along the contact between the anorthosite and a hornblende-mica-gneiss, which is seen on the east point of the first narrows, with anorthosite on the other side of the lake. The anorthosite is generally coarse-grained and almost wholly made up of large crystalline masses of plagioclase, without any play of colour, as seen in the rocks of Lake Michikamau. In some places the rock is medium-grained and contains much pyroxene. This is probably near a contact, as the rock is cut by small dykes or veins of red orthoclase and hornblende. The colour of the mass varies from dark-green to dark-violet, and on the surface weathers to a brownish-green. In the coarser rock, hypersthene and ilmenite are always present in varying quantities.

Further exposures on Ossokmanuan Lake.

No exposures occur along the lake for the next seven miles, but the broken rock scattered everywhere is chiefly coarse grained hornblende-mica-gneiss, and this rock probably underlies the drift. The two large islands that stretch down the middle of the lake, are high and rocky, and from a distance appear to be formed of gabbro. Along the west side of the lake, five exposures are seen in six miles opposite the northern island. The first is a fine-grained, compact, dark greenish-gray basic rock, that is much decomposed but was probably a diabase. It holds fragments of coarse, red hornblende-granite and has an indistinct foliation N. 10° E. It is either a large dyke, or the contact rock of the basic mass with the granites, most probably the latter. The next two exposures are close together, and show a similar rock, with obscure banded structure due to the development of white plagioclase crystals in thin lines. Two miles beyond, these rocks again hold broken bands of red hornblende-gneiss. Strike N. 75° W. The last exposure, a mile further on, is medium dark-gray gabbro-gneiss composed chiefly of rusty-white plagioclase and pyroxene. Strike N. 20° W.

From here the shores of the lake are low and drift-covered for eighteen miles, to where rock in place is again seen for three miles, on several small points, to the mouth of the river. The first exposure is fine-grained, dark-grayish-green, altered diorite or diabase cut by small veins of red pegmatite. Two hundred yards beyond, there is a large exposure of fine-grained, pink mica-gneiss, very much contorted.

At the next point, half a mile farther on, the same gneiss is seen, and is here uncontorted. Dip S. 70° W. < 40°. More exposures of this gneiss, which appears to represent the bedded series, are met with frequently along the river for three miles above the lake, when the drift again covers the rock, and no exposures are met with until Lake Panchiamiskats is passed.

Ossokmanuan to Attikonak Lake.

Between this lake and Lake Attikonak, the mica-gneisses are mixed up with a coarse augen-gneiss that appears to cut the bedded series. At the inlet of the lower lake, on the points and islands, are numerous exposures of coarse augen-gneiss. Strike N. 20° W. This rock is formed of fine-grained, light-gray mica-gneiss, holding strings of well developed crystals of red and pink orthoclase up to $1\frac{1}{2} \times \frac{3}{4}$ in.

Two miles up-stream is a small island of medium-grained bluish-gray hornblende-mica-gneiss. The orthoclase has a purplish tinge. Strike N. 10° E. Along the river above this exposure, the augen-gneiss is often exposed, together with fine-grained, gray and pink mica-gneisses. At the portage these rocks are banded with twenty-five feet of dark greenish-gray hornblende-gneiss. Dip N. < 25°. Above the portage the augen-gneiss appears to die out, leaving only the bedded series of banded mica-gneisses. General strike N. 30° W.

Rocks of Lake Attikonak.

In the northern part of Lake Attikonak only one exposure of rock in place was seen on the west side, about three miles above the outlet, where a reef of fine, pink granite-gneiss (Dip S. 80° W. < 40°) forms a line of low islands. Beyond this for twenty miles, the shores and islands are covered with drift, and no rock is seen in place until a small island is reached four miles from the narrows leading to the south-east bay. From the number of angular blocks of mica-gneiss scattered along the shores, it is believed that similar rock underlies the drift and must be interbedded with white crystalline limestone, which is also found in angular blocks along shore. On the island above mentioned, and in several places along shore to the narrows, medium, red hornblende-mica-gneiss is met with. It is contorted and shattered, and the small cracks are filled with light-green serpentine. Strike N. 80° E.

Anorthosite.

Beyond the narrows no rock is met with for four miles, until a bunch of small islands is reached. From here to beyond the head of the bay the country is quite rough, with the rounded hills characteristic of an anorthosite area. On the first island, medium-grained, violet anorthosite is found, penetrated by small veins of pink orthoclase. The anorthosite holds considerable quantities of ilmenite in small masses that are often crystallized; pyrites is also present in small grains, along with brown hypersthene. There are a few small cavities in the rock partly filled with green saussurite. On the next island the same rock is seen holding much hypersthene. There is a well-marked contact between the coarse violet anorthosite and a gabbro-gneiss on the next small island. The dark-coloured anorthosite cuts straight across the gneiss, the direction of the contact being S. 30° E., while the strike of the gneiss is E. The only difference in the anorthosite close to the contact is that it appears to be slightly finer-grained than away from it. The gneiss is a moderately coarse-grained gray rock, composed chiefly of white plagioclase with a granular structure. It holds bands of biotite and dark hornblende, and is often highly garnetiferous, some of the crystals of that mineral being an inch in diameter and of a dark-red colour.

Gabbro-gneisses.

Similar gabbro-gneisses are met with in several places farther along our route to the southward, and they are everywhere intimately associated with the unfoliated rocks. Their crushed appearance and foliated structure, together with the development of mica, hornblende and garnet, leads to the opinion that these gneissic areas are only patches in the great masses of unaltered gabbros, that for some unknown cause have been subjected to great pressure, and that the line of contact with the unfoliated mass is simply a line of fracture.

The next exposure examined was on the point on the west side, a mile and a half south of the islands; here the foliated gabbro is again seen, but the gneissic structure is not so well marked as on the former exposure, owing to the small quantities of mica present. Strike N. 60° W. On the small island, a quarter of a mile from this point, coarse, violet anorthosite is found, holding large quantities of dark-green saussurite and a few large dark-red garnets. The dark, unfoliated anorthosite is exposed frequently up to the head of the bay, and in a number of places large veins of red pegmatite are seen cutting it. At the head of the bay a six-inch band of mica-gneiss is inclosed in massive gabbro.

Romaine River.

Rounded hills of massive anorthosite are met with along the portage-route to the Romaine River, and the area appears to extend far to the south-west, forming the high rugged hills seen in that direction, beyond Lake Attikonak.

For about four miles below the place at which the portage-route reaches the Romaine River, there are numerous exposures of anorthosite. Opposite the mouth of the portage creek the rock is white and granular, and resembles coarse loaf-sugar. This fine-grained rock holds small masses of coarsely crystalline, violet anorthosite, and masses of brown hypersthene, often several inches in diameter. The hypersthene often exhibits a zig-zag crumpled structure. Ilmenite is also scattered through the white rock in grains and sometimes in irregular lumps several pounds in weight.

Anorthosite of two varieties.

At the head of the rapid, two miles below, the same white, granular anorthosite is seen, with an indistinct foliation N. 70° E. At the portage, a short distance lower down stream, the foliated, white anorthosite, holding many coarsely crystalline lumps of the darker variety, are associated with a light-gray gabbro-gneiss, made up of the granular anorthosite with considerable biotite, hornblende and ilmenite, that give to the rock its gneissic structure. In some places, ilmenite alone is present, and is arranged in thin bands of grains, separated by the plagioclase and thus forming a gneiss. All these rocks are cut by veins or dykes of red pegmatite that vary from a few inches to several feet in width. On the small islands, the masses of coarsely crystalline, violet anorthosite are very numerous, and some of the faces show the opalescent blue, green and bronze-yellow peculiar to labradorite. These masses appear to represent cores of the original rock in an unaltered state, whereas the white granular variety that encloses them, seems to have been formed by the same or a similar pressure to that which induced the gneissic structure in the foliated variety.

Gneissic area entered.

Below the portage, the character of the surrounding country changes; the sharp rounded hills characteristic of the anorthosite areas, give place to flatter and more undulating hills, probably formed of gneiss. No exposures of rock are seen along the river, below this place, nor along the drift-covered shores of the first and second Burnt Lakes, but the underlying rocks are probably hornblende-granite and gneiss. At the outlet of the second lake, coarse-grained, dark-green hornblende-schist is seen, penetrated by numerous small, red orthoclase veins. Strike S. 70° E. The next rock seen in place, is in the rapid at the outlet of the lowest Burnt Lake, and consists of a coarse-grained red hornblende-mica-gneiss.

Exposures below Burnt Lakes.

The river on leaving the Burnt Lakes enters a distinct valley with rocky walls. This valley is partly filled with drift, and the river-channel is cut into the drift, in consequence of which very few rock-exposures are seen along its banks.

Five miles above the junction of the upper western branch, there is a small exposure of coarse-grained, red hornblende-granite, very felspathic, and holding a little mica. Below this no rock is seen for sixteen miles, until the upper chute is reached. Here coarse-grained mica-hornblende-gneiss and hornblende-gneiss occur on both sides of the stream. The rock is mostly red and pink, with some finer broken bands of a dark colour, probably squeezed segregations of hornblende and mica. Strike E.

At the lower chute, the same coarse, pink and red hornblende-mica-gneiss is seen, often with an augen structure. Strike N. 80° E.

The next exposure is twenty-two miles farther down-stream, or four miles above where the portage-route to the St. John River turns off, and the interval is probably occupied by hornblende-mica-gneisses. Here medium to fine-grained, pink and gray hornblende-mica-gneiss is seen, with some of the bands holding small red garnets. Strike N. 70° E.

Portage-route between Romaine and St. John Rivers.

No rock is seen in place, until the first lake of the portage-route is reached, where a great area of anorthosite is entered, that extends far down the St. John River.

Anorthosite-gneiss.

On the first lake, the rock is a light-gray anorthosite-gneiss, made up of granular, crystalline, white plagioclase and mica, and closely resembling that described on the upper Romaine River. On the portage leading from the second lake, a light, violet-gray anorthosite * is seen, holding small quantities of mica, hypersthene and ilmenite. This rock is coarser than the last and does not appear to have been subject to as great pressure. At the lower end of the long portage leading to the first small branch flowing into the St. John River, white, granular anorthosite is seen, enclosing a large mass of light-pink, very quartzose hornblende-granite.

Cliffs of anorthosite.

As far as the next branch, some six miles, the stream is hemmed in between perpendicular walls of anorthosite that rise more than 300 feet. Most of the rock seen is of the light-coloured, granular variety, and at times becomes pink or light violet. It holds much hypersthene, often in large masses, some a foot across. In several places, pegmatite dykes were seen cutting the rock. The light-violet and pinkish anorthosite, with a medium-grained, granular structure, extends along the other branch of the stream past Cliff Lake, where it rises on both sides of the lake in imposing cliffs capped by bare rounded knobs.

---

* See No. 24, Appendix V.

The same rocks are met with, at frequent intervals, along the portage-route, until the second long portage lake is reached, which lies close to a contact between the anorthosite and mica-gneiss. On an island in the middle of the lake, the light-violet anorthosite is cut by large dykes of coarse, white pegmatite. At the outlet the same anorthosite incloses masses of fine-grained, red mica-gneiss, and is itself cut by small pegmatite dykes. The anorthosite has here a gneissic structure and holds a good deal of mica. Strike N. 55° E.

Mica-gneiss.

On the small stream flowing out of the lake, and a mile below the last exposure, medium-grained, red mica-gneiss is seen, and appears to be nearly horizontally bedded. On the first of the three small lakes passed through before reaching the St. John River, there is a coarse, greenish, basic rock, composed of dark plagioclase and mica, that appears to inclose broken bands of red mica-gneiss. On the third lake, dark-violet anorthosite is seen, somewhat foliated. Dip S. 60° W. < 45°-70°.

St. John River.

Rocks chiefly anorthosites.

The next exposure examined was on the St. John River, about a mile below the end of the portage-route. The rock here is a fine-grained, granular, white anorthosite, full of grains of ilmenite and hypersthene. It is somewhat foliated, and strikes S. 10° E. The next exposure is two miles below on the east side, where the rock is coarse-grained, dark-violet in colour and holds large masses of hypersthene. At the next bend, one mile and a half lower down on the west bank, there is a pink and gray, fine-grained mica-gneiss, cut by coarser, red granite dykes. Strike S. 10° E.

Hornblende-gneisses.

As far as the portage twenty-six miles below the last exposures, all the rocks examined were anorthosite, most of it of a light-violet colour, and including masses of the dark, coarsely crystalline variety. In a number of places it is cut by large dykes of red pegmatite. Below the portage the light-violet anorthosite outcrops in many places along the river, to within a short distance of the mouth of the Chambers Branch. Here on the east bank of the main stream, foliated, light-gray gabbro-gneiss is seen. Strike S. 15° E. About 200 yards farther down-stream, on the same side, dark-red, coarse-grained hornblende-granite-gneiss occurs. It is much shattered, and the small cracks are filled with green chlorite. It has all the appearance of an igneous rock and the foliation is probably due to pressure alone. Strike S. 25° E. Unfortunately the contact between these rocks and the anorthosite is concealed, and their relations are consequently unknown.

The coarse hornblende-gneisses outcrop in a number of places along the river, to within ten miles of its mouth, when they pass under the drift which forms the river-banks to its discharge into the Gulf of St. Lawrence.

Manicuagan River.

Gneissic rocks of lower river.

The first rock-exposure examined in ascending the Manicuagan River, was on the north side at the narrows, four miles above its mouth. Here, compact, fine-grained, greenish mica-gneiss is found in low folds, cut by irregular masses of medium-grained hornblende-gneiss, apparently remnants of old squeezed dykes. Red pegmatite veins cut both rocks. General dip N. 65° E. $<$ 10°-50°.

Similar rocks are exposed on the shores and islands to the foot of the first portage, where coarse-textured hornblende-mica-gneiss and hornblende-gneiss prevail, cut by large pegmatite veins. Strike N. 25° E.

At the upper end of the portage, a medium-grained, dark-red mica-gneiss occurs. Strike N. 10° E.; and on the second portage, similar gneiss was also noted, but here it is highly quartzose and passes in places into a quartzite. At the upper end of the portage and on the small islands a couple of miles above, similar rocks occur. Mica-gneisses, cut by much pegmatite, outcrop at intervals up to the third portage, where they are exceedingly quartzose and in places pass into a pure quartzite, which has been waterworn to a smooth porcelain-like surface. Large quartzose pegmatite dykes occur here and cut dark-greenish mica-hornblende-gneiss, and also enclose large angular fragments of the same rock.

Above the third portage, drift covers the rocks in the wide valley, and only a few small exposures are seen for ten miles, to the eastern bend. Red and gray mica-gneisses, often weathering rusty, and cut by a few red pegmatite veins, were seen. Dip N. 10° E. $<$ 60°.

Anorthosite above Toolnustook.

At the bend, the hills surrounding the valley become higher and much bolder in outline, concurrently with the change from the mica-gneisses to a dark greenish gabbro-gneiss and anorthosite. Gabbro-gneiss alone is seen along the river up to about five miles above the junction of the Toolnustook, where it gives place to unfoliated, purple anorthosite. The gabbro-gneiss is usually much weathered on the surface, and has a rusty, greenish colour; it is composed chiefly of plagioclase and mica, with some green hornblende in places.

The unfoliated anorthosite resembles that found along the Romaine and St. John rivers. It is generally of a dark-violet colour, with large crystal-faces, sometimes enclosed in a granular matrix, where the rock has been subjected to crushing. In many places, especially along the gorge at the fourth portage, decomposition has produced in these rocks large irregular masses of saussurite and in other places a gneissic structure is seen where mica and ilmenite are found in thin bands. At the head of the gorge the rocks are well exposed, and are mostly massive anorthosite, with detached patches showing gneissic structure. In places the rock is decomposed to green saussurite. This mineral occurs in irregular masses of varying size, which when large have the inner portion fine-grained, compact, and weathering reddish, while the outer is composed of about half an inch of a dark-green, fibrous, scaly mineral. Several dykes of compact, red pegmatite cut the anorthosite here.

Exposures above Chesniup Portage.

Above the fourth or Chesniup portage, outcrops of anorthosite are frequent in the river-valley for thirteen miles, up to where it again straightens and widens out. The last exposure is of dark-greenish, gabbro-gneiss containing little mica, interbanded with a light-gray, medium-textured, basic gneiss, holding much mica and small garnets, evidently representing rocks near the contact of the anorthosite with the acidic gneisses. Strike N. 50° E.

The country above this place again assumes the character of that underlain by mica-gneisses, and, although no rock-exposures are seen for several miles, from the change in the physical features, it has been assumed that the edge of the anorthosite is close to the last exposure noted.

Up to near the head of the next straight stretch of the river, twenty miles above, no rock is seen in place in the valley. Along the next twenty-four miles, to the portage, several exposures of red and gray, medium-textured, fine-banded mica-gneiss, occur in a few places, interfoliated with medium-grained, red mica-hornblende-augen-gneiss. General strike N. 40° E.

Kikaskuatagan Portage.

Between the fifth and the sixth or Kikaskuatagan Portage, medium to coarse-grained, pink and gray augen-gneiss, often garnetiferous, is seen. Dip N. 50° E. $<$ 20°-70°.

From the last-named portage to the Long Portage, there are frequent exposures of rock in the valley; coarse, augen-gneiss predominates, and is associated with a few bands of fine-grained mica-gneiss. The augen-gneiss is largely composed of orthoclase, with mica, quartz and at times hornblende. Near the lower end of the Long Portage the strike is N. 25° E. Above the portage, similar coarse augen-gneiss is met with for three miles; it is generally micaceous, but at times carries mica and hornblende.

Long Portage.

At and below the next short portage, the coarse augen-gneiss gives place to dark greenish, schistose mica-gneiss, holding small, dark-red garnets and interbanded with a bed of green serpentine-limestone, three feet thick, holding scales of graphite. Immediately above the portage, similar dark mica-gneiss is associated with thin bands of mica-hornblende- and hornblende-schists, some of the bands being highly charged with small garnets. Dip S. 60° E. < 45°. At the next short rapid three miles farther up, schistose mica-gneiss is seen, cut by coarse pegmatite, made up chiefly of purplish-pink orthoclase, with dark-green hornblende, biotite and quartz. Dip S. 70° E. < 60°.

Lake Ichimanicuagan.

The perpendicular walls of the deep valley of the river flowing into Lake Ichimanicuagan, afford fine exposures of the rocks, which are seen dipping regularly towards the S. E. < 45°. Several slip faults almost parallel to the dip are seen, as well as others at right-angles to the dip. The rocks are chiefly red mica-gneiss, together with coarse augen-gneiss, which often encloses large lenticular masses of dark schist. Below the first portage on this part of the river, several exposures show dark greenish-gray mica-hornblende-gneiss with thin bands of a red variety. Both are composed largely of a gray orthoclase, mica and decomposed, green hornblende. At the portage, there are bands of red and yellowish, medium-grained mica-hornblende-gneiss, holding some magnetite in small grains, and weathering rusty. Dip S. 75° E. < 20°-45°.

Rocks of Lake Mouchalagan.

Garnetiferous gneisses.

The next exposure examined is on the west side of Lake Mouchalagan, about two miles north of its outlet. Here the rocks are fine-banded red and gray, garnetiferous mica-hornblende-gneiss, on edge. Strike N. 20° E. These rocks outcrop at several small points on this side of the lake at intervals for the next twelve miles, when coarse-textured, red and gray, garnetiferous mica-gneiss is seen. Strike N. 10° E. On the opposite shore, ten miles above the last exposure, the high rugged hills of the locality approach the shore, and form low cliffs where the lake bends to the east of north. Here a foliated rock is composed wholly of dark green scaly crystals of hornblende and dark red garnets, forming a garnet-diorite. The garnets vary in size from that of small shot to crystals more than an inch in diameter. Interfoliated with this diorite are wide bands of fine-grained, light-gray and pink mica-hornblende-gneiss, also highly garnetiferous. Dip S. 70° E. < 40°. These garnet-diorite rocks are largely developed in the hill behind, where they are easily recognized by their weathering in irregular masses of a rusty colour. They appear to be associated with bands of crystalline limestone.

Crystalline limestones.

At the next point, half a mile farther up the lake, ordinary garnetiferous mica-hornblende-gneiss is seen, and the same rock outcrops two miles beyond at the Partridge-tail Hill on the west side of the lake. The rocks of the first small point beyond, are yellow and reddish-weathering, rotten crystalline limestone and garnet-diorite. The limestone contains many garnets, together with scales of graphite and small quantities of light-green hornblende and mica. The garnet rock is fine-grained and compact; it is composed chiefly of fine-textured hornblende, small garnets and gray plagioclase, and is charged with pyrites. This rock intrudes into and distorts the bands of limestone and garnetiferous mica-gneiss.

Mouth of Mouchalagan River.

At the mouth of the Mouchalagan River, there is a small bluff of light- and dark-gray hornblende-mica-gneiss, holding small scattered garnets and composed chiefly of medium- to coarse-grained hornblende and gray orthoclase, with little mica and quartz. Dip N. 30° E. $< 70°$. Similar exposures occur along the east bank of the river for two miles above, and in places they are cut by small dykes of red pegmatite.

The next exposure of rock is on the west bank, at the foot of the islands above the junction of the Kawikuanapisis River. Here, and at intervals for two miles above, the rocks are chiefly medium-grained gray and pink mica-hornblende-gneiss, the coarse bands sometimes having porphyritic crystals of orthoclase. Associated with these rocks are bands of finer grained pink and light-gray gneiss, holding much mica and quartz and little hornblende or garnet. Dip N. 15° E. $< 45°$.

Gneisses and crystalline limestone.

For three miles above the islands, up to the small tributary, where the portage past the gorge leaves the river, there is an almost continuous wall of rock on both sides of the valley. On the east side, at the lower end of the cliff, dark and light-gray, well-banded mica-gneiss holding rounded fragments of hornblende-schist, is overlain by ten feet of pyritiferous, schistose mica-gneiss, very much decomposed and holding graphite and garnet. This in turn is overlain by one hundred feet of crystalline limestone interrupted by thin bands of mica-schist. Up along the stream, the lower bands dip below the water, leaving only the limestones and mica-schist exposed in the cliffs. The west bank of the river is nearly all limestone, and if the stream does not run on the line of a fault, there is a great thickness of limestone (more than 1000 feet) developed here. The limestone, in its different bands, varies in colour and purity: the white bands are coarsely crystalline and very pure; the impure bands have a yellowish tinge, due to the presence of small scales of light-brown mica. Small veins of white radiating crystalline tremolite are common, as are also little cavities lined with short light-green crystals of that mineral.

Rocks of the gorge.

Immediately above the portage, the gorge is cut out of dark- and light-gray hornblende-granite, with a few pink bands associated with or overlain by dark- and light-gray fine to medium-grained garnetiferous mica-gneisses. Strike N. 80° E.

Line of fault.

At and below the first chute, on the west side, well-banded light-gray highly felspathic mica-gneisses are interbanded with thin layers of garnet-diorite, composed wholly of garnets and dark-green hornblende. These rocks are overlain by bands of limestone twenty and ten feet thick, separated by forty feet of mica-garnet-gneiss. The chute passes over a line of fault, for on the east side of the river where the limestone is well developed, the beds, though greatly crumpled, are nearly flat, above the chute, while below it the limestone and gneiss are on edge. Strike, N. 50° E.

Massive limestones.

At the second chute and above it up to the head of the gorge, the limestones are abundantly developed in bands varying from ten to 200 feet in thickness, but, as they are greatly contorted and faulted, no exact estimate of the total thickness of the beds can be given although they must approximate to 1000 feet if they do not even exceed this thickness. Rotten, rusty-weathered mica-schist always accompanies the limestone bands, usually very pyritiferous, and often carrying much graphite and garnet, while some of the bands contain considerable percentages of magnetite and hæmatite in small grains, with quartz. Veins of white tremolite are common in the limestone ; some of them a foot in thickness, with beautiful radiating needles of that mineral ; other veins of the same radiating mineral are brownish in colour, from iron.

The rocks immediately above the gorge are fine to medium-grained, light to dark-gray mica-hornblende-gneiss, inclosing broken bands and lenticular masses of dark hornblende-garnet-gneiss. Strike S. 75° E. The next exposure occurs on the west bank three miles farther up-stream, where medium to coarse-grained, light-gray, highly hornblendic garnet-gneiss is seen. Strike N. 35° W. Two or three small outcrops of the same rock were seen along shore up to the place at which the portage-route leaves the west shore for Lake Attikopi.

From the portage to the mouth of the Pepechekau River, the rocks are well exposed on both sides of the stream, being almost continuous along the river up to the commencement of the long gorge. They are mostly medium, gray mica-gneiss, together with bands of coarser hornblende-mica-gneiss, often very garnetiferous. Owing to the heavy rapids in the gorge, and the difficulty of landing and examining the nearly perpendicular walls of rock, only a general description of the exposures along this portion of the river can be given. In the gorge above the mouth of the Pepechekau, the rock-exposures on both banks become almost continuous. The structure and association of the various rocks are very complicated, and it would require much work to establish their relations to one another. It would appear that the mica-gneiss and mica-schist, which are most abundant, closely resemble similar rocks on the East Main River, where they in part have been referred to metamorphic clastic rocks of the Huronian. Along the upper part of the gorge, these rocks are found to be cut by various dark-green schists of chlorite and altered hornblende, which correspond closely to the supposed volcanic and ash rocks of the Huronian. All the above rocks in turn are apparently displaced by great masses of generally coarse-textured, pink and gray hornblende-granite, frequently more or less garnetiferous, the mica-gneisses being also often garnetiferous. Great dyke masses, altered to serpentine, are also met with, and in places show stages of alteration, from a coarse diabase. Many of the exposures of chlorite and altered hornblende-schists weather rusty from the decomposition of pyrites, with which they are usually highly charged. They are often cut by quartz-veins, carrying pyrites and crystals of black tourmaline, hornblende and garnets. Towards the head of the gorge, the altered hornblende and chlorite rocks die out, leaving only the schistose mica-gneiss and a few bands of mica-hornblende-schist, both cut by very coarse, highly felspathic hornblende-granite, at times garnetiferous. A short distance above the junction of the Attikopi River, the main stream flows through a large area of hornblende-granite rocks, similar to those found about Nichicun, and probably a south-eastern extension of that great area.

Complicated association of rocks above Pepechekau.

Hornblende granite.

From here to Itomamis Lake, the numerous exposures met with along the stream are all composed of varieties of hornblende-granite that vary in colour from white through pink to red, and in texture from medium-grained to very coarse-grained. Hornblende is always present, and mica in varying quantities nearly always. Orthoclase is the predominant mineral, and quartz is always freely distributed through the mass. These rocks usually show foliation, the strike of which is nearly constant and varies from N. 60° E. to N. 80° E. Segregations of dark-green hornblende-schist are of common occurrence, usually in the form of lenticular masses, at times in strings, so that they appear to have been formed by the stretching and breaking of bands of this rock while inclosed in the granite.

Attikopi River to Itomamis Lake.

Itomamis Lake appears to be situated near the junction of the hornblende-granite mass with a dark-gray garnetiferous mica-gneiss, which

Itomamis Lake.

is seen at the outlet of the lake, and also along the stream leading to Summit Lake. In other places about the shores of the lake only coarse hornblende-granite occurs, often with an augen-gneiss structure. About Summit Lake the rocks are all of the garnetiferous variety. They are usually very quartzose, and often weather rusty. Mica predominates over hornblende, the latter being often absent. Dip N. < 30°-60°.

Portage-route of the Mouchalagan River.

The portage-route to the head-waters of the Mouchalagan leaves the river itself, about twenty-five miles above Lake Mouchalagan, and, passing westward, rapidly rises to the level of the irregular interior plateau. Rock-exposures along the route, though not uncommon, are not nearly as numerous as in the deep river-valley along its rocky walls.

On the summit of the first portage leading from the river, there is a small exposure of dark, rusty-weathering, garnetiferous mica-hornblende-gneiss. Strike N. 10° W. From here to the watershed between the Outardes and Mouchalagan streams no rock is seen in place, but the great number of scattered blocks and boulders show the underlying rock to be chiefly gray mica- and mica-hornblende-gneiss, with some pink hornblende-granite often very coarse in texture.

Little Matonipi Lake.

The next rock seen, was at the entrance to the first small lake above Little Matonipi Lake, where coarse gray and pink mica-gneisses outcrop. Dip S. 50° E. <20°. On a small island in the same lake, similar gneisses occur in nearly flat beds, cut by much coarse pegmatite. At the end of the portage, on the small stream leading to Little Matonipi Lake, there is a low, sharp ridge of coarse pink, and fine-grained gray, highly quartzose mica-gneiss, cut by pink pegmatite. Dip S. 50° W. 4 < 0°.

Great body of iron ore.

On the shores and the small island adjoining the outlet of the lake, there is a remarkable development of bedded iron ore. The sections exposed give a thickness of over two hundred feet of ore, which varies from a pure mixture of magnetite and hæmatite, to a highly quartzose, ferruginous gneiss. The exceedingly quartzose nature of the gneiss and the quality of the ore, have a certain resemblance to the occurrence of the bedded ores of the Cambrian formation, described under that heading; this would lead to a belief that these ores of the Laurentian may have had a similar origin, and are products of a similar character, more completely altered in conformity with the greater metamorphism of the containing rocks.

The next outcrop of rock noted, was found on the long portage leading northward from Lake Matonipi, where two small exposures of the ore rise above the drift at the summit of the hill. The ore here resembles an ordinary medium-grained highly quartzose gneiss, holding a small amount of garnet and orthoclase, and with magnetite taking the place of mica or hornblende. The direction of the strike here (S. 60° E.) coincides with a line drawn through the last mentioned outcrops, and consequently both probably belong to the same band. The small shining crystal-faces of the ore give to the rock a most brilliant effect in sunlight, so that it sparkles as if studded with diamonds. There is mentioned in the *Relations des Jésuites*, a "burning mountain" situated in Labrador near the head-waters of the Manicuagan River, and information obtained from our guide is to the effect that a shining mountain lies about twenty miles to the westward of the portage and directly on the course of the strike of the iron gneiss. There, a similar sparkling effect is produced by the sunlight, and the "burning mountain" of the missionaries is in all probability a large development of the iron ore in a cliff face. There is no ground whatever for the belief in the existence of an active volcano in this region, based by some writers upon the statements of the *Relations des Jésuites.*

The reported "burning mountain."

Along the course of the portage up the gulley to the watershed between the Outardes and Manicuagan rivers, numerous exposures are seen of light-gray medium-grained, highly felspathic mica-gneiss with many bands of dark mica-schist. General strike N. 40° E.

Rocks near watershed between Manicuagan and Outardes.

Beyond the first stream tributary to the Manicuagan met with on the portage, drift conceals nearly all the rocks of the neighbouring rounded hills for about twelve miles, but, from the loose angular blocks, similar gray mica-gneisses probably prevail to within a short distance of Lake Kichewapistoakan, where hornblende-granite is found in connection with the mica-gneisses, probably forming the south-eastern limit of the great area of such rocks centering about Nichicun.

The high range of mountains on the north side of the south-west branch of the Attikopi River, is probably also formed of this hornblende-granite as outcrops of it occur along that stream on the way to Lake Attikopi. At the first portage in descending, there is dark mica-hornblende-schist, cut by coarse, pink hornblende-gneiss. Strike N. 60° E. Similar coarse hornblende-granite, at times unfoliated, is seen frequently along the shores of Lake Attikopi and down its discharge to its junction with the main stream. On the north-east branch of the Attikopi River, from the larger lake to Attikopis Lake, the mica-gneisses are most prevalent along the lower portion with the granites predominating as the upper lake is approached. A large

Lake Attikopi

dyke of coarse, dark-green diabase was noted above the second portage. It is greatly decomposed and largely changed to serpentine.

Lake Naokokan.

Very few exposures were seen along the route leading from Attikopis Lake to Nichicun, until Lake Naokokan was reached, where hornblende-granite is freely exposed on the shores and islands. About two miles above the last-mentioned lake, outcrops of schistose, garnetiferous mica-gneiss occur at the rapids, where they strike N. 80° E. In the valley above, the scattered blocks and boulders are about equally composed of coarse, red hornblende-granite and gray, garnet-gneiss.

Along the route leading north-east from Attikopis Lake to Summit Lake, different varieties of hornblende-granite alone were met with.

Huronian.

General Remarks.

Character of the rocks.

The rocks included under this system belong both to the sedimentary and to the eruptive classes. The sedimentary rocks are represented by beds of arkose, conglomerate, limestone, shale and slate, sandstone, chert, quartzite, and mica-schist. The eruptive rocks, which were in part, at least, contemporaneous in formation with the sedimentary series, are chiefly basic in composition, and at present are chiefly represented by schists, characterized by chlorite, epidote, altered hornblende, hornblende, sericite and hydromica. There are also massive diabases and diorites; all the rocks are more or less decomposed. The acidic rocks, associated with the above, are mica-granites, mica-hornblende-granites, and hornblende-granites, and perhaps quartz-porphyry. The rocks of the various areas found in Labrador bear a more or less close resemblance to the rocks of other Huronian areas in Canada described by Logan, Bell, Lawson and Barlow in former reports of the Geological Survey.

Two main areas.

Two large areas of Huronian rocks, besides a number of smaller ones, have so far been met with in the Labrador Peninsula. The large areas appear to be confined to the western half of the peninsula, with only a few minor ones in the other half. The largest area is found along the East Main River, where it extends from a few miles above the mouth of the river inland for more than one hundred and sixty miles. In this distance the river generally flows closely parallel to the strike of the rocks. In three places granite-gneiss areas are met with along the stream, where they replace the Huronian rocks. It is impossible to state whether the areas separated by these granite-gneisses are all connected, or form separate wide bands. If, as is probable, they are connected, they constitute a very wide belt, known to be more than twenty miles across the strike where the river cuts it diagonally.

Clastic rocks on East Main River.

The clastic rocks are represented by a mica-schist, which always contains grains of white felspar and at times of quartz. In a number of places these schists change to a conglomerate from the inclusion of rounded pebbles of granite and syenite. The conglomerates are local, and are found in long lenticular masses thinning out at the ends along the strike. At Conglomerate Gorge, several of the lenticular masses of conglomerate are found overlapping each other and separated by bands of the mica-schist. The total thickness of the conglomerate here, including the separating bands of schist, exceeds 400 feet. In other places the conglomerates are not so well developed, and are rarely 100 feet through in the thickest beds. The mica-schists have not been microscopically examined, but macroscopically they are seen to be generally quite distinct from the more highly crystalline Laurentian mica-gneisses, although at times they seem to shade into them. The conglomerates are usually fine, but sometimes hold fragments several tons in weight. All the fragments are well rounded, and in many places they appear to have been flattened and drawn out in the direction of the foliation. By far the greater number of the boulders are composed of fine-textured granite and syenite, with dark basic eruptives less abundantly represented.

In conjunction with a great mass of basic eruptives, a small area of agglomerate was found on the upper part of the river, with the contained fragments composed chiefly of quartzite, jasper, and diorite, altogether different from the conglomerates described above. The matrix is a dark greenish-gray chloritic schist, and is probably derived from altered volcanic ash.

Eruptive rocks.

The eruptives of this area appear to be confined to certain places, where they cut the mica-schists or are interbanded with them. The chlorite-schists, hydromica-schists and some of the hornblende-schists are often interbanded with the mica-schist, and seem to have been formed as ash beds along with them. As has been already stated, bands of these supposed altered ash-rocks were found in association with the garnet mica-gneisses and close to the crystalline limestones of the Laurentian along the Mouchalagan River, and other hornblende-schists are clearly altered dykes, that cut the beds of mica-schist, and probably proceeded from the masses of diabase and diorite that represent the cores of the volcanic eruptions.

The granites are evidently of later age, for they cut all members of the Huronian. The nature of the contact and other details are described further on in the report.

Area south-west of Mistassini.

The other important area of Huronian rocks occupies the basins of the large lakes south-west of Lake Mistassini. To the north-east it runs under the Cambrian limestones, while its south-western limit is unknown, but probably extends for a considerable distance, possibly connecting with the great area of similar rocks known to run eastward beyond the head-waters of the Ottawa River.

Clastic rocks.

In this area the clastic rocks are much better represented than along the East Main River. There is a great thickness of arkose material and agglomerates, with a matrix of chlorite-schist, that is likely an altered volcanic material. The agglomerates are associated with bands of red felsitic schists, formed from the finer detritus of the coarse-textured granitic material that affords the boulders of the agglomerate. The other bedded rocks are quartzite and limestone, the latter being only in thin cherty bands.

Eruptives.

The eruptives are massive diabases and diorites, generally highly altered and chloritic, and in one place changed to serpentine. The volcanic rocks, besides the agglomerates, form thick beds of chloritic and epidotic schists.

A mass of later granite is intruded into the western part of this area, and occupies the greater part of the basin of Lake Obatagoman and the south-western part of Lake Chibougamoo. This area was first examined by Mr. Jas. Richardson in 1870, and only a few changes have been made in his delineation of it.*

Smaller Huronian areas.

Smaller areas of Huronian schists occur on the upper East Main River, in the vicinity of the Sharp Rock Portage and along the small lakes leading from that stream to the head-waters of the Big River.

Hydromica- and hornblende-schists occur along the Koksoak River, for some distance below the last outcrop of Cambrian rock, where they are associated with pegmatites. These rocks may be Huronian. On the upper waters of the Ashuanipi Branch of the Hamilton River, there is a large area, in part or wholly underlain by Huronian schists, but as the outcrops are very few, little is known of the extent and kind of rocks occurring here. A small area of similar rock is met with on the Attikonak Branch at Gabbro Lake, and the strike is such as to lead to the belief that this is an extension of the area just mentioned. Below Birch Lake and at the head of the south-east bay of Michikamau Lake, there is a narrow band of talc-schists, hydromica-schists and chlorite-schists, which may be Huronian.

*Report of Progress, Geol. Surv. Can., 1870-71, pp. 292-294.

Along the east coast of Hudson Bay, areas of Huronian rocks have been described by Dr. R. Bell,* as occurring at Cape Hope and Paint Hills, between the East Main and Big rivers. The rocks are hornblendic, chloritic and epidotic schists, together with mica-schist conglomerates like those found on the East Main River. Farther northward, at Richmond Gulf, there are some thin-bedded quartzites, that underlie unconformably the Cambrian rocks of that region, and are supposed by Dr. Bell to be possibly of Huronian age. On the Great Whale River, a small area of Huronian schists was met with by the writer.† East coast of Hudson Bay.

The large quantity of drift, of undoubted Huronian origin, found about Lake Mistassini, leads to the belief that an area of these rocks will be found to the north-east of that lake. Dark-green schists are reported as occurring in the mountains about the heads of the Outardes and Manicuagan rivers. Area north-east of Mistassini.

Along the Atlantic coast, Dr. Bell‡ reports Huronian rocks about the mouth of Nachvak Bay, and about the Moravian Mission station Ramah, in the next bay south of Nachvak. Atlantic coast.

No other areas of these rocks are known in the Labrador Peninsula, but there is yet every probability that other bands will be found when the country is more fully explored. The occurrence of gold, copper, nickel and pyrites in rocks of this age in other parts of Canada, render the tracing of these areas of great importance. Economic importance.

Lower East Main River.

Twelve miles above the mouth of the East Main River, the Laurentian gneisses and hornblende-granites found on the islands about the mouth of the river, give place to a dark-gray, fine-grained mica-gneiss, often schistose. The mica is arranged in thin layers of small plates, separated from one another by very fine grains of white orthoclase and quartz. This rock closely resembles the rocks met with farther up-stream, where they form a conglomerate holding large boulders of granite and other Laurentian rocks. The mica-schists and fine mica-gneisses often have a porphyritic appearance on weathered surfaces, from the inclusion of large grains of felspar and quartz that are evidently only the coarser particles of the detrital material from which the beds were originally formed. Subsequent folding and pressure have probably changed these sedimentary rocks Schistose mica-gneiss.

*Report of Progress, Geol. Surv. Can., 1877-78, pp. 10 C., 11 C., 15 C.

†Annual Report, Geol. Surv. Can., vol. III. (N.S.), p. 54 J.

‡Report of Progress, Geol. Surv. Can., 1882-84, p. 15 DD.

into their present condition. From their field relations to the Laurentian rocks and also to the irruptive members of the Huronian, there is little doubt that these rocks are the representatives of the sedimentary series of the Huronian, and in places they closely resemble the rocks described by Lawson in the region about Rainy Lake, referred by him there to the Couchiching series, which he supposed to be unconformably below his Keewatin series.* In our hurried examination along the East Main River, no such unconformity was observed. These mica-schists and gneisses, in places contain hornblende along with the mica, and thus grade into a hornblende-schist which is quite distinct from the hornblende-schists produced from eruptive rocks, in that the hornblende is in thin laminæ, separated by the fine-grained white felspar and quartz similar to that in the mica-schists. At the first place where they are seen, they form low outcrops along the north shore of the river for a mile. Some of the bands are somewhat hornblendic. Strike N. 75° E.

Resemblance to Couchiching series.

At the head-of-tide, similar mica-schists are seen, cut by large irregular dykes of white pegmatite. Strike E.

Rocks of Basil Gorge.

Along Basil Gorge, six miles above tide-water, these rocks are again found, associated with large masses of hornblende and chlorite-schists. At the foot of the gorge, the bedded schists are cut by an irregular vein of light-pink, finely crystalline limestone, holding much green hornblende and some sericite. The vein varies in width from eight inches to eight feet and cuts diagonally across the bedding, with an obscure gneissic structure developed in it parallel to the bedding of the surrounding schists, which dip S. 75° E. < 80°. As the gorge is ascended, the mica-schists are found to be cut by large masses of fine-grained, dark-green, altered hornblende-schists and chlorite-schists. Owing to the perpendicular walls of the gorge no detailed examination could be made of the relations of these rocks, but they appear to be similar to those found farther up the stream, and described later on.

Talking Falls.

From the head of Basil Gorge to near the Talking Falls, nine miles above, there is only one small outcrop of mica-schist, on the point between the forks of the river, two miles above the gorge. Everywhere else the river has high steep banks of clay that overlie and conceal the rock beneath. At and below the Talking Falls, a medium-grained gray mica-hornblende-granite is seen, with obscure foliation but with every appearance of being an irruptive rock. The mica is much more abundant than the hornblende, and the whole is likely a post-Huronian intrusion, from which great dykes of white pegmatite

* Annual Report, Geol. Surv. Can., vol. III. (N.S.), pp. 1-196 F.

run off and cut the mica-schists, as seen farther up-stream. At the sharp bend a mile above the falls, and for a mile from there to the foot of a long rapid, very coarse-grained, light-gray mica-hornblende-granite is met with on the islands and shores. From the foot of the rapid to its head, for nearly two miles, the northern shore is formed of rock. Along the lower portion of this stretch the dark mica-schists are seen to be cut by great dykes of white pegmatite. This pegmatite is exceedingly coarse, and, embedded in the white orthoclase, are large masses of that mineral having a light-bluish colour. There are also large plates of light-green muscovite scattered through the mass, but they are generally too much crushed and broken to be of value. Quartz in large masses is also present, along with large crystals of black tourmaline. Near the dykes the mica-schists are in many places much disturbed and twisted. As the stream is ascended, the dykes, which run generally parallel to the bedding, become smaller and fewer.

Conglomerates.

About half-way up the rapid, a large pegmatite dyke cuts off great angular masses of the mica-schist, which here dips N. 65° W. $<$ 60°. Near the contact the schist appears to be more siliceous and approaches an impure quartzite. Half a mile from the head of the rapid, the schist is found to include several beds of fine conglomerate from nine to fifteen inches thick. The pebbles are all derived from medium to fine-grained red and gray granite. At the head of the rapid the rock is a rusty mica-schist, charged with partly decomposed pyrites and cut by thin dykes of fine-grained hornblende-schist that run almost parallel to the bedding of the mica-schists.

Island Fall.

At the Island Fall, two miles farther up the stream, the mica-schists again outcrop, striking N. 85° E. For six miles above, the banks of the river are cut out of stratified clays and sands, and no rock is seen in place up to the foot of the rapids that extend for three miles below Clouston Gorge. Along both shores, up to the foot of the gorge, mica-schists are seen at frequent intervals rising from beneath the stratified drift. There is a continuous exposure of rock from the head of this gorge to the rapids below it. The mica-schists are now associated with irruptives in the form of large masses of medium to fine-textured diorite of a dark-green colour. In some of the coarser grained rock there is a beautiful secondary arrangement of hornblende in small radiating masses of crystals. These diorites seem to be intimately connected with bands of dark-green altered hornblende-schists and chlorite-schists, which appear to have originally formed dykes cutting the bedded rocks now represented by the mica-schists, their present schistose structure being due to subsequent pressure. This would also account for the breaking and apparent inclusion of

Clouston gorge.

Altered dykes.

fragments of these chloritic-schists in the mica-gneisses. The large masses of diorite cut the mica-schists and gneisses. The latter rocks, near the contacts with the diorites, are apparently more highly altered than elsewhere, as they then occur either as true mica-schists or as crystalline, fine-grained mica-gneiss. The strike is also disturbed, and all the phenomena of the contact point to an intrusion of the diorites and their associated dykes into the bedded series, previous to the final folding of the latter.

Great diabase yke

Above Clouston Gorge, the banks of the river again become low, and are formed of stratified drift up to within a short distance of the next rocky defile, called Conglomerate Gorge, twenty-two miles farther up-stream. The only rock seen between these places is a low boss on the south shore, eight miles above the lower gorge. This low hill is formed of medium-grained, dark-green diabase, and is probably part of a great dyke similar to others of a like nature that are found everywhere throughout Labrador, where they cut the rocks of all the formations, including the Cambrian. This mass is over one hundred yards wide, but as its borders are not seen, its total width is unknown. About a mile below the mouth of Conglomerate Gorge, there is a small exposure of medium-grained mica-hornblende-gneiss, that has the aspect of a Laurentian rock, but the exposure is so small that it is hardly possible to say what the age of this rock may be.

Conglomerate Gorge.

Conglomerate Gorge is three miles long, and the channel and shores are rocky throughout, but as the strike is almost parallel to the direction of the gorge, no great thickness of strata is exposed. At the lower end of the gorge, mica-schist is seen interbanded with green chlorite-schists, which appear to be either old dykes or altered pyroclastic beds. Both series are cut by a dyke of medium-grained, dark-green diabase, holding a considerable amount of pyrites in small grains. The dyke is about one hundred feet wide and its direction is N. 10° W. The schists on the east side of the dyke strike N. 50° E., while those on the west side strike N. 30° E., showing a disturbance due to the intrusion. The wall-rock is also considerably altered near the dyke. For half a mile between the dyke and the lower fall, the mica-schists are highly charged with pyrites, and are separated from the green chlorite-schists by fifty feet of light yellow slate.

Mica-schists and conglomerates.

Between the chutes, the rock is all mica-schist holding small lenticular masses of a coarse conglomerate. A small dyke of fine-textured, dark-green diabase, nine inches wide, was observed here, being probably a branch from the main dyke already noted.

From the upper chute to the head of the gorge, a distance of more than a mile and a half, only mica-schist and conglomerate are seen. The conglomerate occurs, as before, in heavy lenticular beds, and the total thickness of these must be at least 400 feet. The fragments in the conglomerate range from large pebbles to boulders two feet in diameter. Fully nine-tenths of them consist of a medium-grained, pink granite that closely resembles the rock of a granite area passed through farther up the river. The remainder of the pebbles are made up of a fine-grained, rusty-weathering diorite, light-bluish quartzite, and medium-grained gray mica-hornblende-gneiss, the last being very rare. Above Conglomerate Gorge, the river makes a sharp reversed curve in the next three miles, and the several small rock exposures along it are of mica-schist, with an occasional bed of conglomerate. At the upper end of the bend, there is a small chute where the last conglomerate bands are seen. The matrix is mica-schist and is at times charged with pyrites, and some bands of the schist hold small, dark-red garnets. Last conglomerate.

Mica-schist outcrops frequently along both shores of the river for the next twenty-five miles, up to the mouth of the Wabamisk River, but, as the strike of the rocks is roughly parallel to the direction of the river, only a comparatively small cross-section is displayed. Five miles above the last conglomerate mentioned, a dyke of dark-green diabase of medium texture and holding masses of light-green huronite and a large amount of pyrites, crosses the bedding of the schists. This dyke is seventy-five feet wide, and its direction is N. 75° W., or nearly parallel to the other large dyke seen at Conglomerate Gorge. Several small dykes of the same kind occur a short distance farther down-stream, and differ from the larger only in that their texture is finer. Mica-schists. Huronite.

At the mouth of the Wabamisk River, the bedded series of mica-schists is replaced by hornblende-schists chlorite-schists and altered diorites. On the north bank half a mile above this branch, the chlorite-schists are highly charged with pyrites, which for 100 feet along the strike is found in an almost pure bed ten feet thick. The surface of this ore is much oxidized and changed to brown limonite. On analysis only traces of gold were found in the pyrites. Wabamisk River. Bed of pyrites.

Frequent exposures of green chlorite- and sericite-schists, are met with on the small islands and shores for the next two miles up the stream, where there is a contact between the altered hornblende-schists and a fine-grained, schistose mica-gneiss. The hornblende-schist cuts it sharply, and is itself somewhat altered for several inches from the contact. The hornblende-schist encloses fragments of the gneiss that at times have their foliation transverse to that of the schists. Here also is seen a soft, green steatite rock, holding fragments of boulders of dark green, altered hornblende-gneiss also cut by the green hornblende-schists.

Aquatako River.

At the mouth of the Aquatako River, green chlorite-schists are again seen, charged with pyrites and cut by a vein of calcite nine inches wide. For the next ten miles up-stream, frequent exposures of dark-green altered hornblendic and chloritic schists occur on the shores and islands, the squeezed products of altered diabase, diorite and quartz-porphyry.* Along the upper three miles of this stretch, the exposures of schist are mixed with others of fine- to medium-grained, white mica-hornblende-gneiss. Where the contact between these rocks is seen, the green schists cut the gneisses, and often inclose masses of them, showing that the schists have been eruptive rocks in the gneisses. These gneisses † bear a close resemblance to the majority of the boulders found in the conglomerates already described, and may represent the source from which they have been derived. They now occur along the river-banks for twenty miles, with a total absence of the hornblende-schists, until the lower end of the Great Bend is passed, when the schists and associated diorite rock are again met with. The total width of the band here, including the inclosed bands and masses of gneiss, is slightly less than one mile across the strike, which runs N. 70° E.

Probable source of boulders in conglomerates.

Altered dykes.

Below the whirlpool, the bands of fine-grained hornblende-schist are thin, and the hornblende-granite predominates. At the whirlpool there is a thick band of dark-green, fine-grained, uralitic gabbro,‡ which abuts against a light-pink mica-hornblende gneiss of medium-texture and this latter is interbanded with green hornblende-schists. A close examination proves that the latter are altered dykes, probably connected with the gabbro masses in the vicinity. These dykes, as a rule, run parallel to the foliation of the gneiss, but are found in places to cross it, and also to branch, and again unite, thus inclosing large masses of the gneiss. The foliation of the dykes is constant in direction with that of the gneiss, and when the dyke is not parallel with the gneiss, the foliation is found to be transverse to that of the dyke.

Near the contact the mica-hornblende-gneiss has a hardened appearance, its texture is finer, and numerous small cracks are filled with light green chlorite. The geology here is further complicated by the presence of a number of small dykes of dark-green, fine-textured diabase, which cut all the other rocks. These small dykes show the faulted condition of the rocks they pass through, as at every few feet

* See Nos. 5, 25, 30, Appendix V.

† See No. 21, Appendix V.

‡ See No. 2, Appendix V.

along their course they are broken, with a throw of six to twelve inches at each fault.

Above the whirlpool, for a mile along the south shore, the rocks seen are all thin-banded, fine-grained, light-gray mica-schists and dark-green hornblende-schists. Strike N. 85° E.

The Laurentian gneisses again come in above, and the Huronian rocks are not met with along the river for twenty-one miles, up to a point two miles below the mouth of the Broken Paddle River, where the Huronian irruptives are again found cutting the Laurentian gneisses. Border of the Huronian.

This area of Huronian extends along the river for twelve miles, but as the strike is nearly parallel to the course of the stream, the breadth of the band (if the strike can be taken to represent anything but foliation induced by pressure) is not greater than three miles. The rocks here are all, or nearly all, of volcanic and igneous origin; and they are so intricately associated that little information could be obtained in regard to their relative positions in the necessarily hurried examinations made. The irruptive rocks have to a great extent been rendered schistose by pressure and have been much altered, so that diorites and diabase look alike and are hardly distinguishable under the microscope. From the field relations there appears to have been an older intrusion of diorite, together with volcanic outbursts, resulting in the formation of tuffaceous agglomerates and shales. These in turn appear to have been cut by masses of gabbro and their accompanying diabase dykes. The gabbro masses and dykes have a much older appearance and are more decomposed than the heavy dykes of diabase met with farther down the river, probably belonging to an older period than these. Area characterized by eruptions.

The first contact with the gneisses is on the north shore, two miles below the mouth of the Broken Paddle River, where the rock is probably the remains of a great diorite dyke, now altered to a dark-green amphibolite, holding angular fragments of a fine-grained mica-gneiss, which is seen to be sharply cut on the west side. On a small island, just below the mouth of the river, five dykes of dark-green altered diabase or diorite cut the gneisses almost in the direction of the strike, which is here east. On the shore opposite the island, light-gray and pink mica-gneiss is seen, a good deal contorted. Strike S. 75° E. The next exposure is opposite the mouth of the small river, where the pink and gray mica-gneiss is in contact with a dark-green, coarsely crystalline diabase, holding crystals of light-green plagioclase. The diabase is fine-grained near the contact and abruptly cuts the gneiss, also entering cracks and irregularities in it. Near Broken Paddle River.

Altered diorites and hornblende schists.

No rocks are seen above for a mile and a half, to an island on the south side, where a light-gray, compact, altered diorite of fine texture, containing much disseminated pyrites in small grains, is associated with a compact dark-green, altered trap, and dark-green hornblende-schist. Above this island on the opposite shore, the altered diorite is seen sharply cutting the mica-gneiss, while a few small schistose bands of hornblende penetrate the gneisses along the strike and a larger dyke from the diorite cuts them transversely. Similar contacts are seen on both sides of the river in the next mile, after which the Laurentian gneisses do not appear.

Agglomerate band.

These altered diorites and hornblende-schists continue for more than a mile, when, on the south shore, a band of agglomerate is encountered, which appears to be nearly 300 feet thick, including an intrusion of diorite fifty feet wide. This agglomerate in its western extension appears to pass into a schistose, basic, arkose material full of large rounded grains of quartz. The matrix of the agglomerate is a dark-green and grayish schist,* and the boulders and pebbles are all, or nearly all, well rounded, and flattened or pulled out parallel to the bedding or foliation. The largest boulders are fifteen inches long and twelve inches thick. The greater number are composed of gray quartzite, having at times a pinkish or green tinge. Along with these are a few boulders of dark-red jasper, and a light-green diabase. To the eastward, the conglomerate also passes into grauwacke holding large grains of quartz.

Squeezed clastic rocks.

For the next mile, up to a low chute, the rocks are massive altered diorite and chlorite-schists. Above the chute, there is a considerable thickness of mica-schist, similar to the bedded rock associated with the irruptives, at the places already noted on the lower parts of the river. These mica-schists are associated with a fine-grained, highly siliceous, dark-gray schist, that holds small pebbles of quartzite and fine-textured granite, and is probably a squeezed conglomerate. They are cut by bands of hornblende-schist, and there is a large band of altered diabase† on an island. A mile above the chute, dark green chlorite-schists and altered hornblende-schists are seen, containing narrow quartz-veins that hold small quantities of copper-pyrites.

For six miles above the last-mentioned exposure, there is a constant jumble of chlorite-, sericite- and altered hornblende-schists, along with massive altered eruptives,‡ and small areas of a dark-gray quartzite holding scales of mica, and perhaps representing the bedded series. The eastern contact between the Huronian and Laurentian rocks is not

---

*See No. 28, Appendix V.

†See No. 31, Appendix V.

‡See Nos. 10, 16, 17, Appendix V.

seen on the river, there being an interval of five miles between the upper exposure of the former and the next outcrop of gneiss.

Prosper and Ross gorges.

The next area of hornblende-schists, hornblende-mica- and mica-schists is found between the Prosper and Ross gorges, over fifty miles farther up the stream. These rocks here form a belt less than a mile wide, and are cut by large masses of pink pegmatite. The schists are more gneissic and less decomposed than those previously noted, and there is an absence of the altered diorite and diabase masses commonly found with them. They probably represent only altered schistose dykes, due to the Huronian period, with perhaps some of the micaceous bands of that formation. Taken altogether, they have an older, more metamorphic appearance than any of the Huronian areas previously described, and until further evidence is forthcoming cannot well be separated from the general Laurentian mass.

Huronian Area South-west of Lake Mistassini.

Clastic and eruptive rocks.

Extending from the south-west end of Lake Mistassini to and probably beyond Lake Obatagoman, some sixty miles to the south-west, there is an area of Huronian rocks out of which the basins of Wakwanichi and Chibougamoo lakes have been excavated. The rocks found in a hurried examination along the shores of the lakes, and on the portages between them, show that there is here developed a series of altered hornblendic and chloritic schists, agglomerates and serpentines, probably formed by the alteration of basic eruptives, and associated with volcanic ash rocks. A clastic series is also represented with the eruptives, consisting of thick beds of arkose conglomerate or agglomerate, felspathic schists, with dark chert limestone.

A mass of true granite appears to have been injected along the south-west margin of the area, subsequent to the formation of the basic series. Altogether, this area is worthy of a much more detailed examination than could be afforded by a trip through it to a field of work beyond, and it may prove interesting and important mineralogically, as well as geologically, on account of the rich deposits of iron- and copper-pyrites, seen in several places near the contact of the chlorite-schists with the granite and altered diabases. In this respect the deposits of ore are much like the nickel-bearing deposits of the Sudbury district, and on more extended investigation it is not improbable that such deposits might be found in this region, although assays of the pyrites from here have not given any nickel or have given only a trace of this metal.

Deposits of iron- and copper-pyrites.

Rocks of Lake Obatagoman.

The examination of these rocks was made along the route leading from the head of the Chamouchouan River, north-east to Lake Mistassini. On crossing the watershed, Lake Obatagoman, the first of three large lakes, is entered. The route passes northward through this lake between myriads of small granite islands, to a deep, narrow bay leading north-east, with a portage-route to Lake Chibougamoo. Along the shores of this bay dark-green chlorite-schists and massive dark-green altered diabase* of fine texture are met with. Strike S. 70° E.

On the first portage, a light grayish-green altered eruptive† is found, with schistose felspathic rocks holding many greenish and purplish flattened concretions, which on weathered surfaces show concentric lines. Similar felsitic schists are met with on the second portage, where the concretions are less numerous and the beds are cut by many small quartz-veins, holding chlorite and epidote, and associated with a massive, fine-grained chlorite rock.

Lake Chibougamoo.

The next exposures are along the west shore of Lake Chibougamoo and the adjacent islands, where a probable extension of the granite area is seen. On the small islands, about two miles off the mouth of the narrows, compact, dark-green diorite is cut by small dykes of light-green diabase of fine texture. Along the north-west shore of the lake, just before reaching Paint Mountain, green chlorite rock is seen, weathering to a grayish-green, and holding considerable quantities of magnetite in disseminated grains. At the foot of the mountain the rock is a green chlorite-schist, holding specks of copper- and iron-pyrites. On the south side of the mountain there is a contact between a large mass of coarse, white hornblende-granite and the compact and schistose chlorite rocks. At and near the contact these measures are much broken, and the cracks and cavities are highly charged with iron-pyrites, in a zone extending twenty feet from the contact. The chlorite rocks are penetrated by many small veins of quartz holding epidote.

Vicinity of Paint Mountain.

Iron-pyrites.

Along the east side of Paint Mountain, leading to the discharge of the lake, the schists are again seen, together with a diorite mass nearly 200 yards wide, and followed again by green schists to the northward. Near the southern contact there is a dark-green vein or dyke several yards wide running into the mountain, highly charged with pyrites. On the south side of the narrows, the green schists with pyrites are again met with. In the narrows, there are several exposures in a couple of miles, of what appears to be a volcanic conglomerate or agglomerate. The matrix is a dark-green schistose chlorite, evidently an altered ash,

Conglomerate.

* See No. 15, Appendix V. † See No. 14, Appendix V.

and it appears to have filled up the interstices between masses of Laurentian débris, and by subsequent folding and pressure it has been rendered schistose and decomposed to chlorite. The material forming the pebbles and boulders of the conglomerate is, nearly all, more or less rounded fragments of Laurentian granite, generally red in colour and coarse in texture, and varying in size from small grains to masses several tons in weight. A number of larger boulders consist of pink and grayish-green hornblende-granite, much finer in texture than the red granites, and many of them are somewhat decomposed and slightly impregnated with chlorite. An impure quartzite forms a few of the masses, and there are some pebbles of red jasper and of a fine-grained siliceous chlorite rock. Large boulders.

Where the fragments are small in size, the amount of the green chlorite mixture is not great, owing to there being less space to fill between the particles, and to the difficulty with which the supposed ash would fill these cavities in a large mass of such fine material. Where the boulders are large, the dark-green schist greatly predominates, and the rock finally passes from a conglomerate into a chlorite-schist, in which boulders are absent. Character of matrix.

The small islands at the head of the north-east bay, close to the first portage landing to Lake Wahwanichi, are formed of gray, compact diabase, composed chiefly of dark-gray plagioclase, and holding small crystals of greenish-white plagioclase. Two hundred yards to the west of the commencement of the portage, there is a conical hill of dark-green serpentine, on the top of which, Mr. Richardson found a band of blackish limestone, about a foot thick, interstratified with the serpentine. A sliced portion of the limestone under the microscope revealed a structure resembling that of some coral.* According to T. Sterry Hunt† the serpentines contain much disseminated magnetic iron, that yields on analysis a considerable percentage of chromium and traces of nickel. Serpentine.

On the portages and small lakes between Chibougamoo and Wahwanichi, light and dark chloritic and felsitic schists only are seen. Along the south-east shore of Wahwanichi Lake, no rock-exposures occur to within six miles of its outlet, where green chlorite-schist and squeezed arkose bands again outcrop, on edge. The arkose rock appears to be in places an agglomerate with a schistose paste, holding masses of coarse, red, very felspathic granite. Where the beds are finer grained, they are formed chiefly of grains of red orthoclase, with some quartz. The folding and pressure has induced a schistose Arkose rocks.

* Report of Progress, Geol. Surv. Can., 1870-71, p. 294. † Ibid.

structure in the finest beds, so that they are now an impure felsite-schist.

Richardson on rocks of Wahwanichi Lake.

According to Richardson* :—"On the north-west side of the lake, about the middle, these rocks rise to a height of 150 to 200 feet, forming a bare escarpment extending for about four miles; and, on the same side, near the outlet, Wahwanichi Mountain, which is entirely composed of them, rises about 350 feet, for the most part bare and rocky, and extending along the margin of the lake for nearly three miles. The fragments in the conglomerates in the last two localities are chiefly of Laurentian rocks, and the enclosed masses are often many tons in weight. In some places, without close examination, the conglomerate might be mistaken for a Laurentian gneiss. In many parts of this hill considerable exposures of red shale are met with, as well as gray and chocolate-brown sandstones, made up of fine grains of reddish felspar and white quartz."

At the portage past the chute at the outlet of the lake, a small exposure of light-gray, impure chert, holding grains of quartz and flecked with spots of brownish dolomite, is seen associated with dark-gray chert, holding occasional large grains of quartz and small pebbles of gneiss.

Relations of Huronian with Cambrian of Mistassini.

At the second portage, at the south-west end of Lake Mistassini, there is a small outcrop of the green schistose agglomerate. Beyond this only large angular blocks of dark-gray cherty limestone are seen—belonging to the almost flat-bedded series of Cambrian rocks of the Lake Mistassini basin. These last-mentioned rocks appear to rest unconformably on the tilted-up series of agglomerates, schists and cherts, but this is not here established by an actual contact, as the nearest outcrop seen of the flat-bedded limestones is fully ten miles away from the Huronian rocks. A more detailed examination of the region about the south-western portion of Mistassini must be undertaken, before any definite statement of the actual relations of the two series can be made, except that on the Perch River, which empties into the west side of the south-west bay of Mistassini, the limestones are found resting directly on the Laurentian gneiss, and here either cover the tilted series to the south-west unconformably or overlap them; the former being probably the case.

Large area of post-Huronian granite.

Lake Obatagoman occupies a shallow basin in a large area of granite similar to that already described along the East Main River, which from its cutting the Huronian schists can be distinctly referred to

*Report of Progress, Geol. Surv. Can., 1870-71, p. 294.

as irruptive. This area of granite appears to extend north-east so as to occupy the southern part of Lake Chibougamoo, giving a known length of twenty miles, with a breadth of eight miles. Except where it is seen close to the dark chlorite-schists, on the northern shores of Lake Obatagoman, there are no signs of foliation in the mass, which elsewhere has all the appearance of being of an irruptive origin. The granite, as seen on the islands and points of the last-named lake, is usually of medium texture and always of a light yellowish-gray colour, due to the colour of the contained orthoclase. Quartz is usually very abundant, and mica occurs in fine plates. Hornblende appears to be always associated with the mica, but usually in small quantities. Where seen on Lake Chibougamoo, the granite is coarser and very felspathic, with little quartz, mica and hornblende. It is penetrated by little veins of pyrites, and also by small dykes of white pegmatite. At Paint Mountain on the west side of the narrows, the granite is very coarse in texture, and is almost wholly formed of white orthoclase with green hornblende and little or no quartz, becoming a syenite. This granite cuts the dark-green chlorite-schists that make up the mass of the mountain, and the pyrites found in them is especially abundant in the granite zone within twenty feet of the contact.

This area of granite bears a close resemblance to the granite mass met with about the Talking Falls on the East Main River, where the granite undoubtedly cuts rock of Huronian age.

CAMBRIAN.

General character and thickness.

The series of rocks classified as Cambrian, comprises beds of arkose rock, sandstone, chert, limestone, dolomite, felsitic shale, argillite, and argillaceous shale, together with gabbro, diabase, fine-grained decomposed traps and volcanic agglomerates. No acid eruptives, such as quartz-porphyry, were found.

The sedimentary deposits have a minimum thickness of about 2500 feet, and may have a much greater thickness, which can be determined only by close study of the areas along the Koksoak and Hamilton rivers, where a series of step or overthrust faults cause frequent repetitions of the different members, rendering it exceedingly difficult to determine the total thickness of the measures by means of observations made along a couple of lines of hurried exploration.

General section.

The following section is a rough estimate of the succession and probable thickness of the sedimentary rocks along the Koksoak River in descending order :—

	Feet.
1. Rusty-weathering, black, micaceous shales.......	600
2. Dark-gray, ferruginous cherts..................	200
3. Dark-gray, ferruginous cherts, together with beds of jasper and magnetite..................	500
4. Fine-grained, dark-gray, ferruginous chert, somewhat calcareous and blotched with siderite....	150
5. Light-pink, very compact, brecciated limestone, often very siliceous..........................	20
6. Light-green siliceous shales..................	30
7. Black, carbonaceous, graphitic shales............	100
8. Massive, cherty, dark-blue dolomite............	10
9. Pearly-green shales, with cherty dolomite beds, showing ripple marks.........................	40
10. Coarse, gray sandstone..........................	3
11. Greenish-gray, calcareous shale, with occasional bands (6 in. to 15 in.) of fine-grained, dark-blue dolomite, weathering yellow..................	30
12. Fragmental, violet-pink, calcareous chert.........	200
13. Red calcareous sandrock..........................	200
14. Medium-grained red-sandstone, and thin beds of red felsitic shales............................	10
15. Bands of red and gray sandstone, separated by beds of red felsitic shales....................	425
	2518

Remarks on section.

This section is constructed from several broken sections taken along the river. No. 15 rests unconformably upon Laurentian granite. No. 14 represents the lowest beds of another cliff-face, and perhaps may be the upper part of No. 15.

There is a break in the section between No. 11 and No. 12, with probably a few beds missing. From No. 4 to No. 11 the section is continuous, while the upper measures are added by estimation, from the various exposures seen along the river, and are only an approximation of the thickness of the iron-bearing cherts, shales and limestones.

Correlation of the rocks.

On account of the great distances dividing the respective developments, it is impossible to correlate these rocks directly with those of Lake Superior or Newfoundland, which are supposed to represent the same geological period. The only rocks with which they closely agree are found along the east coast of Hudson Bay, which have been called by Dr. R. Bell,* the Manitounuck and Nastapoka groups. These he correlates with the Nipigon series, the equivalents of the Keweenawan of Lake Superior. From an examination of the various sections given by Dr. Bell, and a comparison of the hand specimens, there appears to be a closer agreement between the rocks of Hudson Bay and the Animikie formation of Lake Superior, which underlies the Keweenawan rocks.

*Report of Progress, Geol. Surv. Can., 1877-78, pp. 11c-20c.

The correlation of the rocks of Central Labrador with those of Newfoundland is difficult owing to the lack of specimens from the latter place. There appears to be considerable resemblance between the section above, and that given by Sir Wm. Logan,† of the rocks along the Labrador shore of the Strait of Belle Isle and the northern part of Newfoundland. The fossils found in these rocks are of Lower Cambrian age. Unfortunately no fossils have been found in the supposed Cambrian rocks of the interior of Labrador or those of Hudson Bay, and until such are found their precise age and equivalency can only be conjectured on lithological grounds.

No fossils found.

Whatever their precise age may be, there must have been a great lapse of time between the deposition of the Huronian rocks and the main period of deformation and folding to which these, in common with the aggregation of rocks classed as Laurentian, were subjected, and the deposit of these later strata, which rest uncomfortably upon both of the older formations. This period of time was sufficient to permit not only the levelling down and removal of great masses of the contorted older formations, but also to allow the sculpturing of the main existing features of the peninsula upon the surface thus formed, including, in part at least, the erosion of the great valley of the Hamilton River and Inlet. In this excavation beds of sandstone identical with the lower beds of the Koksoak and upper Hamilton rivers, and of Lake Michikamau, are found resting horizontally in the valley of the inlet and river, at or near the present water-level. The great basins of Mistassini and Michikamau lakes were also formed previous to the deposition of these sandstones and limestones; and along the shores of these lakes and in other places, where the contact between the older and newer rocks is seen, the gneisses and schists present the same rounded hummocks so characteristic of the uncovered and subsequently glaciated Laurentian and Huronian hills of many parts of northern Canada. In many places the overlying rocks rest undisturbed upon the rounded surfaces, but in other localities they show signs of having been shoved over them.

Evidence of great denudation between Archæan and Cambrian.

When the amount of denudation and erosion implied is considered, and also the length of time required to cut deep valleys out of Archæan granites and gneisses, where the excavation since the glacial period is practically nothing, it must be admitted that the interval between the deposition of the Laurentian and Huronian strata and that of the rocks classed as Cambrian, marks one of the greatest breaks known in geological time.

† Geology of Canada, 1863, pp. 865-67.

Rocks of Koksoak and Hamilton rivers probably connected.

The greatest development of this series is found along the Koksoak and upper Hamilton rivers. From the direction of the strike of the areas, it is highly probable that they are portions of a single great belt that extends from the neighbourhood of latitude 54° N. to beyond the Koksoak River, and continues in a north-north-west direction to Hopes Advance, on the east side of Ungava Bay, from where specimens of similar rocks were brought to Fort Chimo by the Eskimo. The total length would in this case be more than 400 miles. The breadth of this band where examined is about fifty miles. Both on the Koksoak and Hamilton rivers the strata are inclined towards the north-east or north-north-east, at angles varying from ten to eighty degrees. A number of parallel step-faults, with heavy throws, cause a series of repetitions of the various members of the formation. On the Koksoak River, below the junction of the Stillwater River, the hills on the north side of the stream show sixteen of these faults in a distance of twenty miles. Above the Stillwater, the repetitions of measures from this cause are numerous, but their extent and number were not determined. On the upper Hamilton River, where the whole series is well developed, the same step-faults were noticed, and are there marked by the sharp ridges so characteristic of the country underlain by these rocks. The ridges are cut off abruptly on their western faces, while their eastern slopes agree with the dip of the underlying rocks.

Numerous parallel faults.

At Lake Mistassini, where only the cherty limestones are found, similar faults have been noticed, the direction of the thrust there being from east-south-east towards west-north-west. On the east coast of Hudson Bay, at least one line of fault, and perhaps two or more may be observed, so that the rocks now dip seaward at moderately high angles. The coast is fringed with a chain of islands of the newer rocks, and these islands have abrupt faces towards the land, and slope towards the bay at the same angle as the inclination of the beds. The sections observed in the rocks of the islands are in part similar to those on the mainland, and are evidently a repetition caused by an overthrust similar to those met with on the Koksoak River. The thick strata of sandstone, chert and limestone appear to have resisted flexure, under a pressure exerted from the direction of the sea, on both sides of the Labrador Peninsula, and instead of folding they have faulted and have been thrown into a series of steps. The shales, where well developed, have been folded as well as faulted.

East coast of Hudson Bay.

These rocks along the east coast of Hudson Bay, as before stated, form only a narrow fringe on the mainland, and include the islands a short distance off the coast. They extend from Cape Jones northward for three hundred miles to Cape Dufferin.

Lake Michikamau.

The basin of Lake Michikamau is occupied by an outlier of Cambrian rocks, which may connect with the main area of the Koksoak River. Only the lower sandstones and limestones are found here, generally horizontal, but resting at a high angle against the granite hills near the discharge of the lake.

Lake Mistassini.

In the neighbourhood of Lake Mistassini, the cherty limestones only are found, covering an area one hundred miles long and about twenty-five broad. Small patches of arkose sandstone and conglomerate were met with on the Hamilton River about forty miles above its mouth, and similar rocks were found, flat-bedded, along the low shores of Hamilton Inlet, about Milligan Bay.

"Domino gneiss."

Dr. A. S. Packard* mentions as occurring along the Labrador coast from Domino Harbour to Cape Webuc, for a distance of 125 miles, a "development" of "domino gneiss" occupying depressions in the Laurention gneiss, on which it rests uncomformably, generally dipping at low angles. From his description of these rocks, they appear to be arkose conglomerate and sandstone beds, similar to those seen on Hamilton Inlet, and may represent the basal beds of the Cambrian, although Dr. Packard believes them to be of Pre-Cambrian age.

Cambrian igneous rocks.

The igneous rocks of this series, as far as seen, all appear to be basic in composition, and include gabbro and diabase in the form of great masses or large dykes, as the deep-seated irruptives, with finer-grained greenstones, which occur as bedded traps and are generally so much decomposed that they show only chlorite in the microscopic sections. These trap-flows, in the interior regions, are always found interbedded with the clastic rocks. Many of the large diabase dykes or sills also conform with the bedding planes, and only by following the outcrops can they be found jogging from one plane to another. On the east coast of Hudson Bay some of the traps have formed overflows on the surface, and are now represented by dark-green, fine-grained melaphyres, having large amygdaloidal cavities filled with quartz and agate. Similar overflows of trap also occur on the Atlantic coast at Chateau Bay, near the eastern entrance of the Strait of Belle Isle, where the trap rests directly on Laurentian gneisses without any of the bedded clastic rocks.

Iron ores.

The mode of occurrence of thick beds of magnetic iron ore overlain by cherty, non-fragmental carbonates in this series, closely resembles that of the iron ores of the Lake Superior region described by Irving, Van Hise† and others. This, with other characters of resemblance, renders it almost certain that the two

* The Labrador Coast. Hodges, New York, 1891, pp. 286-290.
† U.S. Geol. Surv., Monograph XIX.

developments represent the same period, or, in other words, that the Animikie rocks of Lake Superior, assumed to be Lower Cambrian, are equivalent to the rocks here described as Cambrian in Labrador. There must have been at this time a wide-spread subsidence of the Archæan of north-eastern America.*

Lake Mistassini Area.

Cambrian of Lake Mistassini.

The great basin in the Archæan rocks at present partly filled by the Mistassini lakes, appears to have existed as such at a very remote period, previous to the deposition of the Cambrian limestones that are now found forming the shores and islands of the lakes. The area at present occupied by these limestones, stretches from the south-west end of Lake Mistassini, to a short distance beyond the north-east end of the lakes, about one hundred miles. The greatest breadth of the area is not much over twenty-five miles.

Its limits.

Along the north-west side of Mistassini, the limestone is found on the points and numerous small islands that fringe the shore, while the deeper bays are cut out of Laurentian gneiss. In many places the limestone is seen resting uncomformably on bosses of gneiss, that to all appearance had the same rounded outline as the uncovered and recently glaciated surrounding hills. The north-east limit appears to extend about three or four miles beyond the head of Lake Mistassini, to the foot of a high range of hills that crosses the end of the lake. Beyond the north end of Little Mistassini, there is a low area probably underlain by this formation, that extends a short distance up the Temiscamie River, until the gneiss is met with. The south-eastern boundary is beyond the Temiscamie River, which flows parallel to Little Mistassini Lake, and is separated from it by a narrow limestone ridge. The south-western boundary does not appear to pass beyond Mistassini Lake, where the rocks are cut off by the sharp hills of the Huronian area.

Thickness.

The total thickness of the limestones remaining, probably does not exceed three or four hundred feet, and across the strike there are probably repetitions caused by faults parallel to the strike, like those seen along the Koksoak and Hamilton rivers. The first line of fault, met with in passing from north-west to south-east, is in the middle of Lake Mistassini, and has produced the long points at the ends of the lake and the chain of islands between them. The western sides of the points and islands have abrupt escarpments, with deep water close in to their shores.

*Compare Annual Report, Geol. Surv. Can., vol. II. (N.S.), p. 8 R.

The rocks are also considerably contorted and broken for some distance away from the line of fault. The second line of fault is indicated by the escarpment that divides the two lakes, and a third fault forms another ridge along the south-east side of Little Mistassini and divides the lake from the Temiscamie River. Besides these three principal lines of fault, there appear to be several minor ones that produce lines of low islands along the south-east shore of the great lake as well as in the smaller lake. Except where disturbed, close to the lines of fault, the limestones dip towards the south-east at angles that vary only from four to ten degrees from the horizontal. Faults.

The lowest beds, resting on the gneisses along the north-west side of Lake Mistassini, consist of a dark bluish-gray limestone of medium-grained crystalline texture, and hold irregular concretionary masses of black chert and thin veins and bands of the same material, along with thin bands of black shaly limestone. Above these are thin beds of light-blue, fine-grained, siliceous, dolomitic limestone, that weather to a light buff and are interbedded with thin layers of a grayish, coarse, gritty limestone, containing large quantities of small rounded grains of transparent quartz. Resting on these are beds of light-blue, very compact limestone, exceedingly hard and breaking with a conchoidal fracture. These are followed in ascending order by thinner beds of the same character, interbedded with coarse-gray, siliceous limestones full of grit. Succession of beds.

As before stated, the beds close to the lines of fault are much contorted and broken, and in many places have been greatly shattered and re-cemented with either calcite or quartz, most often the latter, which give the rock a brecciated appearance, and cause it at times to resemble a conglomerate. At the end of the south-west point of the larger lake, where the rock is disturbed and jointed, the small veins of calcite hold little globules of the bright black bituminous mineral "anthraxolite"* or altered bitumen, probably gathered from the surrounding limestones, some of which are quite dark and carbonaceous. Along the portage between Great and Little Mistassini, the limestones are again contorted and broken, and appear to be more altered than elsewhere. The light-gray dolomitic variety is most abundant here, and is finely crystalline and brecciated, the limestone filling the cracks being pink in colour. All are very siliceous, and at times pass into an impure quartzite. On the islands in the smaller lake, the dark bands containing small grains of transparent quartz are most abundant. Disturbance and fracture.

There is a marked resemblance between these limestones and those found along the Koksoak and Hamilton rivers. The resemblance is Rocks like those of other areas.

* See Annual Report, Geol. Surv., Can., vol. VII. (N.S.), p. 66 R.

so great, that from the hand specimens in the office, almost any rock from the one locality can be duplicated from either of the other localities, and when they are mixed together, it is impossible to distinguish them. The same remarks apply to the limestones found along the east coast of Hudson Bay, from Cape Jones northward to beyond Great Whale River.

Koksoak River Area.

Cambrian of Koksoak River.

At Cambrian Lake, about 150 miles above the mouth of the Koksoak River, the west side of the probable northern extension of the Hamilton River area is first seen. The first exposure occurs on the west shore of the lake, five miles below the mouth of the Death River, where the measures form a low cliff and dip N. 10° W. < 100, or at a small angle to the direction of the shore. The section displayed, in descending or natural order, is as follows:—

	Feet.
1. Brecciated, purplish, calcareous sand-rock	100
2. Banded, red and gray sand-rock, consisting of grains of quartz with a calcareous matrix	200
3. Ferruginous red argillite	10
4. Medium-grained, red sand-rock and red argillite	—

The lowest measures are concealed and broken, but from appearances there must be at least 300 feet of red calcareous sand-rock, with partings of red argillite, and some beds of green siliceous argillite holding a good deal of pyrites in cubes. A bay with low shores separates this section from the next exposure, a mile and a half away, but as the second exposure is nearly on the strike of the first there can only be a small break in the series. This second exposure is half a mile long, and gives the following section in descending order:—

Sections on Cambrian Lake.

	Feet.
1. Fine-grained red ferruginous chert; containing small blotches of carbonate of iron	150
2. Light-pink, very compact brecciated limestone, containing a considerable quantity of silica	20
3. Light-green, siliceous argillite	30
4. Blackish graphitic shales	100
5. Blue dolomite, somewhat cherty	10
6. Pearly, green shales, showing ripple marks and parted by thin beds of dolomite	40
7. Coarse gray sandstone	3
8. Greenish-gray, calcareous shale and dark-green argillaceous limestone, with occasional beds of fine-grained, dark-blue, yellow-weathering dolomite (6 inches to 15 inches thick)	30
Total	383

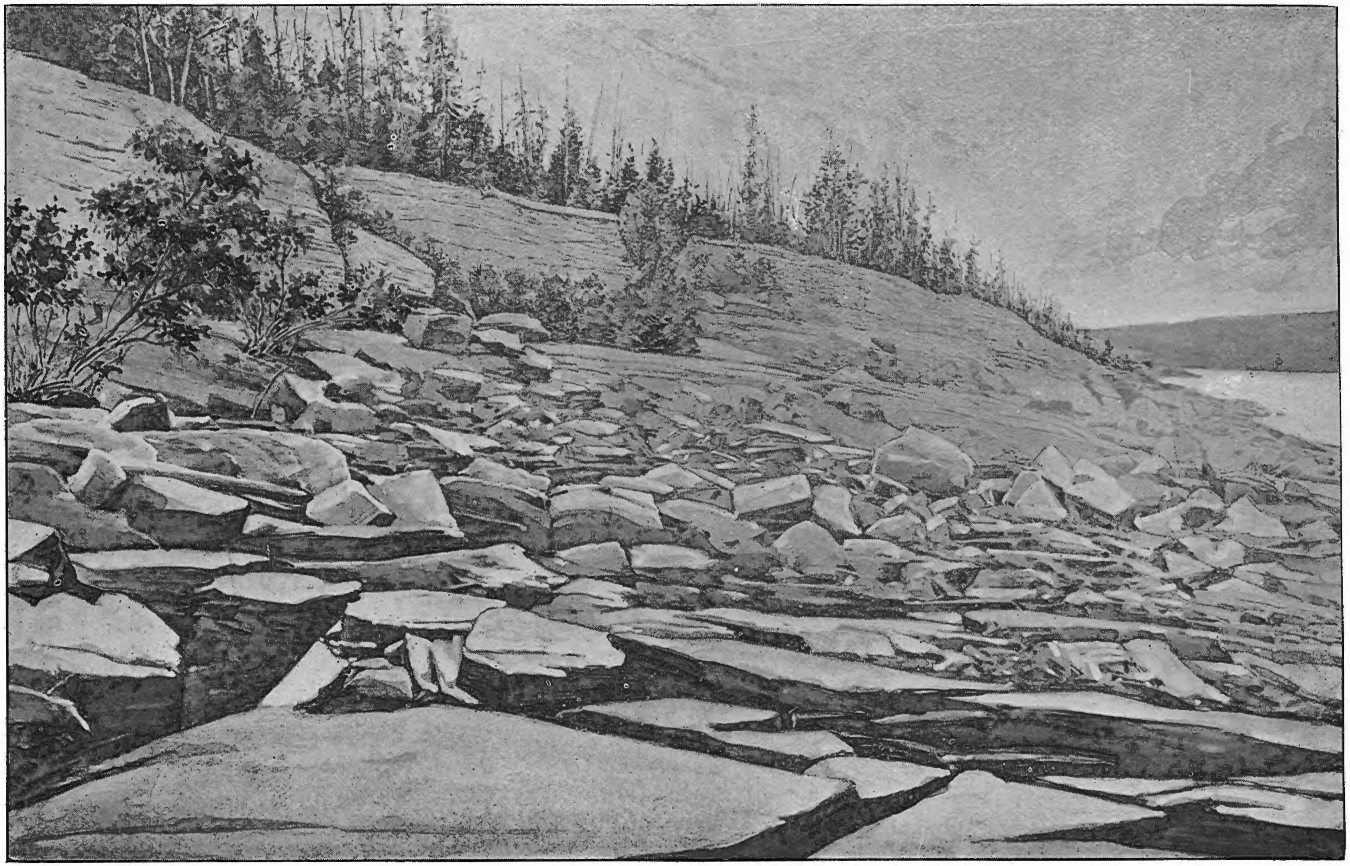


Photo. by A. P. Low, 1894.

BEDDED SANDSTONES AND SHALES, CAMBRIAN LAKE, KOKSOAK RIVER.

The shore is now drift-covered for one mile, and then forms a low cliff for two miles, but as the strike of the rocks nearly coincides with the shore-line no great thickness of beds is seen. The section probably repeats the last, with the addition of some 200 feet of argillaceous limestone and black shales on top.

The next outcrop occurs at a high point on the same side of the lake and five miles northward of the last. Here the Cambrian strata rest unconformably on a boss of hornblende-granite, dipping E. < 70.

The following is a descending section of the beds which probably are the lowest of the series :—

	Feet.
1. Red sandstone	4
2. Red argillite	3
3. Red sandstone	5
4. Red argillite	4
5. Red sandstone	10
6. Red argillite	6
7. Red sandstone	3
8. Red argillite	5
9. Red sandstone	2
10. Red argillite	25
11. Red sandstone	2
12. Red argillite	8
13. Red sandstone	2
14. Red argillite	4
15. Gray sandstone	3
16. Red argillite	5
17. Red and gray sandstone	15
18. Red argillite	40
19. Gray sandstone	2
20. Red argillite	3
21. Red sandstone	8
22. Red argillite	6
23. Red sandstone	8
24. Red argillite	9
25. Red sandstone	30
26. Red argillite	4
27. Red sandstone	2
28. Red argillite	9
29. Red sandstone	4
30. Red argillite	2
31. Red sandstone	3
32. Red argillite	40
33. Red sandstone	5
34. Red argillite	20
35. Gray and red sandstone	60
36. Red argillite	2
37. Coarse, grayish-pink, arkose sandrock	10
38. Concealed, to granite	50
Total	423

The Cambrian rocks are not again seen on the shores of the lake, but cap the high hills on both sides. On the north-west side they are coarse, pinkish-gray sandstone, while on the south-east side red sandstones, rusty-weathering shales and limestones predominate.

River below Cambrian Lake.

The Laurentian hornblende-granite forms two low hills close to the water, the first being on the east side at the point where the lake changes direction from north to north-east, the second is on the north side three miles lower down where the lake again gradually narrows and shallows into the river. For ten miles below the second outcrop of granite, the river banks are low and sandy, until a small exposure is reached on the south bank, of fine-grained, dark green graywacke* composed chiefly of minute fragments of felspar and closely resembling a fine-grained trap, especially on weathered surfaces. This rock is very compact, and exceedingly tough. On a hill near by, the same rock was found capping a high cliff, with argillaceous limestone and black shales beneath it. Dip S. 80° W. $<$ 30°.

Rocks at Shale Chute.

At the Shale Chute there are 500 feet of dark, greenish-gray shale, on edge, along with a few thin bands of light greenish-gray argillaceous limestone. On the south bank immediately below this chute, and for some distance further down, the rocks outcrop in a narrow band between the water and the overlying drift, giving a small section of very cherty, ferruginous limestone, holding thin bands of buff-weathering, pinkish siderite. These rocks are overlain by twenty feet of dark-blue, cherty limestone, containing nests of siderite.

Iron ores and jasper.

Two miles below Shale Chute, there is a large exposure of bedded iron ore (a mixture of magnetite and hæmatite) about twenty-five feet thick, underlain by ten feet of highly ferruginous cherty limestone, with spathic ore in small spots and masses scattered through it. The magnetic ores are interstratified with thin bands of red jasper varying in colour from crimson to vermilion; these bands are of unequal thickness, and sometimes they are broken into lenticular masses. The thickest is about three inches, but they are usually less than one inch through. The next exposure is on the west bank, three miles and a half farther down stream than the last, where a dark-gray, compact chert holds angular fragments of cherty limestone and siderite, both weathering yellow, and all cut by many small quartz-veins. On the same bank half a mile lower down stream, fifty feet of red siliceous shale and jasper are overlain by 200 feet of jaspery magnetite; the shale holds many small red garnets, while the jasper bands are always less than six inches thick. In the next half-mile 400 feet of red jasper

* See No. 9, Appendix V.

and magnetite are overlain by fifty feet of dark-gray, cherty rock containing masses of carbonate of iron. The jasper bands vary from half an inch to eight inches in thickness; the magnetites are mostly impure and shaly.

On the north shore, opposite the mouth of Swampy-bay River, 100 feet of dark-gray, argillaceous limestone are overlain by 400 feet of dark shales, both nearly on edge. Strike N. 15° W. Rocks at Swampy-bay River.

At a heavy rapid, two miles above the Swampy-bay River, there is a large exposure of jasper banded with brownish-gray spathic ore. The jasper is olive-green in colour, and often has angular fragments of red jasper scattered through it, from the fracturing of thin red bands and the filling of the cracks with the green variety. This rock would take a high polish and make a beautiful ornamental stone.

A mile below Swampy-bay River, there is an entire hill of dark-blue, cherty, ferruginous limestone holding large patches of siderite throughout. Along with the limestone are a few bands of jasper. These rocks are continuously exposed for a mile along the river, then follow two miles of drift-formed banks with rusty-weathering, black shales and argillaceous limestones in a greatly disturbed condition.

The river-valley for the next thirteen miles is wider, and only occasional exposures of shale and limestone rise from beneath the drift. Along this distance, down-stream, the limestones gradually take the place of the shales, and at the lower end of the stretch only thin beds of greenish-gray shale are seen at the base of the overlying magnesian limestone. For the next following twelve miles, to the Pyrites Chute, almost constant exposures of limestone occur along the river-banks. This limestone is almost identical with that found at Lake Mistassini and along the east coast of Hudson Bay. It is generally light-blue in colour, very siliceous, breaking into sharp, angular fragments, exceedingly fine in texture where free from grains of quartz, which are found in some of the beds. The rock has been much disturbed, being thrown into sharp folds and faulted into a series of sharp, parallel ridges of hills. The faulting and shattering has broken many of the beds of limestone into angular fragments which have been cemented again with calcareous matter into a sort of breccia. The whole, after being re-cemented, must again have been fractured, when the last cracks were filled with quartz-veins, that now penetrate the mass of rock in all directions. Limestones replacing shales down-stream.

At the Pyrites Chute the black shales are again met with; at the head of the chute they include a few beds of fine-grained, black limestone. The bedding is greatly contorted into small domes, that dip Rocks at Pyrites Chute.

steeply in all directions. About half way down the chute the beds are more regular, and dip away from domes of light-weathering limestone on which they rest. The transition from limestone to black shale is made in about fifteen feet, through a light-gray, argillaceous limestone, that gradually changes to light, pearly shale, and this again to the dark variety. The black shales and limestones are all highly charged with pyrites, usually occurring as separate cubes, but sometimes in large masses.

Below the chute on the east side of the river, the low hills have rusty cliffs, and are probably formed of shale.

At Limestone Fall.

The light-blue magnesian limestones are again seen on the islands above the Limestone Fall, where they are less distributed. At the fall the river descends sixty feet over ledges of limestone. The rock is of a light-blue colour, somewhat siliceous, and brecciated by numerous small veins of quartz that cut it in all directions. A few thin beds of pearly-gray, calcareous shale are interbedded with the limestone. Dip N. 75° E. < 40°.

Black shales at Manitou Gorge.

No rock is seen in the valley from this fall to the head of the Manitou Gorge, four miles farther down-stream, where the river has cut a long, narrow channel out of the shales and limestones. At the head of the gorge, large exposures of black shales are found, with a very regular dip N. 75° E. < 50°. They continue down the east side of the gorge, and were examined for over a mile. Where their edges have been polished in the channel, their colour is green. Pyrites in cubes is scattered in considerable quantities through the shales. A number of thin beds of light-gray pearly shale are enclosed among the black beds. Numerous small veins of quartz penetrate the shales; they are usually barren, but sometimes carry pyrites, and in one place a small quantity of galena was observed.

Junction of limestones and shales.

At the lower end of the portage, on the east bank, the shales overlie limestone; as the junction is approached, the shales change from black to pearly-gray, becoming somewhat siliceous and having interbedded thin bands of limestones which gradually become more numerous and thicker until they finally altogether displace the shales. The bands enclosed in the shales are very siliceous, and some of them pass into quartzite. Some of these quartzite bands are white, others yellowish, and others again have a purple colour. The limestones extend half a mile below the foot of the gorge, the beds gradually becoming flatter.

Rocks below Stillwater.

Four miles below the gorge, or a mile above the mouth of Stillwater River, there is on the east bank a large exposure of light-blue, fine-grained, siliceous limestone. Dip N. 70° E. < 10°. Below this river the valley widens out, and the river-banks are low and sandy, only two rock exposures being seen in seventeen miles. These exposures are respectively three and a half and eight miles below the Stillwater. They consist of well-rounded bosses rising above the drift. The rock at both places is nearly identical, and is a medium-grained, light-green, much altered diorite* holding much whitish plagioclase, with specks of pyrite. The diorites are directly on the strike of the capping rock of the sharp hills that bound the valley on the north side. The hills run in sharp ridges parallel to the strike of the rocks, and have perpendicular faces towards the west, while the slope on the opposite side is quite gentle (10°-20°). The cliff-faces of the ridges are all very similar in appearance; a thick cap of compact rock, perhaps bedded diorite generally overhanging the rocks below, which are rusty-weathering, black shales from 300 feet to 400 feet thick, with limestone forming a steep slope at the bottom. The two upper members of the series are seen in every cliff, the lower one being sometimes concealed, either by being covered with débris, or owing to the lower part of the hill not rising above the east slope of the adjoining ridge. The ridges are from a quarter of a mile to two miles apart, and sixteen of them were counted in a distance of twenty miles down the stream. Each of the cliff-faces of the ridges practically repeats, in a more or less complete form, the section given in the others. This, in itself, appears to be sufficient reason to assume that the beds are again and again repeated by faults, otherwise the total thickness of the rocks would be enormous, and the uniformity of repetition of members wholly improbable.

Numerous similar ridges.

Twenty miles below the mouth of the Stillwater, the Laurentian gneisses again rise from beneath the Cambrian, and the latter rocks are confined to the summits of the hills, from which they gradually disappear as the river is further descended.

North edge of the Cambrian.

Hamilton River Area.

The rocks of the great area of Cambrian on the Ashuanipi Branch of the Hamilton River, were first seen on a number of low islands in the small lake-expansion six miles below the outlet of Birch Lake. The beds here are impure sandstone or graywacke, made up of irregular grains of quartz and red orthoclase cemented together with silica. These beds have evidently been formed from the detritus of the gneisses on which they rest. They dip W. $< 40°$.

Cambrian on Ashuanipi Branch.

Along the river to the outlet of Birch Lake, the banks are formed of drift deposits, and no rock is seen in place. On the low islands

Outcrops on Birch Lake.

* See No. 23, Appendix V.

extending westward from the outlet of the lake and dividing it into two deep bays on the north side of the outlet, there are large quantities of black shale, with thin bands of dark argillaceous limestone evidently broken up in place by the ice. On the south shore, at the entrance to the south bay, is a low bluff of dark-greenish very siliceous limestone, holding small quantities of pyrite and having little irregular veins from two to four inches wide of siderite and calcite. The veins run generally parallel to the bedding which dips S. 45° W. < 30°. The rock has also two sets of cleavage-planes—one vertical and at right-angles to the true dip, and the other dipping N. 60° W. < 45°. On the sharp ridge on the south side of the lake, near its southern inlet, a similar dark siliceous and ferruginous limestone is seen forming the crest of the hill. For three miles up the southern inlet, the only rocks observed were small exposures of a similar limestone, very much fractured and dipping west at a high angle. From the angular blocks scattered about, it is evident that these rocks hold large quantities of carbonate of iron, present as segregations or concretions in the limestone.

The river here becomes obstructed by many small islands, that divide it into numerous channels for the next seven miles to where it flows out of Dyke Lake. These islands appear to be all formed of bedded black shale. Just above the heavy rapid at the outlet of Dyke Lake, there is a rocky ridge extending along the north side. The rocks here are very complicated, bedded siliceous limestones being interbanded with volcanic ash rocks and eruptives and also with a jasper conglomerate. The rocks dip S. 80° W. 70, and the section exposed is as follows:—

Section on Dyke Lake.

40 feet of jasper conglomerate. The jasper is present generally in the form of small water-worn pebbles, but is at times angular, with a few larger pebbles of ferruginous red quartzite. The matrix is a dark-green schistose chlorite. In places where the jasper pebbles are small and numerous, it would appear that all the interstices had not been filled in with the ashy material, and that the pebbles were subsequently cemented together by infiltrations of white quartz.

20 feet of dark greenish compact rock, occasionally holding small amygdules, filled with calcite. This rock is quite ferruginous, distinctly bedded, and is probably a volcanic-ash rock.*

10 feet of brownish, porous rock, highly siliceous and distinctly clastic, probably another ash rock.

5 feet of compact, finely crystalline magnetite, coloured by a small admixture of red hæmatite.

---

* See No. 1, Appendix V.

10 feet of brownish trap rock.
5 feet of bedded magnetite.
20 feet of brownish trap rock.

The cherty volcanic-ash rocks come out along the lake shore for about three miles above the rapid, where they appear to be backed on the hill behind by a large mass of dark-green, fine-grained diabase,* that is much decomposed on the surface.

Fault Hill and vicinity.

On the summit of Fault Hill, at the end of the long point between the northern and southern discharges of Dyke Lake, a medium-grained, dark diabase† is seen, while on the southern flanks of the hill a brownish, fine-grained, highly siliceous shale is met with in broken masses, containing much carbonate of iron. Fault Hill derives its name from the great fracture which traverses it from south-east to north-west, in consequence of which the western portion rises abruptly over 100 feet above the adjoining eastern end.

On the south shore of the lake, opposite Fault Hill, and continuing from there northward some three miles, light greenish-gray shales are seen, along with thin beds of dark-blue cherty rock of a fine texture, often holding small grains of quartz. At times this rock is highly pyritous, and it often holds small yellow patches of siderite. These rocks are all on edge, and strike S. 60° E.

On the large island on the north side of the main channel, four miles north of Fault Hill, low exposures of light-green argillite interbedded with light-gray sand-rock, occur for more than a mile along shore. The argillites show ripple-marks, and in places are somewhat slickensided. All the beds are penetrated by numerous small quartz-veins.

At the point of the next large island to the north, where it adjoins the eastern shore, are twenty feet of light-gray sand-rock, often coarse-grained, and interbedded with thin bands of cherty limestones. These rocks are greatly cut up by small reticulated quartz-veins. Strike S. 30° E.

Great iabase dyke.

On the mainland just above, there is a large mass of light-green diabase,‡ generally quite coarse in texture, except on the north side, where it becomes fine-grained near its contact with the sand-rock, and causes the reticulated structure in the latter. The diabase often contains large porphyritic crystals of huronite and also specks of pyrite and pyrrhotite. This rock is in the form of a great dyke that stretches northward along the west shore of the lake for eight miles, to the narrows leading to Lake Petitsikapau. The direction of the

* See No. 22, Appendix V. † See No. 33, Appendix V. ‡ See No. 34, Appendix V.

dyke is such that, if continued, it would pass through Fault Hill, and the diabase found there points to such a southern extension. The dyke appears to form all the points along the west side of the lake. At one of these, a mile to the northward of the last-described exposure, the dyke is 200 yards wide and its contacts with the bedded series are well seen. The direction of the dyke is nearly parallel to the bedding, but it jogs occasionally from one bed to another. The west wall is formed of light-gray sand-rock, apparently baked at the contact, and full of small quartz-veins, which usually extend only a few feet from the contact. On the east side, black shales form the wall-rock, and near the contact they are changed to a light-green argillite. The diabase continues to be seen on the points, as above described, while in the bays between are black shales with occasional beds of black argillaceous limestone. The shales at times weather rusty from the decomposition of the pyrites contained in them.

Entrance to Lake Petitsikapau,

On the east side of the entrance to the narrows leading to Lake Petitsikapau, there is another contact between the diabase dyke and the black shales and limestones. As before, the dyke runs mainly parallel to the bedding, but is seen in one place to jog four feet, and in another eight inches. The shales and limestones are hardened near the contact, and are of a light, grayish-green colour, owing to the contained carbon having been burnt out. They are cut by small quartz-veins that extend from eight to ten feet from the dyke, and then die out. The shales are tilted up at high angles and strike N. 50° W.

On the western point, at the narrows, a bed of fine granular magnetite, twenty feet wide, is seen extending along the shore for 200 feet. Like all other beds of this kind, the iron ore is associated with red jasper in broken angular masses, scattered in bands through the ore. The appearance of the jasper leads to the belief that it originally formed beds, varying from a quarter of an inch to six inches in thickness, which have been subsequently broken by folding and pressure, so as to assume their present appearance. The beds are on edge and the strike is N. 30° W. On the west side these beds are followed by 200 feet of dark cherty rock, with a brownish fracture, and containing a considerable percentage of carbonate of iron. These rocks contain in some places a few small pebbles of quartzite, and in others irregular masses of apple-green chert.

At the upper end of the narrows, the rock seen is a dark, shaly, siliceous limestone, holding a considerable quantity of iron. Strike W. These shaly, ferruginous rocks are met with along the west sides of the first deep northern bay of Lake Petitsikapau where their strike coincides closely with the trend of the shores.

Along the shores of the other northern bays and on all the low islands in the lake, rock is seen everywhere. In the northern bays limestone predominates, and is accompanied by shale. On the islands the latter is most plentiful, and in places has a perpendicular cleavage. Where the limestone is in thick beds, it has a dark bluish-gray colour and a medium-grained crystalline texture. In many places it includes angular masses of a very fine-grained, black carbonaceous limestone. Some of the beds hold small grains of quartz, and closely resemble similar beds at Lake Mistassini. These rocks are all much fractured, and are tilted up at high angles with evidence of numerous faults. Where the shales predominate, the rocks of the limestone bands are finer-grained and more carbonaceous. The shales are nearly always black, and sometimes bituminous; rarely, bands of a lighter green colour are met with, more especially where limestone is plentiful.

Rocks of Lake Petitsikapau.

Scattered amongst the broken shale and limestone, on two islands near the mouth of the north-east bay, a number of blocks of a black carbon mineral were observed. The largest blocks measured eight inches in thickness, and, from the white vein-quartz attached to their sides, it is obvious that the mineral occurs either in veins or pockets. It has a foliated appearance, with plates arranged at right-angles to the walls. In colour it is black with a high lustre, resembling graphite. A more detailed description of this material is given under the heading of economic minerals.

On the summit of a range of hills along the east side of the lake, were found bedded limestones and ferruginous cherts, tilted up at a high angle, with their strike parallel to the direction of the hill, or N. 20° W. A small dyke of fine-grained diabase* cuts these rocks. In places on the western side of the summit, the rocks appear not to have been glaciated, and are much decomposed on the surface. The limestone is here represented by a residual, impure, black oxide of iron, and the small quartz-veins that penetrate it stand out from six to eight inches above the general mass.

East side of the lake.

Leaving Lake Petitsikapau, and returning to Dyke Lake along the west shore, to the northward of the inlet of the river we find a long exposure of brown-weathering, shaly limestone, and ferruginous chert. Strike N. 60° W. At the inlet of the river, the stream is broken into heavy rapids, as it passes over ledges and between small islands formed by a great dyke, that here crosses the stream and continues N. 30° W., along the east shore of the next lake-expansion above, for

Great diabase dyke.

* See No. 20, Appendix V.

more than five miles. This dyke is over 300 yards wide, and only its eastern contact with the bedded series is seen. The rock forming the dyke is medium-grained, dark-green diabase, holding in places light-green crystals of plagioclase. Near the contact, the rock is much finer in texture and darker-coloured. Dark-blue, medium-grained limestone is found on the east side of the dyke, where the beds dip N. 40° E. < 80°, or away from the dyke. For twelve feet from the contact, the limestone has a baked appearance, its colour being lighter, and the bedding marked by different shades; its texture also appears finer, and it is very hard, brittle and cherty. The dyke runs parallel to the strike, but jogs from bed to bed, in one place crossing about twenty feet.

On the west side of the lake there is only one small exposure of shaly limestone. At the south-west angle, where the river flows in, another great dyke of diabase is met with, and its contact with the cherty limestone is seen. At the contact the limestone is baked, intensely fractured and re-cemented. The diabase near the contact is of a strongly developed porphyritic character.* The dyke is seen passing southward for a mile along the river, when it is covered with drift.

Rocks of Astray Lake.

In Astray Lake two chains of low, rocky islands and reefs extend several miles down the centre of the lake. These are all composed of a compact, light-blue limestone, very fine in texture, cherty, and greatly fractured, the small cracks being filled with quartz, which gives a finely reticulated appearance to weathered surfaces. Large irregular masses of black chert are scattered through it. The rocks weather yellowish-white, with some brown bands. These limestones are identical in appearance with those of Lake Mistassini and those of the Koksoak River at and below the Limestone Fall.

Iron area.

Near the head of the middle northern bay of Astray Lake, on its west shore, a low hill, 150 feet high, of bedded jaspery iron ore is seen; dip S. 50° E. < 20°. The ore is a fine-grained magnetite, with patches of red hæmatite, and holds broken bands of red jasper. Some of the beds more than fifteen inches thick are of pure ore without any jasper. The ore-beds are overlain by the buff-weathering, blue limestones, holding black chert, and are greatly shattered and re-cemented by quartz. These limestones come out in great thickness on a high island about a mile to the south-east. On the west shore, a large dyke of fine-grained, dark-green diabase follows the shore, from behind the island, southward for upwards of a mile. This dyke forms a low escarpment, and its contact with the bedded rocks was not seen.

* See No. 3, Appendix V.

On the north-east bay ledges of buff-weathering limestone are seen along the west shore and on the large islands. On the east side, three miles from the head of this bay, is an escarpment of 120 feet, cut out of black shales and thin beds of limestone; dip, N. 40° E. $< 45°-60°$. Between this escarpment and fifty feet of jaspery iron ore, exposed on a small point, is an interval of 200 feet concealed by drift. The ore-beds contain much jasper and are not very rich in iron.

The west shore of Astray Lake is low and drift-covered as far south as Quartz Hill, which rises in a sharp cone close to the shore between the lake and the river leading to Menihek Lake. The top of the hill is bare, and the rock is a white-weathering, light-gray and green quartzite, holding angular fragments of blue-banded flint that are evidently the remains of broken beds of that material. The beds are on edge, and the strike is N. 30° W. Quartz Hill.

On the long narrow island in Astray Lake, a low rocky escarpment extends for more than three miles along its eastern side. The rocks forming the escarpment are very fine-grained, compact, light-gray and pink cherts, much fractured, and overlain by a very siliceous buff-weathering limestone that dips N. 50° E. $< 35°$. There are frequent outcrops of buff-weathering cherty limestone along the west shore of Astray Lake for five miles, to the small rapid leading to Marble Lake. The strike of the limestone is parallel to the shore, and only a small section is exposed. The dip is N. 50° E. The same buff limestones form low cliffs at intervals along the east shore of Marble Lake for three miles from its outlet, and also appear on the west shore at its north end. On the eastern side of the river there are many loose blocks of dark-green trap, holding angular masses of red jasper. Limestones and cherts.

At the first heavy rapid, where the river turns westward towards Menihek Lake, the rock is nearly horizontal, and lies in low flat domes. It is a well-banded, very dark gray siliceous trap, and resembles an altered compact ash. The same flat-bedded traps are seen at the small fall some three miles below the lower Menihek Lake, where they are full of small specks of pyrites arranged in bands. At the outlet of the lake there are many large loose blocks of alternately bedded jasper and magnetite. These blocks evidently show the condition of the bedded ores when undisturbed, the jasper being in continuous layers from one-half to three inches thick, and not in angular fragments scattered through the ore, as seen where the beds have been tilted and crushed. Route to Menihek Lake.

The shores of Menihek Lake are generally low and formed of drift, so that very few rock-exposures are seen. No outcrops occur on the Rocks of Menihek.

east side of the lake, and only three on the west side. The first noted is on a long point, four miles south of the outlet. Here the rock is not seen in place, but in fragments heaped up by the ice in a mound of large angular blocks. These blocks show a rusty-weathering, coarsely crystalline, siliceous limestone, containing a large percentage of small rounded grains of quartz, and at times containing large pebbles of dark chert, as well as irregular chert masses. Small veins of calcite penetrate the rock and hold globular masses of a brilliant black carbon, probably of the same nature as the "anthraxolite" of Lake Petitsikapau and of Lake Mistassini.

Anthraxolite.

Chert and siderite.

Ten miles to the south, where a small stream enters the lake from the westward, there is an exposure a quarter of a mile long, of flat-bedded dark-gray chert, much broken, and weathering a dark brown. The rock is blotched with siderite, often altered to an earthy limonite. The ore-masses vary from half an inch to two or three feet in diameter, and also occur as thin beds of irregular thickness. The total thickness seen is about forty feet, and the rock is everywhere split up into angular blocks, that are scattered about, giving the exposure the appearance of a dump at a mine.

The last exposure of rock on the Menihek Lake, is at the mouth of the large western branch, twelve miles farther southward. On the south bank of this stream, there is an outcrop of fifteen feet of similar ferruginous chert. From here southward for twenty miles, to the head of the lakes, although no rocks are seen in place, the numerous angular blocks of chert scattered about everywhere, with the continuous similarity in character of the country, lead to the belief that the Cambrian rocks continue underlying the drift to the entrance of the river, where the surface changes in aspect and loose blocks of Huronian schists replace those of chert.

Lake Michikamau.

Rocks on Lake Michikamau.

The basin occupied by Lake Michikamau seems to have been cut out of the lower beds of the Cambrian series, and the area of these rocks here may be connected with the main mass to the north of Lake Petitsikapau, as the wide valley partly occupied by Lake Michikamau extends far beyond the north end of the lake towards the main area.

Lowest beds of the Cambrian.

Although there are only a few places about the lake where the Cambrian rocks are seen in place, there is no doubt but that these rocks are everywhere present in the bottom of the lake, and that the loose angular masses of sandstone which are very abundant in many places along the shores, have been shoved by the ice out of the water into their present position. Only the lowest beds of the Cambrian series are met with, consisting of red conglomerate and red sandstone, with a few beds of limestone above them. On the west side of the lake, from the south end northward to the beginning of the anorthosite area, the shores are low and all the points are thickly strewn with angular blocks of red sandstone. This sandstone varies in texture from fine to coarse, and some of it is mottled with light-pink and green blotches. Such blocks are much more numerous than the gneissic boulders found along with them. The north end of the lake is low and the shores are formed chiefly of sand; the scattered boulders are mostly large and consist of Archæan rocks, these being much more abundant than the Cambrian sandstones. Southward along the eastern side, the blocks of sandstone are not numerous on the sandy shores until the anorthosite rocks have been passed, when they again become plentiful.

Eight miles north of the outlet of the lake, the low granite hills along the shore, and the numerous small islands, are almost completely covered by large blocks of sandstone and light bluish cherty limestone. These blocks continue numerous until the hill on the north side of the discharge is reached, where patches of bluish-gray limestone are seen resting on the sides of the granite hill, and along the base of the hill thin beds of red sandstone rest at a high angle against the granite. Beds nea outlet.

To the south of the outlet of the lake the shores are again low and sandy. As the south end of the main body of the lake is approached, huge blocks of coarse sandstone and fine conglomerate are seen on the low shore and islands.

The conglomerate probably represents the lowest beds of the series. Its matrix is a coarse sandstone, or more properly grauwacke, as it contains many small angular fragments of orthoclase, intermixed with the quartz grains. The pebbles of the conglomerate are mostly small, but are occasionally as much as nine inches in diameter. They are composed almost wholly of various kinds of hornblende-granite, mostly fine-grained, along with a few white quartzite pebbles, no anorthosite pebbles being seen. The conglomerate passes into a coarse red sandstone, and the latter, becoming fine-grained, passes into a very siliceous limestone, of a light bluish-gray or pink colour. The limestone is often greatly contorted, and at times the weathering of the finely bedded and highly contorted rock presents the appearance of organic structure similar to that of *Stromatopera*. Conglomerates.

The low rounded islands of granite that form a wide fringe along the south shore of the lake, are covered by these blocks of sandstone and limestone, the latter predominating towards the western side of the lake. Many of these blocks contain more than fifty cubic feet, and are apparently almost undisturbed.

Economic Minerals.

Gold. *Gold.*—This metal was not actually observed in any of the rocks along the routes followed; but it may occur in the numerous small quartz-veins that cut the Huronian rocks, carrying iron- and copper-pyrites when close to the eruptive masses penetrating this formation. The shales of the Cambrian formation are also cut by numerous quartz-veins, often highly charged with pyrites; and these may contain gold, although careful examination of a number of them failed to show traces of free gold. It is to be regretted that circumstances prevented the search from being carried on by panning the gravels of these areas. The most promising localities for future investigation are along the Koksoak River, especially in the vicinity of the Manitou Gorge, a few miles above the mouth of the Stillwater River, where the quartz-veins carry abundance of pyrites, and some of them small quantities of galena.

Silver. *Silver.*—This metal has only been found associated with lead in the limestones of the Cambrian area of the east coast of Hudson Bay, where, according to Dr. Bell,* it occurs in bunches of galena in a band of magnesian limestone twenty-five feet thick, in quantities sufficient to be of economic value. This band was traced from Little Whale River to Richmond Gulf, a distance of about twelve miles. Assays by Dr. Harrington give 5·104 to 12·03 ounces of silver per ton. An opening was made by the Hudson's Bay Company at Little Whale River several years ago, but the working proved unprofitable and was soon abandoned. This galena-bearing band of limestone was not observed in the Cambrian areas of the interior, and that ore was only found in small quantities in a few little quartz-veins along with pyrites.

Copper. *Copper.*—Copper-pyrites is sparingly met with in the Huronian, but not in the Laurentian or Cambrian rocks along the routes traversed. In the neighbourhood of Paint Mountain, on Lake Chibougamoo, the chloritic schists are charged with a small percentage of copper-pyrites associated with iron-pyrites; but where seen the ore was too sparsely disseminated to be of economic value, and the indications of copper

* Report of Progress, Geol. Surv. Can., 1877-78, p. 20 c.

here are only valuable as pointing to the possible occurrence of more concentrated bodies of ore in the neighbourhood. On the East Main River, a few miles above the mouth of the Broken-paddle River, copper-pyrites was met with in small quartz-veins, cutting the chloritic schists of Huronian age.

Iron.

Iron.—The immense deposits of magnetite, hæmatite and siderite in the Cambrian formation, and their wide-spread distribution, may at some future date be of economic importance, especially those containing a large percentage of manganese which fits them for use in the manufacture of steel by the Bessemer process. The mode of occurrence of these ores appears to be closely analogous to that of the iron ores of Michigan and Wisconsin.*

Possible mode of formation of the ores.

The ores are always associated with a cherty limestone, and this cherty carbonate of lime is very wide-spread, being met with on the east coast of Hudson Bay, at Lake Mistassini, and along the Koksoak and Hamilton rivers. The associated iron carbonates are more limited in their distribution, being confined to portions of the country adjacent to Koksoak and Hamilton rivers, and to the northern part of the Hudson Bay area.

C. R. Van Hise, holds that the similar ores of Michigan and Wisconsin were originally deposited as carbonates along with lime and silica, and that the richer ores of magnetite and hæmatite are concentrations of the iron so deposited, carried by leaching waters holding silica to the lowest beds, where they were re-deposited in a concentrated form, in troughs formed by the tilted lower fragmental beds of the series on the one side, and trap dykes on the other.

From the limited study of the Labrador areas, it is impossible to say whether this is the general case there, but on the Hamilton River, several of the large deposits of magnetite were close to, and apparently influenced by large dykes of diabase. Only in one place were the richer ores found undisturbed, at the entrance of Menihek Lake, and here they rested upon a flat-bedded impervious trap-rock. Along the Koksoak River, large dykes are not seen, and the rich ores are found always beneath and associated with the cherty carbonate ores, but in some places they did not appear to lie beneath these, but were rather interbedded with them.

Ores of Koksoak River.

The bedded iron ores are first met with in descending the Koksoak River, on the south bank, just below the Shale Chute, or a few miles below Cambrian Lake, where a thin section of jaspery magnetite is overlain by twenty feet of cherty limestone containing large blotches

*U. S. Geological Survey, Monograph XIX. Penokee Iron-bearing Series of Michigan and Wisconsin.

Shale Chute.

of carbonate of iron. The following analyses of the ores were made in the laboratory of the survey by Mr. F. G. Wait :—

The jaspery magnetite ore :—

		Per cent.
(1.)	Metallic iron	31·28
	Insoluble matter	55·71
	Titanic acid	none.

The carbonate ore of the upper beds is described as a mixture of ankerite and magnetite.

		Per cent.
(2.)	Metallic iron	33·62
	Insoluble matter	4·99
	Titanic acid	none.

Exposure of bedded ores. Shale Chute to Swampy-bay River.

For the next ten miles, to the mouth of the Swampy-bay River, exposures of iron-bearing rocks are almost continuous, and the amount of ore in sight must be reckoned by hundreds of millions of tons. The ore is not everywhere high-grade, and probably a large proportion of it would be unprofitable to work, but there is certainly an almost inexhaustible supply of high-grade ore. It may here be mentioned that specimens were not procured from the thickest and richest beds, owing to the impossibility of breaking up the rounded and glaciated surfaces with the small hammers. Two miles below the last-mentioned exposure, the rocks were found to consist of a twenty-five-foot bed of jaspery ore, composed largely of magnetite with a small admixture of hæmatite, underlain by ten feet of siliceous, ferruginous limestone, holding spathic ore in bands and nodular masses up to several hundred pounds in weight. A great part of the magnetite is nearly pure and contains little jasper. The beds are exposed along the right bank of the river for more than a quarter of a mile.

Five miles below Swampy-bay River.

The rocks were again examined three miles and a half farther down-stream, where only the cherty carbonates were found; but half a mile below, the river passes close to a high hill on the west side, where fifty feet of red garnetiferous, siliceous, ferruginous shale and jasper are overlain by 200 feet of jaspery ore, composed chiefly of magnetite and coloured by an admixture of hæmatite. An analysis of the ore in the garnetiferous rocks gave :—

		Per cent.
(3.)	Metallic iron	19·14
	Insoluble matter	72·86
	Titanic acid	none.

And another analysis of the ore from the beds above gave :—

		Per cent.
(4.)	Metallic iron	48·29
	Insoluble matter	30·62
	Titanic acid	none.

On the same side, half a mile below, the section exposed on the hill-side shows 400 feet of jaspery magnetite and hæmatite, overlain by fifty feet of cherty carbonate ore. A specimen of the jaspery ore containing a large percentage of hæmatite gave :—

		Per cent.
(5.)	Metallic iron	54·35
	Insoluble matter	16·03
	Titanic acid	none.

The bedded iron ores outcrop along the river for about three miles farther down-stream to near the mouth of the Swampy-bay River, and then the main stream turns eastward and passes between banks of shale and siliceous limestone, so that the iron-bearing members are not again seen along its banks.

Iron ores of Hamilton River.

On the Hamilton River, the cherty carbonate rocks are well developed along the shores and in the hills surrounding the lakes from Birch Lake to the Menihek Lakes on the Ashuanipi Branch. The faulting of the rocks has caused these measures to be repeated in four ridges in a distance of about twenty-five miles across the strike. The most westerly ridge runs along the west side of the Menihek Lakes ; the next is along the east side of Astray Lake ; the third forms the ridge between Dyke and Petitsikapau lakes, and the last forms the watershed between Petitsikapau and the head-waters of the George River.

Ore near Lake Petitsikapau.

The concentrated magnetite and hæmatite ores were first met with at the rapid at the discharge of Dyke Lake, where two beds each about five feet wide were found associated with cherty carbonate and a siliceous trap ash-rock. At the narrows into Lake Petitsikapau, over twenty-five miles beyond along the same ridge, the ores again come out on the shore for 200 feet, with a width of twenty feet. Analysis of the ores from this place gave :—

	Per cent.
Metallic iron	30·43
Insoluble matter	51·22
Titanic acid	none.

At the head of the middle northern bay of Astray Lake, there is a low hill where 150 feet of jaspery magnetite and hæmatite are seen. Some of the ore-beds are two feet thick between the jasper partings. Fifty feet of similar ore are exposed on the shore of the north-east bay, about two miles from its head.

Manganiferous iron ores.

At the outlet of the Menihek Lakes, large blocks of jaspery ore are scattered about, and they appear to rest horizontally on beds of trap. Here the magnetite and jasper are arranged in distinct layers, and the jasper is not broken as in all the other exposures where the rocks have been disturbed. This ore on analysis gives :—

	Per cent.
Metallic iron	40·72
Insoluble matter	29·90
Titanic acid	none.

These were all the outcrops met with on the waters of the Hamilton River, but they are sufficient to show that the deposits are wide-spread and that the ores will be found in practically inexhaustible quantity.

In the Hudson Bay area, the more concentrated ores are not abundant, but there are great thicknesses of the cherty carbonates. Specimens of the ores brought home by Dr. Bell and analysed by Dr. Harrington, gave:—

	Per cent.
Metallic iron	25·44
Carbonate of manganese	24·00

an excellent ore for spiegeleisen, and for conversion with richer ores into Bessemer steel.

The percentage of manganese in the ores from the Koksoak River area is considerably lower than in the Hudson Bay ores, but sufficient is present to give promise of richer deposits. The following analyses of No. 2 and No. 5, show the percentage of manganese in these ores :—

		Per cent.
(No. 2.)	Ferric oxide	23·43
	Ferrous oxide	21·32
	Manganous oxide	1·34
	Insoluble residue	6·72
(No. 5.)	Ferric oxide	80·17
	Ferrous oxide	0·35
	Manganous oxide	3·09
	Insoluble residue	13·78

Mouchelagan River. Great bed of magnetite.

On the portage-route past the upper part of the Mouchalagan River, thick bands of magnetite were met with on Little Matonipi Lake, and on the portage leading northward from the larger lake, the Indians report that there is a hill of similar ore several miles west of the last-mentioned place in the same direction as the strike of the rocks. Large masses of similar ore were also seen on the Mouchalagan River, so that it appears that this deposit may be traced more than forty miles along the strike. The ore is associated with the mica-gneisses and limestones of the supposed bedded series of the Laurentian. In composition it varies from a pure magnetic ore to a ferruginous gneiss. The quantity of ore seen is very great, as the band is more than 100 feet wide.

Titanic Iron Ore.—Throughout the great anorthosite areas of the peninsula, ilmenite or titanic iron ore is always found in more or less abundance, varying from small grains to masses several tons in weight. The banks of the rivers passing through these areas usually have thick beds of black iron-sands scattered at intervals along them, these iron-sands being derived from the disintegration of the anorthosite rocks. Ilmenite.

Pyrites.—This mineral is abundantly found both in the Huronian and Cambrian rocks. In the area of Huronian to the south-west of Lake Mistassini, the chloritic schists, close to the junction of the eruptive masses of basic and acidic rocks, are always highly charged with pyrites. At Paint Mountain, on the south-west shore of Lake Chibougamoo, the schists are very pyritous, and a zone extending twenty feet from the contact with the granite mass holds at least twenty-five per cent of pyrites. Along the narrows leading to the east end of the lake, highly pyritous chloritic schists are met with for upwards of a mile. Pyrites.

On the East Main River, the schists at Conglomerate Gorge, in the vicinity of the large diabase dyke, are highly pyritiferous. Three miles above the gorge there is another large area of schist charged with pyrites.

Half a mile above the mouth of the Wabamisk River, is a large deposit of pure pyrites in a green chloritic schist. Where it is exposed along the river, the deposit is ten feet thick and 100 feet long, being concealed under drift at both ends. Large outcrop of iron pyrites.

In the Cambrian formation, pyrites is found in nearly all the strata, and is always present in the black and green shales. The black shales, when exposed in cliff-faces, always weather brownish-red from the oxidation of the contained pyrites. This mineral is particularly abundant at the Shale Chute, where it is found strung out in lenticular masses between the partings. In many places these masses are so large and close together that, if they were more accessible, they might form a pyrites ore. At the Manitou Gorge, similar masses of pyrites are present in the black shales and also in the quartz-veins cutting them.

Along the Hamilton River, the black shales are usually charged with pyrites, but no locality was seen where the percentage was sufficiently great for profitable working.

Anthraxolite.—A bituminous mineral with the lustre and colour of anthracite, is found in the Cambrian black shales and limestones, where it occurs either as irregular veins or in small irregular globules in veins of quartz and calcite, cutting the limestones. This mineral is widely distributed, being found at Lake Mistassini, at Petitsikapau and Anthraxolite.

Menihek lakes on the Hamilton River, and also on Long Island in Hudson Bay.

At Lake Petitsikapau the largest amount was found in loose blocks scattered about with broken shale, and, from the pieces found, it probably occurs as a vein from six to eight inches wide, with quartz lining the vein. The mineral is arranged in small flattened plates set at right-angles to the walls and these plates inclose little rounded grains of quartz, and are themselves often coated with ferric hydrate. The following is an analysis of a specimen from this locality made by Dr. Hoffmann:—

	Per cent.
Water (at 110°–115° C.)	3·56
Additional loss on ignition in closed vessel	2·48
Fixed carbon	86·83
Ash (light reddish-brown)	7·13
	100·00

"The ash, which consisted for the most part of silica, would appear to be almost solely derived from accidental impurities, a view strengthened by the fact that other fragments of this material—which, although most carefully picked, were not regarded as absolutely above suspicion—left on ignition but 0·31 per cent of ash."

The analysis of a fragment picked up on Long Island, and also examined by Dr. Hoffmann, gave 94·91 per cent of fixed carbon and only 0·25 per cent of ash.

Its character. From the above analysis and the mode of occurrence of this mineral, it is seen that it is the result of the hardening of probably liquid bitumen, derived from the carbon of the adjoining rocks, and inclosed in quartz or calcite veins, where it has lost much of its volatile matter and has assumed its present form. It is obvious that the occurrence of this mineral affords no indication of the existence of coal, as ordinarily understood, that is in beds of economic value for mining and burning.

Mica. *Mica.*—This mineral often occurs in large crystals in the massive pegmatite dykes met with everywhere throughout the Archæan rocks, but in very few places was commercial mica found, owing to the bent and broken nature of the crystals. The best locality noted was on the East Main River, between the Talking and Island falls, where the mica was in large plates of a light greenish coloured muscovite. Near the head of Lake Winokapau, fine crystals were seen in a large dyke of red pegmatite, and other localities might be mentioned which would repay prospecting if they were more accessible.

Ornamental Stones.—The agates found in the melaphyres of the Hudson Bay coast are often large and beautifully coloured and banded, and would polish well. The jasper of the iron-bearing rocks varies in colour from bright vermilion to crimson, and sometimes green. The red varieties are often in large masses, and slabs several square feet in surface and more than six inches thick, are easily obtained in many places. On the Koksoak River there is a thick band of apple-green jasper, brecciated with small angular fragments of the red varieties, which might be used for pannels and other decorative purposes. On the Hamilton River, near the outlet of Dyke Lake, the jasper conglomerate is in places formed of small pebbles cemented with white quartz and it can take a high even polish. Ornamental stones. Jasper.

Labradorite of the precious variety occurs in great abundance on the north-east side of Lake Michikamau, where large and beautiful crystals of this mineral are seen continuously along the shore for more than ten miles. The play of colour in these large crystalline masses when placed below the surface of the water is particularly splendid, the opalescent hues varying from deep cobalt-blue to green and bronze yellow. On some of the faces the lines of growth of the crystal are distinctly marked by the different colours arranged in concentric bands. Among other localities where the precious labradorite is found, may be mentioned the islands in Lake Ossokmanuan, and the shores of the Romaine River above the burnt lakes. Labradorite.

Building Stones.—Many of the limestones of the Cambrian areas would answer admirably for building purposes, as would also the hornblende-granites, but, as the rocks are so far away from any point of shipment, they are valueless. Building stones, cement rock, etc.

Cement Rock.—The rusty-weathering bands of magnesian limestone might very probably yield a hydraulic cement on burning.

Grindstones.—The hard sand-rock at the base of the Cambrian, would answer for this purpose, while the fine-grained cherty beds in the limestones would make good hone-stones.

Excellent flag-stones could be obtained from the green felsite slates of the Cambrian, and other materials such as brick clays, etc., of economic value, when near settlements, are abundant in the Labrador Peninsula, but are practically valueless owing to the distance from any market.

Glacial Geology.

The observations of striæ and other glacial phenomena taken along the different routes followed during these explorations, in conjunction Extent and movement of the ice.

with similar evidence previously obtained on the rivers flowing westward into Hudson Bay, all show that the Labrador Peninsula, with the exception of a narrow strip of highlands along the North Atlantic Coast, was completely covered with ice during a portion at least of the glacial period. The movement of the ice followed the general slope of the country outward in all directions from a central gathering-ground, or nevé, and the thickness of the ice was such that in its flow it passed over ridges and valleys unchanged, or with only minor deflections.

Either the greatest thickness of ice was to the northward of the southern watershed, or there have been slight changes in the relative levels of the central area since the glacial epoch, as the present watersheds do not altogether correspond to the former central nevé grounds.

Position of central nevé.

The central nevé ground, characterized by but slight traces of glacial motion, is situated about midway between the east and west coasts of the peninsula, and between latitudes 53° and 55°, consequently its southern boundary is from fifty to two hundred miles north of the present southern watershed.

Its characteristics.

The region occupied by this nevé is marked by the presence of partly rounded boulders and angular blocks of rock scattered indiscriminately over hill and hollow. These blocks and boulders, in the great majority of cases, rest upon rocks of the same kind, and have evidently not been transported to any distance from their original positions. They are often of great size, and are heaped together loosely, so that it is a dangerous undertaking to scramble up the steep sides of the hills owing to the liability of displacing them. In many places large blocks are seen perched upon much smaller ones, even on the very summits of the highest rocky hills. Either these conditions of the loose rocks must be due to their having been sub-angular cores in the rotted gneisses and granites, from which the finer material has been carried by water or by slowly-moving ice; or their present position is due to the boulders having been dropped upon one another from the ice-sheet that inclosed them when the ice finally melted away. The former supposition seems the most likely. The loose piles along the sides of the hills may in a great measure be due to the simple falling of the harder cores from higher elevations after the removal of the finer material, and the disappearance of the ice.

Few traces of glaciation in it.

In that part of the nevé ground crossed between Nichicun and Kaniapiskau lakes, the country is very rough and broken into ridges of sharply rounded hills of granite, that rise from 300 to more than 800 feet above the neighbouring lakes. In this area the signs of glaciation on the rock surfaces are very indistinct and no well-marked striæ were found showing the direction in which the ice moved. The outlines of the hills, although rounded, are much sharper and more angular than in the regions where the glaciation is well marked by striæ and where the smaller angular projections have been reduced to a common gentle curve by the grinding power of the ice-transported drift.

General directions of motion of ice.

The following list of glacial striæ will show the various directions of the ice-movement down the different slopes of the peninsula.

Watershed south of Lake Mistassini.

The watershed south of Lake Mistassini, extends from north-north-east to south-south-west and slopes rapidly towards the north-west, falling from 300 to 500 feet in a few miles, thus forming an escarpment that has been observed to extend from Lake Temiscamie to the north-east of Lake Mistassini, to beyond Lake Obatagoman to the south-west of that lake, or in all more than 200 miles. This escarpment appears to have played an important part in determining the direction of the ice-flow in that region.

Glaciation north of watershed.

On the north side of the escarpment, along the Mistassini lakes and the large lakes to the south-west of them, the general direction of glaciation was toward S. 30° W., or nearly parallel to the trend of the escarpment.

South of watershed.

On the southern watershed, near its head, and on a considerably higher level, the glaciation was not intense. There was, seemingly, an area where the ice-movement was small, and not to a considerable distance southward are the glacial striæ well-marked, when, as on the different branches of the Chamouchouan River, they show a movement towards the south or generally a few degrees to the east of south. On the Manicuagan River and the surrounding table-land, to the head of the river in Summit Lake, the direction of the ice-movement runs a few degrees west of south. At Summit Lake, on the watershed between the Manicuagan and Koksoak rivers, the striæ are well marked on the top of a hill 565 feet above the lake, thus showing that the thickness of ice here was considerable, and that the centre of movement was situated to the northward of the present watershed.

Two sets of striæ north of Lake Mistassini.

Northward of Lake Mistassini, two sets of striæ are found, extending to the East Main River and down that stream to within 200 miles of the coast. The older of these sets runs S. 20° W., or nearly parallel to the direction of flow about Mistassini. The newer set extends from the nevé region about Lake Nichicun, where the general direction of the ice-movement is towards S. 40° W. to the vicinity of the portage-route from the Rupert River to the East Main, or about 300 miles from the coast. Beyond this, as the coast is approached, the direction of flow gradually tends more and more towards the west, until within the last hundred miles the general course is S. 70° W.

Striæ on various rivers east of Hudson Bay.

When within fifteen miles of the mouth of the river, there is a rapid change in the direction of the striæ, which from here to and about the mouth of the river run about S. 40° W. As stated in a former report,* along the Big River, which flows into the east side of James Bay about 120 miles to the north of the East Main River, the general direction of the striæ for more than 200 miles inland is towards S. 75° W. The direction along the interior route between the Big and Great Whale rivers is S. 60° W., and along the lower course of the last mentioned stream N. 70° W. Farther north, in the area between Clearwater Lake and Richmond Gulf, the glacier moved S. 80° W., or everywhere a few degrees north or south of west into Hudson Bay, at all times following the general slope of the country.

Northward motion of ice.

The first definite striæ showing a northward movement of the ice, were met with at Lake Kaniapiskau, where the striæ run N. 85° E., and after a few miles along the Koksoak River, they bend round to N. 60° E., and then to N. 20° E., which general direction they hold until the Koksoak River passes down off the table-land into a distinct deep valley. In the valley, the direction of the striæ is to a great extent governed by its trend, and runs east or west of north with the valley. Not until the valley widens out and the surrounding country falls away, below the junction of the Stillwater River, do the striæ again have a uniform course of N. 40° E.

On the hills about the Hudson's Bay post, situated some twenty miles above the mouth of the George River, which flows into the south-east corner of Ungava Bay, the glaciation is towards N. 60° E. Near Port Burwell, just inside Cape Chidley, the north-eastern point of Labrador, the lower hills only are glaciated, and the striæ run N. 10° E. On Hamilton Inlet, where the highest hills are rounded and have been apparently well-glaciated to their summits, the direction of the striæ is north-east, or parallel to the general direction of the inlet.

Striæ of Hamilton River valley.

In the valley of the Hamilton River, the conditions are not favourable to the study of the course of glacial movement, owing to the great depth of the valley below the general level of the table-land, as well as to the few exposed rock surfaces. The snow was also deep at the time this valley was examined. Striæ were found on the rocks at the Muskrat Falls, about twenty-five miles above the mouth of the river, where they run directly east. From here no striæ were observed until Lake

*Annual Report, Geol. Surv. Can., vol. III. (N.S.), p. 62 J.

Winokapau was reached, where the southern wall of the valley only is rounded and striated by ice. In the valley the movement was directly east, while on the top of a small peak on the table-land, on the south side of the head of lake, the striæ run N. 80° E. The only other striæ noted in this valley occur about seven miles below the Big Hill Portage, and there the direction is S. 65° E.

Near Grand Falls.

On rising with the river to the level of the table-land at the Grand Falls, the whole surface is well-glaciated, and striæ are found on the summits of the higher hills. In the vicinity of the Grand Falls the ice-movement was towards S. 70° E. Following the river upward to Sandgirt Lake, the striæ are found to vary in direction from S. 45° E. to S. 70° E. This variation appears to be due to the occurrence of two distinct sets of striæ, which, however, were never seen crossing each other.

On Ashuanipi Branch. Two sets of striæ.

Along the Ashuanipi Branch, as far as Dyke Lake, the direction of flow continues towards S. 45° E. Here an older set of striæ towards N. 60° E. is found, at first imperfectly seen beneath those first noted, but in the course of a few miles becoming much better developed as those of the other set gradually die out. About Lake Petitsikapau, only the N. 60° E. set is found, even on the high hills (420 feet) about the north side of the lake. On a small area between Dyke and Astray lakes, the ice-movement appears to have been somewhat erratic, and sets of striæ having S., S. 50° W. and S. 50° E. directions are found. About Astray Lake and along the river above to the Menihek Lakes, the direction is again constant and towards S. 50° E. Along the Menihek Lake and the river stretch above, to the end of survey on the Ashuanipi Branch, no striæ were noted on the few rock exposures met with. This was due to the broken character of the rock, and does not imply any exemption from ice action. Passing north-eastward from Sandgirt Lake to Lake Michikamau, the direction of the striæ varies from S. 70° E. to E.

On Attikonak Branch and southward.

On the Attikonak Branch of the Hamilton River, above Sandgirt Lake, two sets of striæ are met with, S. 45° E. and S. 75° E. respectively, the last being the older. Along Ossokmanuan Lake the older set dies out, leaving the newer striæ, which at the head of the lake bend more to the southward (S. 5° E. to S. 20° E.) until Attikonak Lake is reached, when the general direction again becomes S. 45° E. This direction is maintained southward along the Romaine River to where the portage-route leaves it for the St. John River. On the area of high anorthosite hills between the rivers, striæ were found only at the first lake of the portage-route, and are there S. 10° E. The absence of striæ in this region is due rather to the rotted state of the rock surfaces than to the want of glacial action, as there is distinct evidence in the drift and in the rounded outlines of the hills to show that it was ice-covered.

Along the St. John River the course of the striæ is influenced by the direction of its deep valley, the striæ following in the main the course of the river.

Probable great thickness of ice.

The strong glaciation of the highest hills in the interior, on the edges of the nevé region, the constant directions of the striæ over hill and valley, and the fact that the general slope of the plateau from the interior outwards is very slight and does not exceed two or three feet per mile until within a few miles of the coast, all point to a considerable thickness of ice in the interior such as to cause the strong, radial flow of the ice evidenced by the glaciation of the region.

The following list of striæ, from which the above summary has been compiled, includes all the observations taken during the seasons of 1892, 1893 and 1894.

List of glacial striæ.

List of Glacial Striæ.

Southern Watershed.

	Direction.
Chamouchouan River :—	
Chaudière Portage	S. 15° E.
2nd Portage Chief River	S.
5th " " "	S. 35° E.
3rd " Sapin Croche River	S.
Lake Bonhomme	S. 12° W.
File-axe Lake	S. 05° E.
20 ft. chute, Shegobiche River	S. 25° E.
Chegobich Mountain	S. 05° E.
Height-of-Land Lake	S.
Romaine River :—	
Mouth of Attikonak Portage Creek	S. 45° E.
At rapid, two miles below	S. 45° E.
Foot of Upper Burnt Lake	S. 45° E.
12 miles below Burnt Lakes	S. 45° E.
At Two Chutes	S. 30° E.
Portage route to St. John River, 1st lake	S. 10° E.
St. John River :—	
1 mile below portage route from Romaine River	S. 30° E.
3 miles " " " " " "	S. 40° E.
3 miles below Upper Forks	S. 05° E.
13 miles below Portage	S. 25° W.
3 miles below Chambers River	S. 05° E.

	Direction.
Manicuagan River:—	
4 miles above the mouth of the river	S. 45° E.
Below the 4th portage	S.
10 miles below the 5th portage	S. 10° E.
10 miles up west shore Mouchalagan Lake	S. 55° E.
Partridge-tail Hill, " "	S. 20° E.
Mouth of Mouchalagan River	S. 20° E.
Entrance to Little Matonipi Lake	S. 10° W.
On summit leading from Matonipi Lake	S. 5° W.
On summit near Kichewapistoakan Lake	S. 5° W.
1st chute south-west branch, Attikopi River	S. 45° E.
3rd chute " " " "	S.
Near entrance to Lake Naokokan	S. 15° W.
On summit of hill, 3rd lake beyond Attikopish Lake	S. 40° E.
On summit of hill, south end Summit Lake	S. 10° W.
On east shore, Summit Lake	S. 10° W.
On hill (565 feet) at north end Summit Lake	S. 5° W.
On east shore Itomamis Lake	S. 8° W.
Western Watershed.	
Lake Chibougamoo:—	
Paint Mountain	S. 30° W.
South-west Point	S. 15° E.(?)
At narrows	S. 33° W.
Lake Wahwanichi	S. 20° W.
Lake Mistassini:—	
Near outlet	S. 23° W.
Islands in centre	S. 23° W.
Rupert River:—	
1st portage	S. 25° W.
3 miles below	S. 30° W.
Pinched-neck Lake	S. 25° W.(?)
" "	S. 18° W.
Portage route between Rupert and East Main rivers:—	
Lake No. 1	S. 53° W.(?)
" " 4	S. 55° W.(?)
" " 7	S. 53° W.(?)
Huronite dyke, Lake No. 7	S. 25° W.
Summit of Hill Portage	S. 18° W.
Lake No. 11	S. 35° W.
" " 13	S. 35° W.
Clearwater Lake	S. 43° W.
Discharge, Clearwater Lake	S. 45° W.
East Main River:—	
On shore of James Bay, 13 miles north of river	S. 38° W.
On shore of James Bay 9 miles north of river	S. 48° W.
" " 4 " "	S. 49° W.
Governor's Island, at mouth of river	S. 45° W.
5 miles above mouth of river	S. 48° W.
12 " " "	S. 40° W.
At head of tide	S. 62° W.
Basil Gorge	S. 62° W.
1 mile below Talking Fall	S. 70° W.

	Direction.
Island Fall	S. 66° W.
Clouston Gorge, at foot	S. 54° W.
" " middle	S. 69° W.
" " head	S. 60° W.
Conglomerate Gorge	S. 71° W.
10 miles below Kausabiskau River	S. 68° W.
8 " " " "	S. 71° W.
4 " " " "	S. 68° W.
2 " " Wabistan River	S. 63° W.
At mouth of " "	S. 65° W.
4 miles below Wabamisk River	S. 65° W.
2 " " " "	S. 58° W.
3 " " Akuatago River	S. 53° W.
At mouth of " "	S. 58° W.
4 miles above " "	S. 65° W.
12 miles above the last	S. 65° W.
2 miles below Great Bend	S. 57° W.
At foot of " "	S. 57° W.
5 miles down " "	S. 55° W.
1 mile below north-west bend	S. 40° W.
½ " " " "	S. 36° W.
1 mile above lake expansion	S. 22° W.
1 " " Sharp Rock Portage	S. 40° W.
At next chute above	S. 38° W.
Mink Portage	S. 40° W. S. 15° W. (old)
Channel Portage	S. 40° W.
4 miles above last	S. 35° W.
Cascade Portage	S. 45° W.
Opemiska Lake at entrance	S. 45° W. S. 25° W.
" " (east end)	S. 40° W.
Rapids between Opemiska and Wakemen Lake	S. 40° W.
Wahemen Lake	S. 38° W.
Big River:—	
2 miles below portage from Crooked Lake	S. 40° W.
Little Back Lake	S. 33° W.
1st portage below Lake Nichicun	N. 80° W. (?)
Square-rock Lake	S. 30° W. S. 40° W.
Eagle Lake	S. 55° W.
Koksoak River:—	
Lake Kaniapiskau	N. 50° E.
3 miles below Lake Kaniapiskau	N. 60° E.
8 " " last	N. 60° E.
23 " " "	N. 55° E.
At head of Great Bend	S. 56° W.
½ mile below last	N. 25° E.
Middle of Big Island	N. 20° E.
Foot of Big Island	N. 25° E.
Foot of 1st gorge	S. 85° E.
8 miles below last	N. 15° E.
3 " "	N. 25° E.
12 " "	N. 20° E.
6 " "	N. 25° E.

	Direction.
15 miles above Sandy River	N. 55° E.
3 " " " "	N. 30° E.
2 " " " "	N. 60° E.
At 2nd gorge	N. 20° E. N. 25° E. N. 60° E.
At chute 1 mile below 2nd gorge	N. 30° E. N. 55° E. N. 70° E.
On portage past Eaton Cañon	N. 5° W.
5 miles below Goodwood River	N. 25° W. N. 40° E.
6 miles below last	N. 25° W. N. 35° E.
2 miles above Granite Fall	N. 53° E.
At Granite Fall	N. 30° E. N. 50° E. N. 70° E.
12 miles below Granite Fall	N. 5° W.
4 miles below Broken-paddle River	S. 57° W. S. 14° W. (old)
2 " above " " "	S. 58° W.
5 " " " " "	S. 54° W.
3 " " the last	S. 54° W.
7 " " " "	S. 49° W
4 " " " "	S. 53° W.
9 " " " "	S. 51° W.
11 " below Prosper Gorge	S. 50° W.
Foot of " "	S. 51° W.
At chute " "	S. 53° W.
3 miles above " "	S. 51° W.
Foot of Ross Gorge	S. 47° W.
Outlet of Nesaskuaso	S. 43° W.
1 mile below foot of Grand Island	S. 43° W.
3 miles above " " "	S. 43° W.
Head of " "	S. 18° W.
Two miles above " "	S. 47° W. S. 18° W. (old)
Tide Lake	S. 43° W.
Mouth of Tichagami River	S. 47° W.
End of Survey, 1892	S. 43° W.
3 miles above last	S. 40° W.
Mouth of Kawatstakau River	S. 42° W.
2 miles below Sunday Portage	S. 38° W.
1 mile below Pond Portage	S. 40° W.
10 miles below Death River	N. 51° W.
Bend of Cambrian Lake	N. 25° E.
On peninsula 3 miles below last	N. 25° W. N. 10° W. N. 50° E. N. 30° E.
At Shale Chute	N. 20° W.
2 miles above Swampy-bay River	N. 35° E.
3 miles below Stillwater River	N. 35° E.
8 miles " " "	N. 40° E.
17 miles " " "	N. 40° E.
Head of Tide	N. 40° E.
Fort Chimo	N. 40° E.

	Direction.
George River :—	
On island opposite H. B. Post	N. 60° E.
On hills in rear " "	N. 60° E.
Port Burwell	N. 10° E.
Eastern Watershed.	
Lower Hamilton River :—	
At Muskrat Falls	E.
5 miles above Muskrat Falls	N. 85° E.
Lake Winokapau	E.
On Summit at head of Lake Winokapau	N. 80° E.
4 miles below Portage River	S. 65° E.
Upper Hamilton River :—	
Grand Falls	S. 70° E. S. 50° E.
1 mile above Grand Falls	S. 70° E.
On hill east of Jacopie Lake	S. 70° E.
On west side Lookout Mountain	S. 50° E.
On summit	S. 65° E.
Jacopie Lake, at end of portage	S. 60° E.
" " on island	S. 64° E.
" " "	S. 48° E.
" " east channel	S. 44° E.
Head of Flour Lake	S. 72° E.
Outlet of Sandgirt Lake	S. 60° E.
Ashuanipi Branch :—	
On hill 4 miles above Sandgirt Lake	S. 65° E.
At foot of hill	S. 60° E.
3 miles below Birch Lake	S. 67° E.
Top of Hill, east of Birch Lake	S. 50° E.
Outlet of Dyke Lake	S. 45° E.
Dyke Lake, 8 miles north of Fault Hill	N. 60° E. S. 45° E.
2 miles north of last	N. 65° E. S. 45° E.
4 miles north of last	N. 40° E. S. 50° E.
At Petitsikapau Narrows	N. 60° E. S. 50° E.
North end Petitsikapau Lake	N. 60° E.
Hill on north side Petitsikapau Lake	N. 60° E.
On island, east side " "	N. 50° E.
Hill on north-east side " "	N. 58° E.
Rapids at head of Dyke Lake	S. N. 50° E. S. 50° E.
North end of lake above Dyke Lake	S.
At inlet " " "	S. 50° E.
Quartz Hill, Astray Lake	S. 50° E.
South end " "	S. 45° E.
Rapids between Marble and Menihek lakes	S. 50° E.
Attikonak Branch :—	
Mouth of river, Sandgirt Lake	S. 65° E.
2nd rapid above " "	S. 45° E.
Outlet Gabbro Lake	S. 75° E.

	Direction.
Gabbro Lake	S. 45° E.
" "	S. 80° E.
" "	S. 45° E. / S. 80° E.
Entrance to Ossokmanuan Lake	S. 45° E.
Big Island, " "	S. 55° E.
At inlet " "	S. 55° E.
" " " "	S. 45° E.
" " " "	S. 38° E.
At inlet Panchiamichats Lake	S. 20° E.
1 mile above " "	S. 20° E.
9 miles above " "	S. 5° E.
At outlet Attikonak Lake	S. 15° W.
Attikonak Lake, 4 miles above last	S. 5° E.
" " 3 miles south of narrows	S. 45° E.
" " south-east bay 5 miles to end	S. 40° E.
" " ½ mile beyond last	S. 40° E.
Route to Lake Michikamau :—	
Entrance to Lob-stick Lake	S. 50° E.
" " " (below rapid)	S. 70° E.
Islands in " "	S. 70° E.
" " "	S. 80° E.
East end " "	S. 85° E.
East inlet " "	E.
Outlet Overflow Lake	S. 80° E.
West end " "	E.
Lake Michikamau, west bay	S. 75° E.
" " west side	S. 60°-75° E.
" " east side	S. 78°-85° E.
" " south side	S. 72°-80° E.

Till.

Till or boulder-clay.

In the southern half of the Labrador Peninsula, a detailed study of the boulder-clay or till is almost impossible, owing to the dense forest growth which covers the greater part of the area. It is only where extensive fires have denuded the surface of its trees, and much of the thick coating of moss and vegetable matter, that some investigation becomes practicable. Such being the case, only general facts relating to the drift deposits of the interior plateau are given here.

Unstratified drift is found throughout the whole interior, in varying thicknesses. To a great extent it appears to have been formed from the disintegration due to atmospheric decay of the upper portions of the surrounding rock-masses. Everywhere more than seventy-five per cent of the included boulders are from the immediate neighbourhood.

The amount of erosion and the change wrought upon the general surface by glacial action have not been as great as is often supposed. The ice certainly removed a considerable quantity of disintegrated material, with included cores, from the various hills, and deposited it, for the most part, in the adjoining valleys, working with a kind of "cut and fill" action, to reduce the surface to a general uniform level. There is no evidence to show that the glacier ever hollowed or scooped out deep depressions as has been often stated to have occurred elsewhere.

Amount of rock-erosion by ice.

The amount of rotten débris removed from the hills and perhaps also displaced in the valleys, although great, does not represent an extraordinary depth of decayed rock overlying the harder unaltered portion; and the amount of drift now seen throughout the region would not, if evenly distributed over the whole area, afford a thickness greater than 200 feet of loose material.

Resistance of Archæan rocks to waste.

The Archæan rocks that underlie more than three-quarters of the total area of the peninsula, are for the most part not easily disintegrated by the atmosphere, and in many places the striæ present on their surfaces, are as fresh as if made yesterday. This is especially the case when the rock has been protected by even only a very thin coating of drift. From this it may be seen that general erosion is very slow, and that after a certain depth was reached it would practically stop, so that, although an enormous length of time is supposed to have elapsed between the previous submergence of the peninsula in Palæozoic and the beginning of the glacial period, the amount and depth of surface decay was probably much less than might have been anticipated. A further proof of the slow decay of this Archæan mass, is deduced from the deep and ancient river-valleys that extend far inland from the coast on all sides, and of which the Saguenay, Hamilton, Koksoak and Great Whale rivers may be cited as examples. These valleys are the main arteries of drainage of the high interior table-land, and, along with the valleys of their principal tributaries, have been eroded by the water to depths varying from 200 to 1500 feet below the general level, without any corresponding general reduction of the surrounding country to a base-level of erosion, as might have occurred, had the underlying rocks been composed of the softer sedimentary deposits usually holding carbonate of lime.

Great age of amin drainage valleys.

These valleys are of great age, that of the Saguenay having been at least partly formed before the Cambro-Silurian period, while the Hamilton Valley antedated the deposition of rocks of Lower Cambrian age.*

* If the deductions from the evidence above be correct, it follows that the theories advanced by several writers to the effect that the gorge of the Saguenay and other similar valleys in this part of the continent were eroded mainly during the Pliocene uplift immediately preceding the glacial period are incorrect.

The process of formation of these valleys has continued slowly to the present day, by the agency of falling water and of frost. At their heads the valleys can be seen cutting farther and deeper into the central area, as at the Bodwoin Cañon below the Grand Falls on the Hamilton River. These deep-cut valleys, not having yet become complete, the drainage of the central area is by streams flowing in shallow channels, and following the light general slope of the country. In this central region, the former drainage system appears to have been considerably modified by the movement and deposition of glacial drift, which forms low ridges traversing the country, damming back the rivers to form lakes, with rapid stretches between, where the streams either flow over low rocky ledges, or down rapids full of boulders.

Till usually in ridges.

The greatest mass of the till is arranged in long ridges, roughly parallel to the direction of the glacial striæ, and these are often separated by almost driftless tracts, which are rarely seen along the principal water-courses, but are met with when the routes leave the streams and pass through the small chains of lakes, as between the Hamilton River and Lake Michikamau, and at the head of Lake Attikonak. These driftless tracts are, however, small and narrow in comparison with the drift-covered areas. The drift ridges found throughout the country are readily divisible into two distinct varieties. The most abundant vary from moderately sharp to wide flat-topped ridges made up of ordinary till and boulders. Where cut by streams they show a section of till with boulders scattered indiscriminately through the mass. They are probably of the nature of drumlins, and may have been formed under the glacier without the agency of water.

These of two kinds.

Esker ridges.

Eskers or ridges of the other variety are generally very sharp and narrow on top, and their outlines and the minor ridges about them are less regular than those of the drumlins. In section they are always seen to be formed of fine, well-rounded drift, and almost always show signs of stratification. The bedding is generally at low angles, and almost constantly dips in the direction of the ice-flow. Boulders are rarely found in the mass, and when they occur are small and well rounded. These ridges are commonly found along the present courses of the larger streams, and appear, in a manner, to determine their direction. It is supposed that they were formed in the beds of streams flowing on or below the ice, near the close of the period of glaciation, when the movement of the ice had become very slow or had ceased on the almost level plateau, the irregularities in their shape and outline being possibly due to variations in their ice-walled channels.

In many places the surfaces of these ridges are exceedingly irregular in outline and are strewn with boulders. The main ridges are traversed by many minor ones, with "pot-holes" between them. The sides of these minor ridges are exceedingly steep, the slopes being higher than the angle of repose of water-laid deposits. The summits of the ridges are usually very narrow and sharp.

Mode of formation.

In their irregular configuration, with numerous "pot-holes" and boulder-strewn surfaces, these ridges resemble terminal moraines in a striking manner, but their general directions are parallel with instead of transverse to the direction of the ice-movement. The conclusion arrived at in regard to their formation and minor outlines, is that the streams which deposited their finer material, must have flowed over ice and were in turn sometimes covered by ice transporting boulders. At the close of the glacial period, when the glacier was finally receding, this superjacent ice, wherever present, when melting dropped the boulders upon the surface, and then the ice below melted, forming in places the sharp irregular ridges and "pot holes," and causing all the irregularities of surface.

Notably long eskers.

These esker ridges can often be traced for long distances. The longest noted, extends from near Summit Lake, in a direction a few degrees west of south, for nearly one hundred miles, to within a short distance of Lake Pletipi, on the upper waters of the Outardes River. Along the Hamilton River, another, beginning at a jumble of broken rock of morainic character at Flour Lake, follows the present course of the river upwards to Dyke Lake. Still another follows the east shore of the Menihek lakes of the Ashuanipi Branch. And others from ten to twenty-five miles long were noted along the East Main, Koksoak, Romaine and Manicuagan rivers.

Moraines.

In many places, boulders heaped up in ridges that appear to run transversely to the direction of the glaciation were seen, being apparently moraines, marking halts in the retrocession of the glacier; but as it was found impossible to trace out these boulder-ridges, nothing definite can be said about them, beyond the fact that they occur and are sometimes found at the lower ends of the esker ridges.

Local boulders.

Boulders are scattered everywhere over the country, and most of them can be traced to the rocks in the immediate neighbourhood; often they are hardly moved, and have simply been broken by frost from the underlying ledges, the angles of the upper blocks being partly rounded. Heaps of this nature are exceedingly common along the portage-route between the Rupert and East Main rivers, and also on the several portage-routes between the head-waters of the larger streams.

Erratics.

Although by far the greater number of the boulders in the drift belong to the immediate neighbourhood, a considerable percentage

Photo. by A. P. Low, 1894.

ESKER RIDGE, ALONG ASHUANIPI BRANCH, HAMILTON RIVER.

of them is far-travelled. The presence of these "erratics" in the drift, proved to be of practical benefit when ascending the different rivers, as they indicate the character of the rocks which occur farther back along the course of the glaciation. Rounded boulders of the Cambrian rocks of the Upper Hamilton River, were thus met with in the river-valley, a short distance above Lake Winokapau, 150 miles from the nearest outcrop, giving the first intimation that an area of these rocks would be found in that part of the interior. These boulders became more numerous as the river was ascended, and were found on the top of Lookout Mountain (500 feet) near the Grand Falls. Above Sandgirt Lake they form over twenty-five per cent of the drift, and on a nearer approach to the Cambrian area constitute over ninety per cent. of its coarse material. From the presence of large numbers of boulders of hornblende-granite in the drift about the Menihek Lake, it is believed that the Cambrian area does not extend far beyond that neighbourhood. In a similar manner, the occurrence of an abundance of Huronian boulders about the Mistassini Lakes, points to the presence of an area of these rocks in the region immediately to the north-east.

Lake Terraces.

On the table-land of Labrador, terraces are met with in many places, both in the river-valleys and along the sides of the lakes. These terraces have been formed at the former margins of the waters in post-glacial or glacial times, when the level was maintained, either by dams of drift since cut down, or by probable local dams of ice, during the last stages of the glacier. Dams of drift will account for perhaps the majority of these terraces, but others remain which cannot have been formed in that manner, and there is no other evidence to show that the post-glacial marine subsidence in Labrador was sufficiently great to form such terraces at elevations varying from 1500 feet to 2000 feet above the sea-level.

Terraces possibly due to drift damming.

Among cases of the first-mentioned kind, may be mentioned Chegobich Lake, at the head of a small branch of the Chamouchouan River, which flows into Lake St. John. This lake, except to the north-west, is surrounded by rocky hills, and has a narrow outlet to the south-east between similar hills, where a dam of drift sufficient to raise its water twenty feet might have occurred and have enabled it to form the terraces found along its shores up to that level.

Lake Wahwanichi, the large lake that empties into the south-west bay of Mistassini Lake, is surrounded by low terraces up to fifteen feet above its present level, which might easily be accounted for by a slight block along its narrow discharge channel.

No signs of terraces are found about Lake Mistassini, and they would be impossible there without an ice dam, as the land to the north and north-west of the lake is low, and slopes rapidly.

Low local terraces were noted on the shores of a number of the smaller lakes on the various portage-routes, but their importance is not sufficient to require a detailed description.

Others not thus explicable. Michikamau Lake.

The terraces about Michikamau Lake may be taken as an example of those formed along a large body of water, where no local dam of drift would prove sufficient to retain the water at a level requisite for their formation. The highest terraces seen about the lake are thirty-five feet above its present level. These are best seen on the islands of drift that fringe the shores, especially off the entrance to the Northwest River. The islands, when lower than thirty-five feet, are flat-topped and have been evidently levelled by water; when higher, their sides are terraced at that elevation, and above it the surfaces are rolling. In small coves along the rocky shores of the lake, distinct beaches of water-worn pebbles are found at two levels, the highest corresponding to the thirty-five-foot terrace, and the lower being about twenty feet above the present lake. This great lake is surrounded by low, broken ridges, separated by wide, flat valleys, only slightly elevated above the present level of the lake, and to the northward another large body of water is separated from the main lake by a low ridge of drift only. Beyond, wide valleys extend to the head-waters of the George River, without any practical change in the general level. At high stages of water the lake at present discharges into the Hamilton River, through one of the numerous low gaps in that direction. To the southward, similar conditions are said to prevail. To the eastward, with such surroundings, a rise of thirty-five feet in the level of the lake would increase its area enormously; this is practically impossible without some barrier such as does not at present exist, for, owing to the minute differences of level in the surrounding water-surfaces, the lake in such a case would simply pour out in all directions, and might empty by either the Northwest, Hamilton or George rivers. A barrier of ice seems to be the most probable explanation of the manner in which the lake attained its former level, and its extent would then be determined only by the position of the barrier. The present level of the lake is practically that of the highest interior plateau, and with so slight an increase even as thirty-five feet, under present conditions, its water would overflow on all sides, nothing intervening between the lake and the coasts.

At Birch Lake, on the Ashuanipi Branch of the Hamilton River, there is a long esker ridge on the south side of the outlet, dividing it from a deep bay on the same side. The ridge is terraced on both sides into eight low steps. The lowest of these is twenty feet and the highest sixty feet above the present water-level. The terraces are floored with small water-worn gravel. Conditions similar to those about Lake Michikamau exist in this neighbourhood, and an ice-dam only would permit of an elevation of the lake sufficient to form such terraces. Birch Lake

Farther up this branch, towards the head of the Menihek Lakes, there is a persistent terrace ten feet above the present level and another at thirty feet, with others less continuous, one at fifty feet and a couple of intermediate ones. At the upper narrows of the lake, there are three well-marked terraces at thirty, forty and sixty-five feet above the present level, with beaches of gravel on them. These terraces are on drift ridges, with a wide area of country to the south-south-west and west that is considerably lower than the height of the lowest terraces, and the lake, at a level to correspond with the upper terraces, would cover the whole country (with the exception of a few ridges) to, and perhaps beyond, the southern watershed. It must, consequently, have been at least partly enclosed by an ice barrier. Menihek Lakes.

Similar terraces are seen along the lake-expansions of the Koksoak River about twenty miles below Lake Kaniapiskau, where the highest are about fifty feet above the present level of the river and considerably above that of much of the surrounding country. Similar terraces elsewhere.

As has been previously reported,* similar terraces were found on the western watershed along the north side of the Big River, over 200 miles inland from Hudson Bay. The river flows along the southern base of a high plateau, at the foot of which terraces twenty, thirty and fifty feet above the present level of the river and 1500 feet above sea-level are cut into esker ridges. To the south and south-west, the country is low and almost flat, and would have been flooded while the water was at its higher level, forming a lake, which without an ice or other barrier, from what is known of the intermediate country, would have extended to the coast.

River Terraces.

Wherever the rivers approach sufficiently near the coast to pass from their shallow, irregular, post-glacial courses between the ridges of drift, and to enter their ancient distinct valleys cut down below the Relation of river to marine terraces.

* Annual Report, Geol. Surv. Can., vol. III. (N.S.) p. 47 J.

general surrounding rock-surface, their valleys are found to have been wholly or, more often, partly filled with glacial drift. The rivers in these valleys have cut later channels in this drift, leaving it with terraced faces that mark the former levels of the streams. These terraces follow the valleys downward and merge into the marine terraces, formed during the period of subsidence, and it is often very difficult to reach a conclusion as to where the change from one kind of terrace to the other takes place.

Terraces of Koksoak.

Along the Koksoak River, terraces begin to appear immediately below the first gorge, or fifty-five miles below Lake Kaniapiskau. These terraces are at first about fifty feet high, but increase in height as the stream descends in the deep rocky valley, and there rise in places more than a hundred feet above the present river-level. Below the first gorge, for ten miles, the valley is narrow and the current very strong. Along this portion, the terraces are flanked by almost perpendicular walls of tightly packed boulders, to a height from thirty to sixty feet above the ordinary summer level. These boulder-walls are apparently caused by river-ice, which no doubt jams and piles up in the rapids to a great height, and which when the jam breaks moves along with great force at the front of the pent up water behind. A fine example of the size and influence of such a jam was found here on August 16th. Masses of ice more than ten feet thick were still piled along the west bank for a quarter of a mile and from twenty to thirty feet above the water level. These had for nearly three months been exposed to the action of the sun's rays, and were but small remnants of an immense mass of ice which had been pushed far up the banks, scooping out the fine material and boulders and piling them up in ridges several feet high.

Boulder walls.

Heights noted along the Koksoak.

Terraces continue to the junction of the Sandy River, where the river-channel is nearly level with the surrounding country. They are again seen immediately below Eaton Cañon, and the narrow valley to the north of the Goodwood River appears to have been completely choked with drift, the banks being terraced to their summits, 200 feet above the water. From the mouth of the Goodwood to Granite Fall, the terraces are nearly continuous, the best marked being at 60 and 100 feet above the present water-level. Between Granite Fall and the head of Cambrian Lake, the ancient valley is very deep, with rocky walls that rise more than 800 feet above the stream. This valley was filled with unstratified drift, in which the later channel is cut to depths ranging from 200 to 300 feet, with well-marked terraces at and below the 150-foot level. Along the upper part of Cambrian Lake, the till banks are terraced up to 200 feet, with very distinct terraces at 50 and 100 feet, and lower down with a broad one at 20 feet.

Along the flanks of the high hills, about the lower part of the lake, terraced banks are seen at 300, 175, 150, 100, 80, 60, 50 and 20 feet above the level of the lake. Along the river, below the lake, for more than twenty miles, terraces up to 250 feet are freqently seen. After that the valley widens and the hills become lower with long sloping sides, where the terraces are not so well marked. At the foot of the Manitou Gorge, a few miles above the mouth of the Stillwater River, the river has cut its channel out of about forty feet of stiff blue clay, well stratified horizontally, and darkened with an admixture of fine particles of the black shale of which the hills in the immediate neighbourhood consist. This occurrence of stratified clay is believed to be an indication that the sea extended up the river-valley at least as far as this point, and probably beyond, and that the terraces along the wide valley below are of marine rather than fluviatile origin. These will be noticed further on. Probable marine limit.

The deep valley of the Hamilton River, from the Grand Falls to its mouth, has everywhere been in part filled with drift, which has subsequently to a great measure been removed by the river, and much of it deposited in the upper part of Hamilton Inlet, shoaling its waters for over twenty miles below the mouth of the river. The flanks of the rocky hills that form the walls of the main valley, are covered with drift, cut into terraces which often rise 250 feet above the present level of the stream. These terraces are best seen about the mouths of the small tributaries, where the drift is generally more abundant and the terraces better marked than along other parts of the valley, where the drift is at times very scanty. Terraces of Hamilton River.

At the time the river was ascended, the banks of the stream in most places were thickly covered with snow, and in consequence less is known about their composition than might have been under more favourable conditions. The junction between the marine and river terraces was not actually determined, but the former probably extend inland about seventy miles, to the foot of the gorge of Gull Rapid.

On the Romaine River, distinct river-terraces are found along the sides of the valley from the Burnt Lakes to where the portage-route leaves it below. The highest of these terraces do not greatly exceed 100 feet above the river-level. Where the portage-route reaches the St. John River, the river-channel is cut out of stratified sands underlain by clay, which can be traced down stream to the mouth of the river and are undoubtedly of marine origin. Of Romaine and St. John rivers.

River-terraces are found along the shores of the Chamouchouan River, above the Chaudière Falls, where the stream rises above the level of the marine deposits of the Lake St. John basin. Of Manicuagan River.

Along the whole course of the Manicuagan River, from its mouth to Summit Lake on the watershed, terraces are seen almost continuously. Between Summit Lake and Natokapau, the terraces rise rarely more than 30 feet above the present river-bed. Below the last mentioned place, there is very little drift in the river-valley until the long gorge is passed, when terraces become well-marked on both banks to more than 100 feet above the water. At Lake Mouchalagan, the highest terrace is 150 feet above the lake, with several at intermediate altitudes. Terraces up to 150 feet are common along the steep walls of the river-valley below the large lakes, and, below the first portage above the Toolmistook River, are cut out of marine clays overlain by stratified sands.

Conditions along valleys of East Main and Rupert rivers.

The country of the western slope of Labrador falls gently from the interior towards James Bay, and is not broken by persistent, deep and narrow river-valleys as in the case of the other slopes. The valleys, where they are inclosed between low hills on either side, have at times low terraced banks up to fifty feet above the streams, but as a rule they are much less. On the East Main River, from the neighbourhood of Conglomerate Gorge, eighty miles above the river's mouth, the valley is cut out of sandy marine drift, underlain by clay lower down-stream. As previously described, the river descends in a number of steps, where it rushes down narrow rocky gorges, so that at the foot of each gorge, where it issues into a deep valley in the drift, its banks are high and steep, affording good sections of the marine sands and clays. As the country slopes gradually, at the head of each step the river-valley is but little below the general surface.

The conditions of the valley of the Rupert River are similar to those of the East Main, the marine deposits extending inland along its course for about one hundred miles. To the northward the country rises more rapidly. The Big River has moderately high banks of marine drift for forty miles, and then enters a deep valley between high rocky hills. This part of the river, where it rises to the level of the interior plateau, is unnavigable with canoes for about one hundred miles. The Great Whale River has a deep, distinct rocky valley to within a few miles of the coast, and the sides of the valley are terraced to a level above one hundred feet in many places.

Marine Deposits.

Extent of marine deposits along East coast, Hudson Bay.

Wherever observations have been made on the coasts of the Labrador Peninsula, deposits of marine sands and clays have been found. The breadth of this margin of marine deposits depends upon the height of the country and the amount of subsidence during the period of their deposition. Along the east side of James Bay, the slight elevation of the land along the coast and the gradual rise inland were favourable to the formation of a wide area of marine deposits. As previously stated, continuous beds of clay, overlain by stratified sands, can be traced inland on the Rupert River for more than 100 miles from its mouth. On the East Main River similar deposits extend for eighty miles, and on the Big River more than forty miles, to where the line of exploration left the stream. On the Great Whale River and to the northward, owing to the abrupt ascent to the table-land, these deposits are found only along the coast and a few miles up the larger river-valleys. In Richmond Gulf,* where the land rises abruptly almost 1000 feet above the sea level, ancient sea-beaches are seen up to a height of 440 feet above the present level of the sea. Marine terraces at the mouth of the Clearwater River also rise to an elevation of 350 feet, and in both cases the heights of the beaches and terraces were limited by that of the land where they were found. A short distance inland, terraces of stratified sands, most probably of marine origin, are found 675 feet above sea-level. These probably represent the maximum of subsidence along this portion of the coast. The greatest elevations at which marine deposits are found along the Rupert and East Main rivers, have been only approximately determined by aneroid measurements and by computations of the fall of the rivers, but they may be taken to slightly exceed 500 feet above the present level of Hudson Bay. About Ungava Bay, the elevation, as marked by raised beaches, terraces, and marine deposits, does not appear to have been nearly as great as on the west side of the peninsula, not exceeding 300 feet. The lower portion of the valley of the Koksoak River appears to have formed a long estuary, in which marine clays were laid down to above the forks of the Stillwater River. The highest terraces seen along the flanks of the hills, from Stillwater to the mouth of the river, are about 250 feet above sea-level. Along the George River, from its mouth to the Hudson's Bay post, terraces, up to an altitude of 200 feet, flank the hillsides in protected bays, and probably mark the maximum amount of elevation along this part of the coast.

Height of deposits.

Deposits about Ungava Bay.

Nachvak Bay.

Nachvak Bay, on the Atlantic coast, about one hundred miles south of Cape Chidley, is situated in the midst of the high unglaciated range of that coast. As already noted by Dr. R. Bell,† the mountains about here rise directly from the sea to heights varying from 1500 feet to 3400 feet. These mountains are sharp in outline and their sides are covered with angular fragments of the rocks beneath, in a

* Annual Report, Geol. Surv. Can., vol. III. (N. S.), p. 58 J.
† Report of Progress, Geol. Surv. Can., 1882-84, p. 14 DD.

more or less decayed condition, and without any sign of glaciation except along their lower margins. Behind the Hudson's Bay post, situated some twenty miles from the sea, signs of glaciation were noted by myself up to a height of 340 feet. Along the lower part the rocks are glaciated, the striæ showing that the ice moved outwards from the head of the bay. The upper level is marked by a broken line of erratics deposited along the edge of the upper margin of the ice. The highest sea-beach here is only 180 feet above the present tide-level, which shows that the post-glacial rise has been very slight in this part of the peninsula.

Nain.

Dr. Bell mentions that the hills behind Nain, about 160 miles south of Nachvak, are glaciated to their summits, over 1000 feet above the sea. From here southward, judging from the rounded outline of the hills, it would appear that the whole country has been over-ridden by ice pushing out to the coast. Dr. A. S. Packard* mentions the occurrence of raised beaches along the coast, from the Strait of Belle Isle northward 250 miles to the vicinity of Hopedale. None of the beaches observed by him were more than 200 feet above the present sea-level.

Hamilton Inlet.

Along the high shores of Hamilton Inlet, and more especially along Backway, terraces are well-marked up to a height of about 200 feet. Similar terraces are cut into the drift along the wide margin of low country extending southward from Hamilton Inlet to Sandwich Bay.

At the mouth of the Northwest River, near the head of the inlet, a wide deposit of sand separates the inlet from Grand Lake, a former north-west extension of the inlet. On the sides of the sandy deposit facing the open water of the inlet, there are fourteen distinct terraces, at different heights ranging from eighteen inches to ten feet. The summit of the sandy ridge is 110 feet above the present tide-level, and it is flat on top, with evidence of water-levelling. These numerous small terraces show that the elevation of the land about the head of Hamilton Inlet was very gradual and regular. As has already been stated, marine terraces along the valley of the Hamilton River probably extend about seventy miles above its mouth, to the Gull Rapid Gorge.

Marine deposits along Gulf shore.

The elevation along the Gulf shore of Labrador appears to have increased to the westward. At the Strait of Belle Isle, the highest marine beaches and terraces have an elevation of about 200 feet, while at the mouth of the Saguenay River the highest terraces are more than 600 feet above the level of the river, and in the vicinity of Quebec marine shells have been found 515 feet above the sea,† while

* The Labrador Coast, p. 310.
† Annual Report, Geol. Surv. Can., vol. V. (N.S.), p. 55L.

in the valley of the Chaudière River south of Quebec, Mr. R. Chalmers has traced marine terraces to a height of 895 feet above sea-level. In the valley of the St. John River, deposits of marine clays, overlain by sand, are found continuously for over forty miles inland and to a height of 380 feet above its mouth. Along the Manicuagan River, marine clays can be continuously traced inland for upwards of fifty miles, where they are elevated over 400 feet above the present sea-level. The Betsiamites River, which flows into the Gulf of St. Lawrence about half-way between the Saguenay and St. John rivers, also has terraced banks cut out of marine clays and sands beyond its lowest fall, or more than fifty feet from its mouth and about 400 feet above the sea. Lake St. John, at the head of the Saguenay River, is about 350 feet above the sea. This lake is surrounded by terraced banks cut out of marine clays and sands, to elevations at least 200 feet above its surface. North of the lake, a wide sandy plain rises in successive terraces more than 200 feet above its level, and this plain extends some thirty miles beyond the northern limits of the lake to the foot of a rocky ridge that crosses the country in the vicinity of the Pimonka Rapid on the Chamouchouan River. Along this stream clay banks are found underlying stratified sands up to the Bear Portage, twenty miles above the mouth of the river and about 600 feet above the sea. Above this portage the level of the river is higher than that of the clays, and only stratified sand is seen in the scarped banks in the Pimonka Rapid at the thirty-fourth mile, where the river enters a narrow rocky valley extending to the Chaudière Falls. Terraces sixty feet above the level of the stream and about 700 feet above the sea, are met with along the walls of this gorge, but the evidence is not sufficiently strong for us to assert that they are of marine origin. Lake St. John.

From the above evidence it will be seen that the post-glacial uplift of the Labrador Peninsula has not been equal around its coast, but that along its southern and western margin it was at least three times greater than along its north and east coast, where 200 feet appears to be the limit of raised marine terraces and beaches. Unequal uplift of the peninsula.

APPENDIX I.

LIST OF MAMMALIA OF THE LABRADOR PENINSULA, WITH SHORT NOTES ON THEIR DISTRIBUTION, ETC., BY A. P. LOW.

The following notes on the habits and range of the mammalia of Labrador, as far as refers to the interior, are largely the results of observations and information obtained during the recent explorations :—

Lynx Canadensis, Desmarest (Canada Lynx, Mountain Cat).—The lynx is commonly found within the wooded area, from the Atlantic coast to Hudson Bay. During the winter of 1893, many skins were taken in the valley of the Hamilton River. The number is said by the Indians and traders to vary with that of the rabbits which form the natural food of the lynx. When the rabbits are dying off after seasons of plenty, the Indians all say that the lynx does not breed, and only when the rabbits are again becoming plentiful do they again produce young. These animals are generally caught in dead-falls placed at the mouths of hollow logs.

Canis lupus, Linn. (Wolf).—The wolf is seldom met with in the southern regions since the extermination of the caribou there. It is now found only in the barren and semi-barren lands, where the caribou are still plentiful. A wolf was seen at the post at Northwest River, and a single skin was seen in the possession of an Indian on the upper Hamilton River ; the animal had been shot near Lake Michikamau. On the Hudson Bay coast, wolves were formerly plentiful, but of late years are quite rare.

Canis lupus, var. *albus*.—The White or Arctic Wolf is occasionally taken in the barren grounds, but does not appear to enter the timbered regions of the interior.

Canis familiaris, Say.—The Eskimo Dog is common along the coast everywhere, but south of Sandwich Bay the breed is much mixed. This animal plays an important part along the coasts, being used in the place of horses, or other animals for hauling. The methods of attaching the dogs to the sleds is different from that employed in the west, each dog having an independent trace, so arranged in length, that when the dogs are in line each one falls in behind another. The number of dogs in a team varies from four to thirteen. They are extensively used by the Eskimo and resident whites in travelling about the coast, and also for hauling wood, water and other loads. On ordinary 'roads' each dog will haul about 100 pounds, but when travelling on the crust, in the spring time, the load can easily be doubled or trebled.

Vulpes vulgaris, Fleming (Red, Cross, Silver and Black Fox).—These different animals are only colour varieties of the same species. On the Moose River, in 1887, the writer found a litter containing seven kits; of these two were red, three were cross and the remaining two black or silver—thus showing that the colour of foxes no more constitutes varieties than does the difference of colour in a litter of kittens of the common cat. There appears to be a greater proportion of dark-coloured foxes in the northern region than in the southern. The fox is found throughout Labrador from the St. Lawrence to Hudson Strait, where it is taken in the barrens and along the coast by the Eskimo. Most of the skins are taken before Christmas, as the fur becomes poor early in the spring.

Vulpes lagopus, Linn. (Arctic Fox, White Fox) is found most abundantly in the barren grounds. It is taken rarely south of Lake Michikamau or Nichicun. Along the seaboard the white fox ranges farther south, descending to the southern part of James Bay, and on the Atlantic coast being plentiful about Hamilton Inlet, but more rare southward to near the Strait of Belle Isle. Most of the foxes along the southern Atlantic coasts are said to be migrants from the northern coasts, and they are rarely caught south of Hamilton Inlet before that body of water is frozen over. The blue fox (var. *fuliginosus*) is much less abundant than the white, with which it is found. It is very rare along the southern half of the Atlantic coast.

Mustela Americana, Turton (Sable, Pine Marten).—The marten is one of the most abundant and valuable fur-bearing animals of Labrador. Its northern range is practically limited to the southern boundary of the semi-barrens, and it is found only in the wooded stretches of the river-valleys north of this line; north of the Big and Hamilton rivers, it is rarely found. The largest and darkest skins are taken along the edge of its northern limits, and on this account the skins bought at Fort George, Nichicun, Fort Chimo and Northwest River are much more valuable than those procured at the southern posts. The marten hunt is made after the smaller lakes set fast until December, and again during the months of March and April, after which the skins become poor.

Mustela Pennantii, Erxleben (Fisher, Pekan).—This animal only rarely enters the south-west limits of Labrador, not being known to occur east of Mingan, or north of Mistassini.

Putorius vulgaris, Linn. (Weasel).—Common everywhere south of the tree limit.

Putorius ermineus, Linn. (Ermine).—Common everywhere throughout the wooded regions.

Putorius vison, Brisson (Mink).—The mink is limited to the southern part of Labrador, and is only rarely found north of the East Main and Hamilton rivers. Not a single specimen was seen on the upper Hamilton River during the summer of 1894, and the Indians of that locality report it as rare. It is common on the lower river and about Hamilton Inlet. Several specimens were taken on the upper East Main River, but it is rare about Nichicun.

Gulo luscus (Linn.) Sabine (Wolverine, Carcajou).—Abundant throughout Labrador, especially in the northern portions, where it is taken by the Eskimo as far north as Hudson Strait. This animal is the personification of the devil among the Indians, owing to its cunning and destructive habits. Every Indian has wonderful stories to relate about the ferocity and intelligence of the wolverine. No câche of provisions or outfit is safe from the attacks of these animals, unless built up from the ground on high posts, in such a manner that the floors project and prevent the animals from reaching the sides or top. When a wolverine breaks into a câche, it not only eats the provisions, but breaks up and destroys other articles not fit for food. A wolverine in the vicinity of an Indian's hunting grounds, proves a very disagreeable neighbour, from its habits of following the hunter's tracks and either springing his traps and removing the bait, or else devouring the martens and other animals already caught. The wolverine is seldom caught itself, as its cunning is sufficient, after it has lost a few claws in the traps, not to put its feet in the set traps without first springing them by moving them about. When caught, they frequently gnaw off their foot above the trap and leave it, at other times they depart, taking trap and chain with them. In the fall of 1893, a wolverine carried away a trap from the Northwest River, and was taken a few days later in another trap on the Hamilton River, some thirty miles away from the place where it had picked up the first trap. The reason it was taken in the second trap, was because it could not obtain food while dragging the trap and chain through the bush, so, being reduced to starvation and hampered by the trap attached to its front leg, it was not able to spring the second one without being caught.

Mephitis mephitica, Shaw (Skunk).—Stearns says that it is rarely seen on the southern coast.

Lutra Canadensis, Turton (Otter).—The otter is common throughout the wooded region and ranges northward into the barren grounds. The skins taken in the northern regions have the darkest and most glossy fur. Very abundant on the upper Hamilton River, especially in the vicinity of the Grand Falls, where a number of Indian families congregate in the spring to hunt it.

Ursus arctos, Richardson (Barren-ground Bear).—There is no doubt that this species is found in the barrens of Labrador, as skins are brought in at intervals to Fort Chimo, and the Nascaupee Indians have numerous tales of its size and ferocity.

Ursus Americanus, Pallas (Black Bear).—The wooded country is the northern limit of this species, and it is most abundant in the southern regions in the burnt districts. Specimens were seen on the East Main River and about the Grand Falls on the Hamilton River. About Lake Winokapau and the lower Hamilton River bears are numerous. At Cambrian Lake, on the Koksoak River, the tracks of a large bear were seen along the shores, but it is not known whether these were those of a black bear or a barren-ground bear.

Thalassarctos maritimus, Linn (Polar Bear).—This species is as a rule confined to the coast and rarely travels inland, except to produce its young. At such time it is met with from twenty-five to fifty miles from the coast. On the Atlantic coast it is occasionally found as far south as the Strait of Belle Isle, whither it is carried from the north on ice floes. North of Hamilton Inlet, it is frequently met with along the coast and on the islands, being common about Cape Chidley and along Hudson Strait. During the winter of 1894 the tracks of three white bears were seen close to Northwest River, at the head of Hamilton Inlet, and a few specimens have been killed in that locality. In Hudson Bay, the white bear ranges southward to Charleton Island, near the south end of James Bay, in latitude 52°.

Odobaenus rosmarus, Malmgren. (Walrus).—This species, once common along the entire Labrador coast and the Gulf of St. Lawrence, is now found only on the Atlantic coast about and to the northward of Nachvak. It is common at all seasons in Hudson Strait, and along the northern Hudson Bay coast. Large numbers are killed by the Eskimo on the chains of outer islands which stretch southward to opposite Little Whale River off that coast.

Phoca vitulina, Linn. (Harbour Seal, Fresh-water Seal).—Common to the coast and low parts of the rivers all round Labrador. There are two or three large lakes inland near the head of the Stillwater Branch of the Koksoak River, but probably drained by the Nastapoka

River into Hudson Bay, where seals are reported by the Indians as plentiful. Another large lake inhabited by seals, is situated at the head of the north branch of the Northwest River, which flows into Hamilton Inlet. Skins in possession of the Indians, taken from these lakes, show that the seals belong to this species. According to the Indians, these animals never leave the lakes, and consequently have acquired a fresh-water habit.

Phoca foetida, Fabricius (Ringed Seal).—Along the whole Labrador coast. Commonest species in the Hudson Strait, and the principal food of the Eskimo.—(Tyrrell.)

Phoca Groenlandica, Fabricius (Harp Seal).—Very abundant along Labrador coast. Common on south shore of Hudson Strait. Common in Hudson Bay.

Erignathus barbatus, Fabricius (Bearded Seal, Square-flipper).—Rare on the St. Lawrence and southern Labrador coasts. Common about Nachvak, where the dog-traces made from this skin are obtained for the southern Hudson's Bay Company's posts. A large specimen was seen at the head of tide, some sixty miles above the mouth of the Koksoak River. Common in Hudson Strait and Hudson Bay. Numbers seen about the Twin Islands in James Bay. Specimen obtained at the mouth of Moose River by Dr. R. Bell.

Halichœrus grypus, Fabricius (Gray Seal).—Rare along Atlantic coast, Hudson Strait and Hudson Bay.

Cystophora cristata, Erxleben (Hooded Seal).—Not common along the coasts of Labrador.

Delphinopterus catodon, Linn. (White Porpoise, White Whale).—Found everywhere along the coasts of the Labrador Peninsula from the St. Lawrence to the southern extremity of Hudson Bay. Fisheries for these animals are established in the mouths of the Koksoak, Leaf and Whale rivers flowing into Ungava Bay, and were formerly carried on at Great and Little Whale rivers on Hudson Bay. The whales are driven, as they ascend the river at high tide, into ponds inclosed by strong nets, and when the tide goes out they are either speared or shot in the shallow water.

Monodon monoceros, Linn. (Narwhal).—The "horns" of these animals are frequently brought to the Hudson's Bay posts by Eskimo from Hudson Strait and the north part of Hudson Bay.

Alce Americanus, Jardine (Moose).—It is very doubtful if this species enters the south-west limits of Labrador from the head-waters of the Ottawa River, where it is found abundantly.

Rangifer caribou, Linn. (Woodland Caribou).—Within the past twenty-five years the woodland caribou was plentiful throughout the southern wooded region, but now is practically exterminated on the southern watershed, being met only in small numbers about the heads of the rivers flowing into the eastern part of the Gulf of St. Lawrence. In 1892, along the route from Lake St. John to Mistassini, and from there to the mouth of the East Main River, not a single deer track was seen. In 1885, the last herd of seven caribou was killed in the vicinity of Lake Mistassini. A few woodland caribou are annually killed about the head-waters of the East Main River and Nichicun post. On the upper Hamilton River this species is still met with in small bands, but, according to the Indians the numbers at present killed are only a small percentage of the numbers annually slaughtered a few years past. This extermination of the caribou is very detrimental to the interior Indians, who in former times depended largely upon them both for food and clothing. Notwithstanding the quantity of flour now brought inland, and the fish caught and preserved for winter use, cases of starvation are of annual occurrence from the lack of animal food in place of the deer meat. In 1892, a deserted camp where a dozen persons had died of starvation two years previously, was passed on the East Main River. The survivors—a woman and a boy—told the usual tale of failure to find deer and consequent starvation. There appears to be no remedy for this except the abandonment of the interior by a large proportion of the Indians, with the total suppression of caribou hunting for a number of years. This is probably not practicable, and the Indians of the interior will consequently, it is feared, continue to die off.

The astonishing rate at which the fur-bearing and other animals multiply when undisturbed, was noted along the East Main River, where, owing to the death of Indians above mentioned, no hunt had been made for two years—and in that short interval the beavers had overstocked the small streams, and were common all along the main river.

Rangifer Groenlandicus, Linn. (Barren-ground Caribou, "Reindeer"). —This species ranges in immense herds over the barren and semi-barren grounds. On the Atlantic coast, caribou of this variety are found south to the Mealy Mountains, a high barren range between Hamilton Inlet and Sandwich Bay. To the northward they are more or less common and at certain seasons of the year very plentiful about Davis Inlet and Nain. On the Hudson Bay coast they were formerly very abundant as far south as Cape Jones or the mouth of James Bay, but of late years they are found only in small numbers north of Great Whale River.

From information obtained from the Nascaupee Indians and others, the reindeer is believed to spend the summer season on the barren highlands near the coast, where the strong breezes keep down the pest of flies. In the autumn they migrate inland and southward into the semi-barrens, returning to the true barrens again in the months of April and May. In the northern part of the peninsula there appear to be three distinct herds, one on the Atlantic coast, that passes the summer on the highlands between Nachvak and Nain; a second, which crosses the lower part of the Koksoak River and summers on the west side of the Ungava Bay and Hudson Strait; and a third, which passes northward from the vicinity of Richmond Gulf and Clearwater Lake, and summers along the highlands of the north-east coast of Hudson Bay. Of late years, this last herd has become very small, and many of the Indians who lived on it have migrated from Hudson Bay to Fort Chimo, while the second herd was undiminished. The first herd supports the Indians living on the George River, and almost all from the Hamilton River. The principal hunt is made during the fall migration, when the bucks are fat and have not yet mated with the females. The Indians congregate along the George River, about a hundred miles beyond Lake Michikamau. They spread out along the river and await the crossing of the bands of deer on their way from the coast to the wooded country. As soon as a large body begins to cross, signals of smoke are made, and the Indians soon congregate and kill great numbers from their canoes by spearing them while in the water. The season for crossing lasts from ten to fifteen days. Much of the flesh is smoked for winter use, while the skins are preserved and dressed, either for clothing and other purposes or for sale. In the spring the deer migrate in small bands and are not so easily taken, as the snow and ice are then beginning to melt and they have to be killed by shooting after a chase. The migration of the second band is similar to that already described, except that during the fall migration small herds are continually crossing backwards and forwards along the river. Wide paths, caused by a single passage of the deer, were met with along the Koksoak River as far south as Cambrian Lake, and smaller paths as far as Lake Kaniapiskau, where a small number of the reindeer appear to remain throughout the summer. A couple of large paths were found on the Ashuanipi branch of the Hamilton River, and in the spring a number of tracks, made by small herds, were encountered below the Grand Falls. Periodically, the reindeer omit to return to the wooded areas from the barrens, and when this happens the Indians depending on them are left in a most lamentable condition, being largely without food and clothing. Many die of starvation in consequence unless outside aid is given. The death of over 150 persons along the Koksoak River during the winter of 1893, is but one of several such calamities which have happened during the last fifty years. In the evidence given before the committee of the Hudson's Bay Company, 1851, a letter was read from Wm. Kennedy as follows: "Starvation has, I learn, committed great havoc among our old friends the Nascopies, numbers of whom met their death from want last winter; whole camps of them were found dead, without one survivor to tell the tale of their sufferings."

Ovibos moschatus, Zimmermann (Musk Ox.)—There is no evidence to show that the musk ox was ever found in Labrador.

Vespertilio lucifugus, Leconte (Blunt-nosed Bat).—A small bat is common in the southern portion of the peninsula, having been seen on the Hamilton River and at Lake Mistassini, and it is supposed to be referable to this species.

Vespertilio subulatus, Say, is reported by Stearns from Natashquan.

Sorex personatus, Geoffroy St. Hilaire (*S. Cooperi*, Baird).—This small shrew was obtained at Sandwich Bay.

Sciuropterus volucella, Pallas, var. *Hudsonius*, Gmel. (Northern Flying Squirrel.—Common in the valley of the lower Hamilton River and about the head of Hamilton Inlet. Found at St. Augustine (Stearns).

Sciurus Hudsonius, Pallas (Red Squirrel).—Found throughout the southern wooded region as far north as the East Main River, and to the westward; on the Hamilton River from its mouth to Sandgirt Lake, and southward on the Attikonak Branch, but not along the Ashuanipi Branch.

Arctomys monax, Linn. (Woodchuck, Ground-hog).—Common in the country between Lake St. John and the East Main River, and on the Romaine River. Not seen on the Hamilton River, but said to be found about the head of Hamilton Inlet. "Common at Mingan, growing scarce towards Bonne Espérance" (Stearns).

Castor fiber, Linn. (Beaver).—Common in the wooded region and extending into the semi-barrens where food is found. On the Hudson Bay coast, rare north of Big River. In 1887 a specimen was killed in Richmond Gulf, latitude 56°. Charleton Island, in James Bay, was well-stocked with beaver introduced by the Hudson's Bay Company, but they were totally exterminated by wandering Eskimo in 1890. As before stated, beaver are very plentiful on the Lower East Main River. About Nichicun they are now more plentiful than formerly.

Common about the Lower Hamilton River and upwards to Sandgirt Lake, becoming very rare to the northward towards Lake Michikamau.

Hesperomys leucopus, Rafinesque (White-footed or Deer Mouse).—Common at Northwest River, Hudson's Bay post.

Arvicola riparius, Ord.—Specimen taken on Upper Hamilton River near Lake Petitsikapau. The Indians report a smaller species as not rare in the interior wooded country.

Cuniculus torquatus, Pallas. (Hudson Bay Lemming).—Common throughout the barren ground and southward to about latitude 54°. Specimen obtained from Lake Michikamau.

Zapus Hudsonius, (Zimmermann) Coues, (Jumping Mouse).—Not rare in the wooded region. Specimens taken at the mouth of the Hamilton River, near the Grand Falls, and on the Romaine River portages. The Indians who saw these specimens say that there is a much smaller species found in the interior, which closely resembles the larger, except in size.

Fiber zibethicus, Linn. (Muskrat).—Common in the southern-wooded region, but rare along the Upper Hamilton River.

Erethizon dorsatus, Linn. (Canada Porcupine).—Ranges from the St. Lawrence northward into the semi-barrens. Very plentiful along the Hamilton River, where it is largely used for food by the Indians. Common at Hamilton Inlet, and northward to Hopedale. Traces seen along the Great Whale River, and also on the Koksoak River, above Cambrian Lake.

Lepus timidus, Linn., var. *arcticus*, Leach. (Polar Hare).—Confined to the barren and semi-barren lands of Labrador. On the Hudson Bay coast a few are taken about Great Whale River. On the Atlantic they occur southward as far as Hamilton Inlet. A few are killed about Lake Michikamau.

Lepus Americanus, Erxleben (Hare, "Rabbit").—Found throughout the wooded region. Like the western rabbit, it is visited periodically with an infectious throat-disease, which about once in five years practically exterminates the animal. The disease apparently travels from the west towards the east and takes about two years to cross Labrador. The rabbit is largely used for food by the Indians, but is not sustaining, and they all say that on a diet of rabbits alone they rapidly become weak and unfit for work.

APPENDIX II.

LIST OF BIRDS OF THE INTERIOR OF THE LABRADOR PENINSULA.

Urinator imber, Gunn. (Loon).—Common throughout the interior; breeds.

Urinator lumme, Gunn. (Red-throated Loon).—Common on upper Hamilton River and Koksoak River; breeds.

Urinator arcticus, Linn.—Seen June 3rd at Lake Mistassini; not common.

Uria troile, Linn. (Murre).—Common in open water of Hamilton Inlet until January 20th, 1894.

Alle alle, Linn. (Dovekie).—Very common in Hamilton Inlet until January 20th, 1894. Numbers of this and the preceding found frozen in bushes along the edge of the open water.

Gavia alba, Gunn. (Ivory Gull).—Specimen obtained at Rigolet, where it was shot during the winter; seen at Northwest River late in December after the inlet was frozen; not common.

Larus glaucus, Brunn. (Glaucous Gull).—Common throughout the interior; seen May 19th; eggs June 14th.

Larus Delawarensis, Ord.—Nests at Mistassini Lake; seen June 11th.

Sterna Forsteri, Nutt. (Forster's Tern).—Common throughout interior; seen June 13th, Hamilton River, June 1st, Mistassini.

Merganser Americanus, Cass. (American Merganser).—Common throughout interior; seen May 28th; eggs June 25th.

Merganser serrator, Linn. (Red-breasted Sheldrake).—Abundant throughout the interior; seen May 28th; eggs June 25th.

Anas obscura, Gmel. (Black Duck).—Not common throughout the interior; seen May 1st; eggs May 23rd.

Glaucionetta clangula Americana, Bp. (American Golden-eye).—A few flocks seen on upper Hamilton River during June; seen at Mistassini May 3rd.

Somateria spectabilis, Linn. (King Eider).—One specimen killed at Lake Mistassini.

Oidemia Americana, Sw. and Rich. (American Scoter).—Common on Hamilton River, May and June, in migration; seen May 26th.

Oidemia perspicillata, Linn (Surf Duck).—Common on Hamilton River during migration, May and June; seen May 26th.

Branta Canadensis, Linn. (Canada Goose).—Breeds in marshes throughout the northern interior, and is seen along the rivers with young broods about July 1st; seen at Mistassini May 2nd, at Grand Falls, Hamilton River, May 4th. From the journals of the Hudson's Bay Company, the average date of first arrival at Lake Winokapau and Northwest River, is May 10th; several large broods seen on Burnt Lakes, Romaine River; not common at Lake Mistassini, but abundant on East Main River—especially on lower part, where the river is cut out of clays, with good bottom-lands; breeds in large numbers on the islands of James Bay.

Branta bernicla, Linn. (Brant).—Very rare in the interior; one sick killed at Mistassini July 2nd. If these birds cross Labrador in their northern migration, they fly high and only rarely rest, as the Indians, who know them well on the St. Lawrence coast, report them very rare in the interior.

Nycticorax nycticorax nævius, Allen (Black-crowned Night-Heron).—Single specimen at Lake Mistassini, August 6th.

Phalaropus lobatus, Linn. (Northern Phalarope).—Seen on upper Hamilton River, June 13th. Not common.

Gallinago delicata, Ord. (Wilson's Snipe).—Male heard and seen at Lake Petitsikapau, Hamilton River, June 28th.

Tringa minutilla, Vieill. (Least Sandpiper).—Common about Upper Hamilton River. Breeds.

Totanus melanoleucus, Gmel. (Greater Yellow Legs).—Met with occasionally throughout the interior. Breeds. Seen May 31st.

Totanus flavipes, Gmel. (Yellow Legs).—Seen only after August 1st, on Hamilton River and at Mistassini.

Totanus solitarius, Wils. (Solitary Sandpiper).—Common throughout the interior, especially south of latitude 54°. Breeds. Seen May 27th. Eggs June 19th.

Actitis macularia, Linn. (Spotted Sandpiper).—Common along the upper Hamilton River. Seen May 27th. Eggs June 20th.

Ægialitis semipalmata, Caban. (Semipalmated Plover).—Common on Upper Hamilton River. Seen June 16th. Breeds.

Dendragapus Canadensis, Linn. (Canada Grouse, Spruce Partridge).—Common throughout wooded and in the semi-barrens. Eggs June 1st.

Bonasa umbellus togata, Linn. (Ruffed Grouse, "Partridge." Birch Partridge).—Common at Mistassini. Not rare at mouth of Hamilton River. Not found on Upper Hamilton River.

Lagopus lagopus, Linn. (Willow Ptarmigan).—Common throughout the winter. Breeds on Upper Hamilton River. Eggs June 25th.

Lagopus rupestris, Gm. (Rock Ptarmigan).—Common in valley of Hamilton River during winter. Leaves for northward about April 15th.

Ectopistes migratorius, Linn. (Passenger Pigeon).—Very rare. Eggs obtained at Fort George, 1887.

Accipiter atricapillus, Wils. (American Goshawk).—Specimen killed near Cambrian Lake, Koksoak River; also on lower Hamilton River. Not common.

Aquila chrysaetos, Linn. (Golden Eagle).—Breeds at head of Lake Michikamau. Seen in several places along upper Hamilton River.

Halidetus leucocephalus, Linn. (Bald Eagle).—A pair seen on Hamilton River below Grand Falls, April 28th. White heads distinctly seen.

Falco rusticolus obsoletus, Gmel. (Labrador Gyrfalcon).—Specimen shot at Cape Chidley.

Falco peregrinus anatum, Bon. (Duck Hawk).—Not uncommon throughout the interior.

Pandion halidetus Carolinensis, Gm. (Osprey).—Common throughout southern interior, to lat. 54°. Seen May 27th. Eggs June 12th. Nest on top of large white spruce.

Asio accipitrinus, Pall. (Short-eared Owl).—Seen on Upper Hamilton and Romaine rivers.

Nyctale Acadica, Gmel. (Saw-whet Owl).—Specimen shot near Lake Mistassini.

Bubo Virginianus saturatus, Ridgw. (Dusky Horned Owl).—Common about Northwest River during winter. Common in the interior.

Surnia ulula caparoch, Müll. (American Hawk Owl).—Seen several times on Upper Hamilton River.

Ceryle alcyon, Linn. (Belted Kingfisher).—Was not found north of the vicinity of the Grand Falls, Hamilton River. Common on Romaine River and at Lake Mistassini. Seen May 30th.

Dryobates villosus leucomelas, Bodd. (Hairy Woodpecker).—Shot in valley of Hamilton River in March. Not rare.

Dryobates pubescens, Linn. (Downy Woodpecker).—Common on Hamilton River throughout the year.

Picoides arcticus, Swains. (Black-backed Three-toed Woodpecker).—Common along Lower Hamilton River.

Colaptes auratus, Linn. (Yellow-shafted Flicker).—Single specimen seen near Grand Falls, Hamilton River, 30th May.

Chordeiles Virginianus, Gmel. (Night-hawk).—Very rare on Upper Hamilton River. Single specimen seen near the Grand Falls, May 31st. Common at Mistassini and along Romaine River.

Empidonax flaviventris, Baird. (Yellow-bellied Fly Catcher).—Common at Lake Mistassini. Not seen at Hamilton River.

Otocoris alpestris. Linn. (Horned Lark).—Common on barrens of Upper Hamilton River and about Lake Michikamau.—Eggs June 19th.

Perisoreus Canadensis, Linn. (Canada Jay).—Very common throughout the interior. Nest with four eggs taken at Rigolet March 24th, 1894; and another at North-west River, with three eggs, about the same date. Young able to fly from nest on May 18th, at Grand Falls, Hamilton River.

Perisoreus Canadensis nigricapillus, Ridgw. (Labrador Jay).—Abundant throughout northern interior.

Corvus corax principalis, Ridgw.—Common throughout the interior. Resident.

Molothrus ater, Gray. (Cowbird).—Common at Lake Mistassini.

Scolecophagus Carolinus, Müll. (Rusty Black Bird).—Common throughout the interior.

Pinicola enucleator, Linn. (Pine Grosbeak).—Common on the Upper Hamilton River. Male seen May 1st.

Loxia leucoptera, Gmel. (White-winged Cross-bill).—Common on Hamilton River in March and April.

Acanthis linaria, Linn. (Common Redpoll).—Abundant about the Hamilton River.

Plectrophenax nivalis, Linn. (Snow Bunting).—Plentiful on Hamilton River in early spring.

Calcarius Lapponicus, Linn. (Lapland Longspur).—Common on Hamilton River in early spring.

Ammodramus Sandwichensis Savanna, Wils. (Savannah Sparrow).—Very common on upper Hamilton River. Eggs June 24th.

Zonotrichia Leucophrys, Forst. (White-Crowned Sparrow).—Very common on upper Hamilton River. Seen May 16th. Eggs June 25th.

Zonotrichia albicollis, Gmel. (White-throated Sparrow).—Common at Lake Mistassini. Heard at Grand Falls, Hamilton River. Common on the Romaine River.

Spizella monticola, Gmel. (Tree Sparrow).—Common everywhere in Labrador. Breeds in great numbers on upper Hamilton River. Seen May 31st; eggs June 21st.

Junco hyemalis, Linn. (Black Snow-bird).—Common at Lake Mistassini and upper Hamilton River. Seen May 29th. Eggs June 27th.

Melospiza fasciata, Scott (Song Sparrow).—Common at Lake Mistassini.

Tachycineta bicolor, Vieill. (White-bellied Swallow).—Common throughout the interior. Seen May 25th.

Ampelis cedrorum, Vieill. (Cedar Wax-wing).—Rare at Lake Mistassini.

Lanius borealis, Vieill. (Great Northern Shrike).—Common on Hamilton River; seen April 16th.

Helminthophaga peregina, Wils. (Tennessee Warbler).—Not rare at Lake Mistassini.

Dendroica æstiva, Gmel. (Yellow Warbler).—Common at Lake Missassini; seen near Grand Falls, Hamilton River, May 31st.

Dendroica coronata, Linn. (Myrtle Warbler).—Specimen from Grand Falls, Hamilton River, May 31st.

Dendroica maculosa, Gmel. (Magnolia Warbler).—Not rare at Lake Mistassini.

Dendroica striata, Forst. (Black-poll Warbler).—Common on upper Hamilton River. Seen May 31st.

Seiurus Noveboracensis, Gmel. (Water Thrush).—Common about Grand Falls, Hamilton River. Seen May 31st.

Sylvania pusilla, Wils. (Black-capped Yellow Warbler).—Seen near Grand Falls, Hamilton River, May 31st. Not rare at Lake Mistassini.

Parus Hudsonicus, Forst. (Hudsonian Chickadee).—Abundant on Hamilton River from April 1st.

Regulus satrapa, Licht. (Golden-crowned Kinglet).—Common on Hamilton River between Grand Falls and Sandy Lake; rare to northward; seen May 19th.

Regulus calendula, Linn. (Ruby-crowned Kinglet).—Very common along Hamilton River between Grand Falls and Sandy Lake. Seen May 29th.

Turdus ustulatus Swainsonii, Caban. (Olive-backed Thrush).—Very common along the upper Hamilton River. Seen May 16th. Eggs June 30th.

Turdus Aonalaschkæ Pallasii, Caban. (Hermit Thrush).—Not rare at Lake Mistassini.

Merula migratoria, Linn. (American Robin).—Abundant throughout the interior. Seen May 10th. Eggs June 13th.

APPENDIX III.

List of the principal Food Fishes of the Labrador Peninsula, with Short Notes on their Distribution.

Petromyzon (sp.)—A small Lamprey was taken on the Bersimis River a few miles below Lake Pipmaukin, 1884, adhering to a large brook trout.

Accipenser (sp.)—A species of Sturgeon is very plentiful in the Rupert River, being taken in large quantities at Lake Nemiskau, where the Indians congregate and dry the fish during September. The fish here are usually under three feet in length. Also abundant in the river from Lake Nemiskau to its mouth. Common in the East Main River, from its mouth to Conglomerate Gorge. Also found in the lower part of the George River and in the Nottaway at Lake Obatogaman, near its head.

Catostomus longirostris, LeSueur (Long-nosed Sucker, Northern Sucker).—Common in rivers and lakes throughout the interior. The principal food of the Indians in many parts of Labrador.

Catostomus Forsterianus, Richardson. (Red Sucking Carp, Red Sucker).—This is usually regarded as a variety of the above, but Sir John Richardson gives it as a distinct species, and the fish found in Labrador is quite distinct in shape, size of scales and colour, from the first-named sucker. It is at least two weeks later on the spawning beds. Common throughout the interior. Preferred by the Indians for food to the gray sucker. Average weight of both species about 5 pounds.

Osmerus mordax (Mitchill), Gill. (American Smelt).—Common at the mouth of the Northwest River, Hamilton Inlet, where it is abundantly taken in November and the early part of December.

Coregonus clupeiformis (Mitchill), Milner (Common Whitefish).—Found abundantly throughout the interior, in lakes and rivers. Largest fish taken in Lake Mistassini, 14 pounds weight. Average weight 3 or 4 pounds. A small species of whitefish closely resembling the common whitefish is caught in abundance in the shallow salt water along the east coast of James Bay. These fish ascend the rivers of James Bay during the autumn months along with sea trout.

Salmo salar, Linn. (Common Atlantic Salmon).—Abundant in the rivers of the St. Lawrence and the Atlantic coasts and also in the rivers flowing into Ungava Bay. Reported by Dr. R. Bell, as taken by Eskimo at Stupart Bay, at the western side of Ungava Bay or Hudson Strait. The salmon enter the rivers of the St. Lawrence coast early in June, are taken in Hamilton Inlet in July, but do not ascend the Koksoak and other rivers of Ungava Bay until about the middle of August. From this there would appear to be some connection between the time at which the fish strike into the rivers and the temperature of the water along the coast, that to the northward rising more slowly than the southern waters; or else the fish follow northward along the coast and take at least two months to pass from the Strait of Belle Isle to Ungava Bay. There is no evidence, however, to show that the fish thus follow the coast. The time at which the salmon enter Ungava Bay from the Atlantic and the absence of this species from Hudson Bay, would seem to show that the waters of the western part of Hudson Strait do not rise sufficiently in temperature to allow the salmon to enter Hudson Bay in time to ascend its rivers before the spawning season, and this is the probable cause why no Atlantic salmon have been are found in its rivers.

The land-locked variety of *S. salar*, or ouinaniche, is found in Lake St. John and the tributaries of the Saguenay River, where it has free access to the sea, but as the same fish was found plentifully in both branches of the Hamilton River, above the Grand Falls with its sheer drop of 300 feet, it is certainly land-locked there. It is also common in the Koksoak River below Lake Kaniapiskau, above perpendicular falls of eighty feet and sixty feet. Common in Lake Michikamau on the head of the Northwest River. It is also reported by the Indians as numerous in the upper George River, the Romaine River, the Manicuagan and several other of the rivers flowing into the Gulf of St. Lawrence. It has not yet been reported from the rivers of the western watershed. Average weight of the fish caught, not above three pounds. The Indians report that the largest in the Hamilton River do not exceed ten pounds in weight.

Salmo Hearnii, Richardson (Hearne's Salmon).—A small salmon, with bright red spots on its sides, is found along the northern east coast of Hudson Bay, and probably belongs to this species. Its southern limit is a small river a few miles south of Cape Jones. It is taken in nets set in the salt water near Long Island, just north of Cape Jones, and also in some small streams flowing into Richmond Gulf. The Eskimo also report it common in some of the rivers north of Richmond Gulf.

Salvelinus namaycush (Walbaum), Goode (Great Lake Trout).—Very plentiful in all the larger lakes of the interior northward to Hudson

Strait. Very abundant in the lake-expansions of the Hamilton River and Lake Michikamau. Average weight about 8 pounds, but many taken more than 25 pounds in weight.

Salvelinus fontinalis (Mitchill), Gill and Jordan (Brook Trout).—This fish is abundant in many of the rivers and lakes of the Labrador Peninsula. Sea-run fish of this species are plentiful along the shores and lower parts of the rivers from the St. Lawrence to the southern part of James Bay. On the Atlantic coast and Ungava Bay, they are particularly plentiful and of large size. Along these coasts the mouth of every river swarms with trout during the late summer and autumn. The largest fish reported was taken at Nachvak and weighed fourteen pounds. In the Koksoak and George rivers, the average weight of the sea-run trout is about seven pounds. In Hamilton Inlet, there is less change in the sea-run fish than along the coast. At Northwest River the fish are small and do not average over one pound in weight. Here they were freely taken with a fly, up to the middle of December, when the mouth of the river was frozen over. In the mouth of the Hamilton River, sea-run trout average about three pounds in weight.

In James Bay, the trout taken along the coast and in the lower parts of the rivers are generally small and do not exceed two pounds in average weight. Between the lowest falls and the upper waters of the western rivers, brook trout are rarely taken, but in the northern, eastern and many of the southern rivers they are abundant along their entire length.

In the Koksoak River, for a few miles below Lake Kaniapiskau, large trout were abundant, but lower down they became smaller, until the sea-run fish were met with. On the Hamilton River, below the Grand Falls, the trout do not average over one pound in weight. Above the falls, the fish are much larger, and average more than three pounds in weight, while fish of five pounds and seven pounds are common. On the Romaine River, no trout were taken until the Burnt Lakes were passed, when they became plentiful, though small. Outside of the rivers and small streams, this species is found abundantly in most of the numberless lakes throughout the interior. Two varieties are met with everywhere; one has pink flesh, the other yellow, the former having the finest flavour.

Esox lucius, Linn. (Pike).—This fish is found abundantly throughout the interior in the lakes and quiet-flowing streams; common on the rivers of the southern, eastern and western watersheds; not so abundant in the Koksoak River. It varies in weight from two to fifteen pounds.

Anguilla (Sp).—The Indians report eels as common in the upper Romaine River.

Stizostedium vitreum (Mitchill), Jordan and Copeland (Wall-eyed Pike, Doré, "Perch" of the Hudson Bay Co).—Common in the southern rivers flowing into Lake St. John and to the westward, also in the Rupert and East Main rivers of the western watershed. Rare in the Betsiamites River, and not found east of that stream, being unknown to the Indians of Mingan. Not found in the Big River, or streams to the north of it, nor in the rivers of the eastern or northern watersheds. Average weight, three pounds.

Lota maculosa (Le Sueur), Cuvier and Valenciennes (Ling, LaLoche, Maria).—Common in all the deep lakes throughout the interior. An important source of food for the Indians, owing to its taking bait freely during the winter months, when other fish cannot be caught. Weight, two pounds to fifteen pounds.

Gadus callarias, Linn. (Common Cod-fish).—Plentiful along the St. Lawrence and Atlantic coasts to Cape Chidley, also along the east shore of Ungava Bay to the mouth of George River. The following abstract from the Census of Newfoundland (1891) will show the extent and value of the cod-fishing of the Atlantic coast:—

"10,478 men, 2081 women and 828 children were employed in the fishery in 861 vessels, of which the tonnage amounted to 33,689 tons. The total catch of codfish amounted to 488,788 quintals." Fishing beyond Cape Chidley, along the east coast of Ungava Bay, was not undertaken until 1893, when a Newfoundland steamer was so successful that in 1894 two steamers and three schooners made successful catches in the neighbourhood of Port Burwell. The Eskimo report cod as being plentiful about the mouth of George River in the month of August. It is at present unknown whether this fish enters Hudson Bay, and it is a question which should speedily be settled by a properly equipped vessel, as valuable fisheries in the northern part of that great body of water may be lying idle for want of proper information concerning them.

APPENDIX IV.

List of Insects collected in the Interior of the Labrador Peninsula, 1894. Determined by Dr. Jas. Fletcher, Dominion Entomologist.

LEPIDOPTERA.

Argynnis Atlantis, Edw.	16th July	1	specimen.
" *Chariclea*, Ochs.	16th July	6	"
" *Triclaris*, Hbn.	8th to 16th July	4	"
Chionobas Jutta, Hbn.		1	"
Lycæna Lucia, Kirby	26th to 28th May	5	"
Colias Scudderii, Reak	20th to 27th July	7	"
Papilio Turnus, L.	10th July	4	"
Pyrgus Centauriæ, Ramb.	18th June to 16th July	7	"
Laria Rossii, Curtis	12th May	2	"
Rheumaptera hastata, L.	20th July		
Agrotis (?)	19th July		

COLEOPTERA.

195.	*Nebria Sahlbergi*, Fish	1	specimen.
206.	*Pelophila Ulkei*, Horn.	5	"
	Agabus (?)		
	Pterostichus (?)		
1706.	*Silpha Lapponica*, Hbst.	2	specimens.
1490.	*Dytiscus dauricus*, Gebl	2	"
3059.	*Coccinella transversoguttata*, Fab.	2	"
4787.	*Eros aurora*, Hbst.	1	"
4901.	*Podabrus piniphilus*, Esch	1	"
6273.	*Acmæops proteus*, Kirby	2	"
6452.	*Pogonocherus penicellatus*, Lec	1	"
6557.	*Syneta ferruginea*, Germ	1	"
6843.	*Gonioctena pallida*, L	2	"

Note.—Insect life is not abundant in the interior of the Labrador Peninsula, and the above list probably represents over half of the species of Lepidoptera and Coleoptera commonly found about the region drained by the upper Hamilton River. A few more butterflies were seen of which specimens could not be obtained, but in all they did not make more than three or four extra species.

APPENDIX V.

Notes on the Microscopic Structure of some Rocks from the Labrador Peninsula.

BY

W. F. FERRIER, B. A. Sc., F.G.S.,

Lithologist, Geological Survey of Canada.

INTRODUCTORY REMARKS.

The following notes on a series of thirty-four rock specimens, collected by Mr. A. P. Low in the Labrador Peninsula, in 1893, 1894 and 1895, are offered as a contribution to our knowledge of the petrography of that little-known country.

It must be understood, however, that the proportions in which the various rock types occur in the collection do not in any sense represent the relative frequency of occurrence of these types in the field. Only such specimens as were of a doubtful character, or had some special points of interest attaching to them, were selected by Mr. Low for microscopic examination.

Of the thirty-four specimens examined, some fourteen are undoubted diabases and gabbros of varying degrees of freshness. Eight others, now mainly dioritic, have probably been derived from similar rocks by alteration. One specimen (23) was apparently originally a diorite. Three hornblende-schists or amphibolites (4, 16, 17) have been, without doubt, produced by the crushing and shearing of basic eruptives.

Three of the diabases (32, 33, 34) have been already described by Mr. A. E. Barlow,* and are of interest as containing decomposed porphyritic crystals of plagioclase very similar to the "Huronite" of Dr. Thompson.† Among the gneissic rocks the interesting hypersthene syenite gneiss (6) may be specially noted.

The granites, quartz porphyries and syenites are not numerous in the collection, the two former being represented by a single specimen each (19, 5), and the latter by two specimens (6, 21).

* On some Dykes containing Huronite. Ottawa Naturalist, vol. IX., No. 2, 1895.
† Thompson's Mineralogy, I., p. 384, 1836.

The beautifully fresh felspar-free pyroxenite or hypersthenite (13) is worthy of special mention as an excellent example of these rocks, which have seldom been met with in Canada.

The white anorthosite (24) is a typical example of its class, and closely resembles those described by Dr. Adams from the Saguenay and Morin areas of Norian rocks.

Rocks of clastic origin are represented in the collection by a fine-grained greywacke (9) which, in the hand specimen, might readily be taken for an eruptive, and a much altered specimen (1) which may possibly be an ash-rock.

The literature of the subject is not very extensive, and those papers which enter into details regarding the rocks deal chiefly with the anorthosites.

A list of the principal papers and books which have appeared, taken, with some additions and alterations, from Dr. Adams's paper on the Norian rocks of Canada,* is here appended :—

Adams, F. D.:—

Ueber das Norian oder Ober-Laurentian von Canada. Stuttgart, 1893; also translation of same in Canadian Record of Science, Vol. VI., 1895.

Barlow, A. E.:—

On some Dykes containing Huronite. Ottawa Naturalist, Vol. IX., No. 2, 1895.

Baddeley, Lieut. (F. H.):—

Geology of a portion of the Labrador Coast. Trans. Lit. and Hist. Soc. of Quebec, Vol. I., 1829.

Bayfield, Capt. :—

Notes on the Geology of the North Coast of the St. Lawrence. Trans. Geol. Soc., London, Vol. V., 1833.

Bell, Robert :—

Observations on Geology, Mineralogy, Zoology and Botany of the Labrador Coast, Hudson's Bay and Strait. Ann. Rep., Geol. Surv. Canada, 1882-84.

The Labrador Peninsula. The Scottish Geographical Magazine, Vol. XI., No. 7, 1895.

Cayley, Ed.:—

Up the River Moisie. Trans. Lit. and Hist. Soc. of Quebec, Vol. V., 1862.

*Ueber das Norian oder Ober-Laurentian von Canada, Stuttgart, 1893: also translation in Canadian Record of Science, vol. VI., 1895.

Cohen, E.:—

Das Labradorit-führende Gestein der Küste von Labrador. Neues Jahrb. für Min., 1885, I., p. 183.

Davies, W. H. A.:—

Notes on Esquimaux Bay and the surrounding Country. Trans. Lit. and Hist. Soc. of Quebec, Vol. IV., 1843.

Hind, H. Y.:—

Observations on Supposed Glacial Drift in the Labrador Peninsula, etc. Q. J. G. S., Jan., 1864.

Explorations in the Interior of the Labrador Peninsula. London, 1863.

Jannasch, P.:—

Ueber die Löslichkeit des Labradors von der Paulinsel in Salzsäure. Neues Jahrb. für Min., 1884, II., p. 42.

Lieber, O. M.:—

Die amerikanische astronomische Expedition nach Labrador, im Juli, 1860. Peterm. Mitth., 1861.

Low, A. P.:—

On the Mistassini Expedition. Ann. Rep., Geol. Surv. Canada, 1885, Part D.

The Recent Exploration of the Labrador Peninsula. Canadian Record of Science, Vol. VI., No. 3, 1894.

Packard, A. S.:—

The Labrador Coast. London, 1861.

Observations on the Glacial Phenomena of Labrador and Maine, etc. Mem. Boston Soc. Nat. Hist., Vol. I., 1865.

Observations on the Drift Phenomena of Labrador. Canadian Naturalist (New Series), Vol. II., 1865.

The Labrador Coast. London, 1891.

Puyjalon, H. de :—

Report on the Copper, etc., found to exist on the North Shore of the Gulf of St. Lawrence. Report of Com. of Crown Lands, Province of Quebec, 1883.

Report of Exploration for minerals on North Shore of the Gulf of St. Lawrence. Report of Com. of Crown Lands, Province of Quebec, 1884.

These two reports contain references to the anorthosites, syenites and other rocks of the region.

Reichel, L. J.:—

Labrador, Bemerkungen über Land and Leute. Peterm. Mitth. 1863.

Richardson, J.:—

The Geology of the Vicinity of Lake St. John. Rep. Geol. Surv. Canada, 1857.

The Geology of the Lower St. Lawrence. Rep. Geol. Surv. Canada, 1866-69.

Roth, J.:—

Ueber das Vorkommen von Labrador. Sitz. Berlin. Akad. XXVIII., p. 697, 1883.

Selwyn, A. R. C.:—

Summary Reports of the Geol. Surv. Canada, for 1879-80 and 1889.

Selwyn, A. R. C., and Dawson, G. M.:—

Descriptive Sketch of the Dominion of Canada. Published by Geol. Surv. Canada, 1882.

Steinhauer, M.:—

Note relative to the Geology of the Coast of Labrador. Trans. Geol. Soc., London, Vol. II., 1814.

Van Hise, C. R.:—

Correlation Papers, Archæan and Algonkian. Bull. U. S. Geol. Surv., No. 86, p. 398, 1892.

Vogelsang, H.:—

Sur le Labradorite Coloré de la Côte du Labrador. Archives Néerlandaises, T. III., 1868.

Van Werveke, L.:—

Eigenthümliche Zwillingsbildungen am Feldspath und Diallag. Neues Jahrb. für Min., 1883, II., p. 97.

Wichmann, A.:—

Ueber Gesteine von Labrador. Zeitschr. d. d. Geol. Ges., 1884, p. 486.

Wilkins, D. F. H.:—

Note on the Geology of the Labrador Coast. Canadian Naturalist (New Series), Vol. VIII., 1878.

Williams. G. H.:—

Describes Porphyritic Diabase or Diabase Porphyrite from Nachvak, and Hornblendic Pyroxenite from near Skynner's Cove, Nachvak, Labrador. Ann. Rep., Geol. Surv. Canada, Vol. V., Part I., 1890-91. Part F., Appendix I., Nos. 38 and 43.

DESCRIPTIONS OF THE ROCKS.

1. Ash Rock ?—Outlet of Dyke Lake, Ashuanipi Branch, Hamilton River.

A dark coloured, fine-grained rock, having an amygdaloidal appearance, due to embedded rounded little masses of crystalline calcite with some harder mineral stained red.

The rock exhibits imperfect partings and has porphyritically-developed bisilicates scattered through it, now much decomposed.

Under the microscope it is seen to be composed of a confused mass of secondary iron ore, chlorite, epidote, calcite, etc., with some small, quite fresh, porphyritic hornblende crystals, which have good cleavage and somewhat sharp crystal outlines.

Owing to the extreme alteration of nearly all its constituents, it is impossible to refer the rock with certainty to any particular type, but I am inclined to think that it may be a bedded ash rock.

2. Uralitic Gabbro, or Gabbro Diorite.—Great Bend, East Main River.

A dark green, fine-grained, laminated rock, somewhat mottled with white calcite, and having pyrite plentifully scattered through it.

In the thin section it is seen to be much altered, squeezed, and sheared, producing very uneven extinction in its constituent minerals.

It possesses a crystalline granitic structure, and consists chiefly of plagioclase, hornblende, magnetite, quartz, pyrite, apatite, epidote and chlorite.

The plagioclase is in allotriomorphic individuals which are almost entirely saussuritized, but still retain traces of the original twinning striation, and are frequently penetrated by slender little crystals of apatite.

The hornblende, which has every appearance of being secondary in origin, is the "compact"* variety so characteristic of those rocks which have been subjected to metamorphism. It is green in colour and strongly pleochroic, with $\mathfrak{a}$ = greenish-yellow, $\mathfrak{b}$ = yellowish-green, and $\mathfrak{c}$ = bluish-green. Teall† has pointed out that this development of hornblende at the expense of augite or diallage in basic igneous rocks in regions not affected by contact metamorphism, is one of the most definitely established facts in petrographical science.

The hornblende of this rock occurs in irregular aggregates of grains having no uniform orientation. Some quartz, apparently secondary, much cracked, and with very uneven extinction, is present, and pyrite is exceedingly abundant.

* That is, homogeneous, neither fibrous, nor actinolitic.
† British Petrography, 1888, p. 161.

This combination of saussurite and secondary "compact" hornblende, as the result of the alteration of gabbros, is very characteristic and has frequently been described.

3. Diabase, highly altered.—Head of Dyke Lake, Ashuanipi Branch, Hamilton River.

A dark gray, fine-grained, rusty-weathering rock, holding numerous small white oval patches, consisting chiefly of calcite, which give it a decidedly porphyritic appearance. Smaller, dark coloured porphyritic forms also occur, which were probably augites.

On weathered surfaces the rock has a cavernous appearance, due to the removal of the calcite in the oval areas referred to above.

As seen in the thin section, the rock is much altered and filled throughout with crystalline calcite.

Small, interlacing, lath-shaped crystals of plagioclase make up the bulk of the section, giving to it a decided ophitic structure, and it is thickly sprinkled with little granules of secondary iron ore and scales of chlorite. Comparatively large patches of calcite and chlorite represent what were probably originally phenocrysts of plagioclase and augite.

The rock is apparently a much altered and highly calcareous diabase.

4. Hornblende Schist, probably resulting from the shearing of some basic eruptive.—Jacopie Lake, Hamilton River.

A rather light green, fine-grained, glossy, chloritic schist, with intercalated red felspathic layers, and very wavy and crinkled lamination.

Microscopic examination shows that it has been subjected to intense shearing action, the hornblende being all pulled-out, and the larger plagioclase fragments occurring in elongated streams of finely-granulated material of the same kind.

The principal minerals present are hornblende, felspar (both striated and non-striated), chlorite, epidote, a little quartz, and a very little iron ore and titanite.

Streaks of finely-granulated felspar, evidently derived from the breaking-up of larger individuals, fragments of which still occur distributed through the granulated material, alternate with wavy streaks of hornblende pulled-out in the same manner from larger individuals. These hornblende layers wind around the larger fragments of felspar in such a manner as to give a regular "flow-structure" to the section.

In one instance a large felspar individual lies almost at right angles to the general direction of lamination of the rock, and the hornblende layers bend around it in a most marked manner.

Both twinned and untwinned felspar grains occur, but the former are more plentiful. Inclusions are very common.

The hornblende is compact, except where it has been excessively drawn-out by the shearing action to which the rock has been subjected. It is now generally of pale yellowish or bluish-green tints, owing to chloritization, possesses well-marked cleavages, and rather feeble pleochroism.

The rock may be regarded as a greatly sheared and crushed basic eruptive, perhaps a diorite.

5. CRUSHED QUARTZ PORPHYRY.—Mouth of Akuatago River, East Main River.

In the hand specimen this is a medium-grained rock of a somewhat dark gray colour, mottled with whitish phenocrysts of quartz and felspar, and with a lamination due to shearing. Many of the quartz phenocrysts exhibit a bluish opalescence. Pyrite and calcite are plentiful, the rock effervescing freely with dilute hydrochloric acid. The thin section shows a micro-granitic groundmass composed of quartz and felspar, in which lie numerous phenocrysts of quartz and felspar, the former frequently having a rude dihexahedral form, and the latter being mainly non-striated and probably orthoclase.

Biotite in irregular scales and aggregates, accompanied by some muscovite, is abundant. A little hornblende is present, and pyrite, epidote, chlorite, titanite, zircon, and apatite also occur.

The rock has been greatly crushed and sheared; the phenocrysts of both quartz and felspar possess very uneven extinction, are much cracked, and peripherally granulated.

The felspar is decomposed and filled with carbonates, epidote, muscovite, and other alteration products. A few slender needle-like crystals of an intensely pleochroic (indigo-blue to light yellow or almost colourless) mineral resembling tourmaline were observed. The biotite is largely altered to chlorite. Some of the epidote possesses the low double refraction of zoisite. The rock may be regarded as a much crushed and sheared quartz porphyry. Only small portions of it have resisted the crushing action.

6. HYPERSTHENE SYENITE GNEISS.—First Gorge of the Koksoak River.

A rather coarse-grained, greenish-gray, gneissic rock, with granitic structure, and consisting chiefly of a non-striated felspar, a little quartz, an orthorhombic pyroxene strongly pleochroic in light-green and pink tints, a deep reddish-brown pleochroic biotite, apatite, and iron ore.

A very few grains of plagioclase were also observed. Micropegmatitic structure is beautifully shown in portions of the section. The rock is tolerably fresh, but the orthorhombic pyroxene (hypersthene) shows the characteristic alteration, the grains being traversed by a network of cracks filled with serpentinous material.

A determination made in the Laboratory of the Survey, gave 62·68 as the percentage of silica present in the rock. This would place it with the syenites rather than with the granites, and it might perhaps be termed a hypersthene syenite containing a little quartz. It bears a close resemblance to some of the rocks from Château Richer, Quebec, described by me as pyroxene granite gneisses but which have not yet been analysed.

7. Gabbro, approaching diabase in structure.—End of Survey, Ashuanipi Branch, Hamilton River.

A very dark coloured, medium-grained, massive-looking rock, having for its principal mineral constituents plagioclase felspar, stained brown by decomposition products; monoclinic and orthorhombic pyroxenes, the former being the more abundant; some deep reddish-brown strongly pleochroic biotite; ilmenite accompanied in some cases by leucoxene; a small quantity of apatite.

The structure, whilst in the main that of a gabbro, in some portions is ophitic, approaching in that respect to a diabase.

8. Gabbro Gneiss ?.—Ossokmannau Lake, Attikonak Branch, Hamilton River.

A medium-grained, dark green and brown, rusty, gneissic rock, which, under the microscope, is seen to be greatly granulated, affording an excellent example of Törnebohm's "mortar-structure." Both striated and non-striated felspars are present, the latter in considerable quantity, so that a separation would be necessary to determine its true character. But I am inclined to believe that much of this non-striated material is plagioclase, as pressure-twinning has been developed in portions of some of the grains. Quartz is present, but not abundant, and both monoclinic and orthorhombic pyroxenes occur. The monoclinic form is pale-green in colour and feebly pleochroic, whilst the orthorhombic (hypersthene) is strongly pleochroic in red and green tints. Hornblende and biotite occur in small irregular individuals, and ilmenite with leucoxene is very abundant. The rock has a granitoid structure, and exhibits abundant evidence of intense dynamic action in the cracking and granulation of its constituent minerals,

*Ann. Rep., Geol. Surv. Can., vol. V., 1890-91, part L., appendix, pp. 81, 82.

and their very uneven extinctions. It is stained a yellowish-brown colour throughout, due to hydrous oxides of iron.

9. GREYWACKE.—Outlet of Cambrian Lake, Koksoak River.

An exceedingly fine and even-grained, massive, dark green, rusty-weathering rock, the clastic origin of which is at once revealed by the microscope. It consists of angular and sub-angular fragments of quartz and felspar with granules of iron ore and epidote, in a matrix, not at all abundant, of sericitic and chloritic material. Both striated and non-striated felspar are present, and the rock is a typical greywacke.

10. DIORITE ?—Ten miles above Broken Paddle River, East Main River.

This is a medium-grained massive rock, of a very dark green colour, mottled with yellowish-brown, and showing an indistinct foliation. The microscope shows it to consist of a clear mosaic of interlocking grains, evidently re-crystallized, and containing both felspar and quartz, although it is now impossible to distinguish between the two minerals without obtaining axial figures.

Through this mosaic are scattered irregular patches of a green, strongly pleochroic, compact hornblende, which has a secondary appearance, and is frequently arranged in rudely radiating groups of individuals. It is intimately associated with patches of granular, and apparently secondary, iron ore. The section suggests a basic eruptive rock, which has been changed to its present conditions by contact or dynamic metamorphism.

11. DIORITE, EXTREMELY ALTERED.—Muskrat Falls, Hamilton River.

A medium-grained, somewhat foliated, dark yellowish-green, rusty weathering rock, the hand specimen of which is studded with small cubes of pyrite. Under the microscope it is seen to be in a highly altered and crushed condition, consisting now chiefly of much decomposed and granulated plagioclase felspar, small masses of fibrous chloritized hornblende evidently secondary in origin, and patches of a peculiar deep brown granular titanite, which, from the fact that they hold occasional cores of ilmenite, have probably been derived from the alteration of that mineral.

The whole section is filled with the products of decomposition, such as epidote, chlorite, and sericite, and is plentifully sprinkled with pyrite. The rock is evidently a much altered diorite, perhaps derived from a gabbro.

12. Uralitic Gabbro.—Lookout Mountain, near Grand Falls, Hamilton River.

A medium-grained, mottled green and yellowish-white, massive-looking rock.

The thin section shows it to be greatly altered, with a gabbro-like structure, and consisting principally of plagioclase felspar (some non-striated grains also occur); hornblende of a pale green colour and uralitic appearance, having the borders of the grains of a darker colour than the centres; a deep brown strongly pleochroic biotite intimately associated with the hornblende, and ilmenite with leucoxene.

The felspar is full of prismatic crystals of epidote and scales of sericite. Chlorite is very abundant in the section. The rock is evidently an altered gabbro.

13. Pyroxenite (Hypersthenite).—Five miles above the Minipi Branch, Hamilton River.

The hand specimen shows a coarse-grained mixture of broad tabular crystals of hypersthene and plates of biotite, the rock being of a brownish-green colour, and these two minerals apparently its sole constituents.

About the only minerals observed in the thin section were a strongly pleochroic orthorhombic pyroxene (hypersthene) and a deep brown biotite. A very few minute areas of a clear, colourless mineral, apparently quartz, lie between some of the pyroxene grains.

The orthorhombic pyroxene is quite fresh, and, as stated, strongly pleochroic, with $\mathfrak{a}$ = red, $\mathfrak{b}$ = yellowish-green, $\mathfrak{c}$ = green.

Examined in convergent light it gave the optical characters of hypersthene. It is remarkably free from the dark scales and rods usually present in that mineral, a fact already noted by Dr. Adams in the case of the Norian rocks of Canada.* The rock is evidently a member of the pyroxenite group and may be termed a hypersthenite.

14. Diabase?, extremely altered.—First Portage from Obatagoman Lake to Chibougamoo Lake.

A pale green, fine-grained, rusty-weathering, massive-looking rock, with indistinct traces of foliation. This is an extremely altered basic eruptive, probably a diabase, as traces of ophitic structure can still be detected in the section, which is traversed by little cracks filled with quartz, and exhibits such a stage of decomposition as to render a minute description of no special interest. The bisilicate, augite, origi-

* Ueber das Norian oder Ober-Laurentian von Canada. F. D. Adams. Stuttgart, 1893.

nally present, has been changed to a fibrous hornblende, and this again is largely altered to chlorite. The plagioclase felspar is almost completely saussuritized.

15. Porphyritic Diabase.—On the portage route between Obatagoman and Chibougamoo lakes.

A dark green, fine-grained, massive, porphyritic rock, with distinct ophitic structure in the groundmass and having numerous large phenocrysts of plagioclase scattered through it.

The rock is much altered, but the ordinary structure of a diabase is seen in the thin section. The numerous porphyritically-developed plagioclases are much saussuritized. The section is thickly sprinkled with small granules of iron ore and presents no unusual features.

16. Amphibolite (sheared basic eruptive).—Ten miles above Broken Paddle River, East Main River.

A medium-grained, pale greenish, well-foliated schistose rock, with slickensided surfaces evidently due to shearing. The thin section shows that the rock has been subjected to intense dynamic action, consisting now of a very finely granulated mosaic of quartz and felspar in which a few larger fragments of these minerals are embedded, together with bunches of a fibrous hornblende, now largely altered to chlorite, and patches of a peculiar deep brown granular titanite evidently resulting from the decomposition of ilmenite and still holding an occasional small core of that mineral.

The rock has evidently resulted from the shearing and crushing of some basic eruptive, perhaps a gabbro.

17. Amphibolite (sheared basic eruptive).—Ten miles above Broken Paddle River, East Main River.

A dark green, medium-grained, distinctly banded rock, having a much more massive appearance than No. 16, to which, as regards origin, it is closely allied; but re-crystallization has proceeded farther in this case and it is consequently in a much fresher condition. Its foliated character is well seen in the section. The quartz and felspar form a clear interlocking mosaic, and the hornblende is of the "compact" variety so characteristic of rocks of this class and is intergrown with the quartz and felspar. A brown pleochroic biotite, apparently secondary in origin, is abundant in small scales distributed through the quartz-felspar mosaic. Small granules of iron ore are also plentiful.

The rock as seen in the section is apparently the final stage of alteration of some basic eruptive and greatly resembles that described by Teall in the case of the Scourie Dyke in Scotland.*

18. Uralitic Diabase.—Two miles below Ross Gorge, East Main River.

In the hand specimen this is a dark greenish-gray, fine-grained, massive rock, with distinct ophitic structure and containing much pyrite.

The section reveals the fact that both plagioclase and augite are extremely altered, but the structure of the rock is undoubtedly that of a diabase. Granules of iron ore and epidote are plentifully scattered through it in addition to the pyrite.

The augite has altered to a fibrous hornblende which, in its turn, has become largely chloritized.

19. Hornblende Granite Gneiss.—Three miles above Grand Falls, Hamilton River.

A rather coarse-grained, well-foliated, greenish and yellowish "augen"-gneiss.

A marked cataclastic and foliated structure is exhibited in the thin section. Larger fragments of quartz and felspar are embedded in a finer-grained mosaic of the same materials, through which run strings of hornblende and biotite with large crystals of a clove-brown, strongly pleochroic titanite.

Both orthoclase and plagioclase occur, the former predominating, and occasionally showing the structure of microcline due to pressure.

The rock has apparently been partially re-crystallized and is filled with needles and irregular grains of epidote. The larger fragments of quartz and felspar are remarkably full of inclusions of this and other minerals. The titanite crystals are remarkable for their size and deep brown colour.

I regard the rock as being a hornblende granite squeezed into a gneiss.

20. Diabase, extremely altered.—Lake Petitsikapau, Ashuanipi Branch, Hamilton River.

A fine-grained, dark green, massive rock, full of pyrite. The thin section shows two portions of the rock, an outer and more altered portion, and an inner one, which, whilst still much altered, is not quite so much so as the outer or surface portion.

---

*Teall. On the Metamorphosis of Dolerite into Hornblende Schist. Q. J. G. S., vol. XLI, 1885, p. 133; also British Petrography. pp. 154, 198-200, and plate XXI.

The mass is evidently diabasic in character, the ophitic structure being still visible. The pyroxene now exists as small cores in masses of brown serpentinous decomposition products lying between the lath-shaped sections of plagioclase. The lighter and more highly altered portion of the section contains more light green chlorite than the darker.

Irregular patches of leucoxene with occasional cores of ilmenite, and pyrite, are plentiful. An orthorhombic pyroxene is also apparently present in small quantity. Epidote is abundant, often in radiating bundles of needle-like crystals.

21. CRUSHED GRANITE (OR SYENITE ?).—Foot of Great Bend, East Main River.

A mottled, greenish-gray and white, medium-grained, granitic-looking rock, which has been greatly crushed and now consists of a mosaic of felspar and quartz lying between larger grains of these minerals ("mortar-structure"), with scales of biotite plentifully distributed throughout the mass. Epidote is exceedingly abundant, and occasionally encloses sharply defined pleochroic allanite crystals. Much of it has evidently resulted from the saussuritization of the felspar and is accompanied by sericite.

Both orthoclase and plagioclase are present, but the former greatly predominates. Some titanites and apatites also occur.

In the particular section examined, quartz is comparatively scarce, and suggests that a further study and analysis of the rock might lead to its being placed with the syenites rather than with the granites.

22. DIABASE, MUCH ALTERED.—Outlet of Dyke Lake, Ashuanipi Branch, Hamilton River.

An exceedingly fine-grained, dark green, rusty-weathering, compact, massive rock, with occasional felspar crystals embedded in it. It is now extremely decomposed and filled with calcite, epidote, chlorite, hydrous oxides of iron, and other alteration products, but traces of its original ophitic structure may still be seen. Magnetite in small granules and crystals is abundant. The rock is undoubtedly a highly altered diabase.

23. DIORITE ?—Five miles below Stillwater Branch, Koksoak River.

A medium-grained, greenish-gray, rusty weathering rock, which the thin section shows to be made up of a bleached chloritic hornblende associated with much saussuritized plagioclase felspar.

Leucoxene, resulting from the alteration of ilmenite, is abundant, and pyrite is also sprinkled through the mass. The hornblende conveys the impression of being primary in its origin and occasionally shows a twinned structure. The rock is probably a decomposed diorite.

24. Anorthosite.—First lake on portage route from Romaine River to St. John River.

A pale grayish, almost white, medium-grained, crystalline granular rock, looking very much like a crystalline limestone.

Only a few streaks and spots of coloured bisilicates occur in the specimen, which is mainly composed of plagioclase felspar.

This is a typical representative of that division of the gabbro family in which the coloured constituents constitute only a very insignificant portion of the mass of the rock. The section is almost entirely composed of clear, colourless, well-striated labradorite with an extinction angle on $\infty P \breve{\infty}$ of about 25°. It is in general quite fresh, but traces of alteration to sericite, calcite, epidote, zoisite, etc., were here and there observed. A very few irregular grains of a fresh green hornblende, with the characteristic cleavages and pleochroism of that mineral, are present, usually associated with an opaque iron ore, which also occurs in smaller granules dotted through the felspar.

Mica and hypersthene are also present in other portions of the rock.

25. Mica Diorite Gneiss (crushed and altered eruptive ?)—One mile above Broken Paddle River, East Main River.

In the hand specimen this is a dark greenish-gray, distinctly foliated and rusty-weathering rock, having numerous fragments and crystals of quartz, felspar, and hornblende scattered through the finer-grained groundmass, also numerous cubes of pyrite.

It has evidently been greatly crushed and squeezed and now consists chiefly of a fine-grained quartz-felspar mosaic containing larger fragments of these minerals, much biotite, and some hornblende largely altered to chlorite. Pyrite, titanite, epidote, ilmenite with leucoxene, and a large quantity of calcite are also present. Owing to the extremely granulated condition of the material it is difficult to make out the nature of the felspar, but plagioclase appears to predominate (it certainly does in the larger fragments) and the rock is probably the result of the crushing of a diorite or gabbro.

26. Diorite (altered gabbro ?)—Near mouth of Akuatago River, East Main River.

A dark greenish-gray, medium-grained, indistinctly foliated rock.

The section bears evidence that it has been greatly crushed and granulated. Plagioclase felspar, hornblende, some quartz, biotite and iron ore are the principal minerals present. Pyrite, apatite, chlorite, and epidote also occur.

Much of the hornblende has a frayed-out, actinolitic appearance, and occasionally surrounds more compact cores of a deeper green colour, largely altered to chlorite, which resemble augites.

The biotite is largely secondary and is intimately intergrown with the hornblende.

The rock may be an extremely altered gabbro.

27. Uralitic Gabbro, with an approach to diabasic structure. —Eight miles above Broken Paddle River, East Main River.

A dark green mottled with white, compact, rusty-weathering rock. It is much altered and now consists chiefly of plagioclase felspar and a pale green uralitic hornblende, the individuals of which have borders of a deeper colour than the centres.

The section is filled with granules of epidote, chlorite, and other decomposition products. Some titanite is also present. An approach to diabasic structure may be seen in portions of the rock, which, in the main, may be regarded as a crushed and altered gabbro.

28. Extremely crushed porphyritic rock ?—Three miles above Broken Paddle River, East Main River.

A dark green, somewhat porphyritic, indistinctly foliated rock. The section exhibits such an extreme stage of granulation as to render a determination of the true character of the rock a matter of great difficulty.

Fragments of plagioclase, orthoclase, quartz, and granules of iron ore with numerous scales of an apparently secondary biotite, are scattered through a very fine-grained quartz-felspar mosaic. Pyrite is rather abundant.

29. Diorite.—Prosper Gorge, East Main River.

A medium-grained, dark green, rusty-weathering, compact, massive rock. Plagioclase felspar and a pale green uralitic hornblende are its chief constituents, together with some biotite and iron ore.

The plagioclase is quite fresh, and portions of the section have a decided diabasic structure.

The whole of the hornblende may have resulted from the alteration of the augite of a diabase, as, although no cores of the latter mineral were detected, the hornblende has a secondary appearance.

30. Altered Diabase.—One mile below Akuatago River, East Main River.

A dark green, chloritic-looking rock, which in the thin section exhibits a coarse ophitic structure, the spaces between the plagioclase crystals being filled with a mass of scales of rather pale brown biotite, evidently of secondary origin. The plagioclase is very turbid. No iron ore was seen in the section.

31. Altered Diabase.—Three miles and a half above Broken Paddle River, East Main River.

A medium-grained, dark green, rusty-weathering, compact rock, in which the plagioclase felspar is almost completely saussuritized, retaining only traces of its original striation.

The augite is largely altered to pale green hornblende, chlorite and a serpentinous substance. Epidote, and ilmenite accompanied by leucoxene are abundant. A little quartz was seen.

The section shows the typical ophitic structure of a diabase.

[The three following descriptions of rocks from Labrador have been condensed from a paper by Mr. A. E. Barlow* of this Survey :]

32. Gabbro, with an approach to diabasic structure.—Ten miles north of Lake Kawachagami, on the portage route between the Rupert and East Main Rivers.

In the hand specimen this is a dark greenish gabbro-like rock, with yellowish-green plagioclase phenocrysts. It consists chiefly of plagioclase, augite and ilmenite.

The larger phenocrysts of plagioclase show marked alteration, and are precisely similar to those described by Thompson as "Huronite." Their specific gravity is 2·725.

The augite is largely altered to hornblende, but cores of the former mineral still remain. Ilmenite, occasionally altered to leucoxene, is rather abundant. Epidote is present as a decomposition product, and apatite is very plentiful. Considerable areas of granophyre were observed in the section, portions of which also show a coarse ophitic structure.

33. Olivine Diabase.—Fault Hill, Dyke Lake, Ashuanipi Branch, Hamilton River.

In the hand specimen this is a medium-grained, dark green almost black rock, with occasional small imperfect phenocrysts of saussuritized

*On some Dykes containing Huronite, by A. E. Barlow, M.A., Ottawa Naturalist, vol. IX., No. 2, 1895.

plagioclase. Under the microscope it is seen to be composed chiefly of plagioclase, considerably altered to saussurite, especially in the case of larger individuals; fresh brownish-red, pleochroic augite, mostly allotriomorphic in form, but occasionally with sharp crystal outlines; serpentine, which has evidently resulted from the alteration of olivine; and ilmenite in large irregular fragments and small granules, in both cases showing alteration to leucoxene.

34. DIABASE.—Near entrance to Dyke Lake, Ashuanipi Branch, Hamilton River.

A dark greenish-gray, rather coarse-grained rock, in which are embedded numerous phenocrysts of altered, greenish felspar (Huronite), some of which in the main mass of the rock are three-fourths of an inch in diameter.

They are extremely abundant, and, together with the plagioclases of the groundmass, are largely altered to sericite and epidote. Their specific gravity is 2·773.

The augite, when fresh, which is rarely the case, is reddish in colour and distinctly pleochroic. Ilmenite, altered to leucoxene, is abundant, as are also chlorite, apatite and pyrite.

APPENDIX VI.

LIST OF THE PLANTS KNOWN TO OCCUR ON THE COAST AND IN THE INTERIOR OF THE LABRADOR PENINSULA. COMPILED BY JAMES M. MACOUN.

The following list, which has been carefully compiled from lists already published and from MS. notes and specimens in the herbarium of the Geological Survey, is divided into four columns, so that the distribution of each species, so far as known, may be seen at a glance.

The first column contains those species known to occur on the coast of Labrador, the second those growing in the basin of the upper Hamilton River, the third those growing in the basins of the Rupert and East Main rivers and the fourth those growing along the shores of James Bay. The area included in the second and third columns comprises the whole central part of the peninsula, and many of the plants noted in the third column and not in the second doubtless grow in the basin of the Hamilton River; but, while the third column represents the collections made in three seasons, under favourable conditions and over a wide area, one season only was spent on the Hamilton River.

The first column has been copied from Dr. Packard's "The Labrador Coast," with the addition of a few species overlooked when his list was compiled, or which have since been collected. The species included in the other three columns have all been collected by Mr. Low or his assistants, Mr. J. M. Macoun having made the collections in 1885 and 1887, and Mr. A. H. D. Ross, in 1892, the very complete collection of the plants growing along the East Main River. Lists of the plants found at Lake Mistassini, on the Rupert River and along the shores of James Bay have been printed as addenda to Mr. Low's reports of 1885 and 1887, and to these the results of his explorations in 1888, 1892, 1893 and 1894 are now added.

Recent revisions of genera have in some cases changed the names that appear in this list, but to obviate the printing of synonyms the names under which species and varieties have been already recorded from the Labrador Peninsula have been retained, except where a correction was necessary or there was the possibility of confusing two plants: in such cases both names are given.

——	1.	2.	3.	4.
RANUNCULACEÆ.				
Anemone parviflora, Michx	*	*	*	*
" multifida, DC	....	....	*	*
" dichotoma, Linn	....	....	*	*
Thalictrum dioicum, Linn	*	*	*	....
" polygamum, Muhl. (*T. Cornuti*, Linn.)	*	....	....	....
Ranunculus aquatilis, Linn., var. trichophyllus, Chaix	....	*	*	....
" Cymbalaria, Pursh	....	....	*	*
" repans, Linn	*	*	*	....
" affinis, R. Br	*	....	....	....
" " var. validus, Gray	....	....	....	*
" abortivus, Linn	....	*	*	*
" recurvatus, Poir	....	....	*	....
" pygmæus, Wahl	*	....	....	....
" nivalis, Linn	*	....	....	....
" ac is, Linn	....	....	*	*
" Pennsylvanicus, Linn	....	....	*	....
Caltha palustris, Linn	*	..	*	*
Coptis trifolia, Salisb	*	*	*	*
Actæa spicata, L., var. rubra, Ait	....	*	*	....
" alba, Big	....	....	....	*
NYMPHÆACEÆ.				
Nuphar advena, Ait	*	*	*	....
SARRACENIACEÆ.				
Sarracenia purpurea, Linn	*	....	*	....
PAPAVERACEÆ.				
Papaver nudicaule, Linn	*	....	....	....
FUMARIACEÆ.				
Corydalis glauca, Pursh	....	*	*	....
CRUCIFERÆ.				
Nasturtium palustre, DC	....	....	*	*
Cardamine hirsuta, Linn	....	*	*	*
" pratensis, Linn	*	....	*	*
Arabis stricta, Huds. (*A. confinis*, Wat.)	*	....	....	....
" alpina, Linn	*	*	....	....
" humifusa, Wat., var. pubescens, Wat	....	....	....	*
Barbarea vulgaris, R. Br	....	*	...	....
Erysimum cheiranthoides, Linn	....	....	...	*
Sisymbium humile, C. A. Meyer	....	....	....	*
Draba alpina, Linn., var. (?) corymbosa, Dur	*	....	....	...
" stellata, Jacq., var. nivalis, Regel	*	....	....	....
" incana, Linn	*	....	....	....
" " var. confusa, Poir	*	....	....	*
" arabisans, Michx	*	....	....	....
" aurea, Vahl	*	....	....	*
Cochlearia officinalis, Linn	*	....	....	....
" tridactylites, Banks	*	....	....	....
Capsella Bursa-pastoris, Mœnch	*	....	*	*
Thlaspi arvense, Linn	....	....	..	*
Viola blanda, Willd	*	*	*	*
" palmata, Linn., var. cucullata, Gray	....	....	*	....
" palustris, Linn	...	*	....	....
" canina, Linn., var. Muhlenbergii, Gray	*	*	*	*

——	1.	2.	3.	4.
CARYOPHYLLACEÆ.				
Silene Armeria, Linn	....	....	....	*
" noctiflora, Linn	....	....	....	*
" acaulis, Linn	*	....	....	*
Lychnis apetala, Linn	*	....	....	....
" alpina, Linn	*	....	....	....
Arenaria verna, Linn	*	....	....	....
" " var. hirta, Wat	....	....	*	*
" Michauxii, Hook	....	....	*	....
" Grœnlandica, Spreng	*	*	....	....
" serpyllifolia, Linn	*	....	....	....
" lateriflora, Linn	....	*	....	*
" peploides, Linn	*	....	....	*
Stellaria media, Smith	....	....	....	*
" borealis, Bigel	*	*	....	....
" " var. alpestris, Gray	....	....	*	....
" crassifolia, Ehrh	*	....	....	....
" longipes, Goldie	....	*	*	....
" " var. minor, Hook	*	....	....	....
" " " Edwardsii, T. and G	*	....	....	*
" humifusa, Rottb	*	....	*	....
Cerastium vulgatum, Linn	....	....	....	*
" arvense, Linn	....	....	*	*
" alpinum, Linn	*	*	....	*
Sagina nodosa, E. Meyer	*	....	....	*
Buda borealis, Wat. (*Spergularia salina*, Presl.)	*	....	....	....
PORTULACACEÆ.				
Montia fontana, Linn	*	....	....	....
LINACEÆ.				
Linum perenne, Linn	....	....	....	*
GERANIACEÆ.				
Geranium Carolinianum, Linn	....	....	*	....
RHAMNACEÆ.				
Rhamnus alnifolius, L'Her	....	....	*	....
SAPINDACEÆ.				
Acer spicatum, Lam	....	....	*	....
LEGUMINOSEÆ.				
Trifolium repens, Linn	....	....	....	*
Astragalus alpinus, Linn	*	....	....	*
Oxytropis podocarpa, Gray	*	....	....	....
" campestris, Linn., var. cærulea, Koch	*	....	....	....
Hedysarum boreale, Nutt	*	....	....	....
Vicia Cracca, Linn	....	....	....	*
" Americana, Muhl	....	....	*	*
Lathyrus maritimus, Bigel	*	....	....	*
" paluster, Linn	*	*	*	*
ROSACEÆ.				
Prunus Pennsylvanica, Linn	*	*	*	....
Spiræa salicifolia, Linn	....	*	*	....

—	1.	2.	3.	4.
ROSACEÆ—*Continued.*				
Rubus Chamæmorus, Linn	*	*	*	*
" arcticus, Linn	*	*	*	*
" " var. grandiflorus, Ledeb	*	*	*	*
" triflorus, Rich	*	*	*	*
" strigosus, Michx	....	*	*	*
Dryas octopetala, Linn	*	....	....	....
" " var. integrifolia, Cham. Sch	....	*	....	*
Geum macrophyllum, Willd	....	....	*	....
" strictum, Linn	....	*	*	....
" rivale, Linn	*	....	*	....
" triflorum, Pursh	*	....	....	....
Sibbaldia procumbens, Linn	*	....	....	*
Fragaria Virginiana, Ehrh	....	*	*	*
Potentilla Norvegica, Linn	*	*	*	*
" arguta, Pursh	....	....	*	....
" Pennsylvanica, Linn	....	....	*	*
" nivea, Linn	*	....	....	....
" maculata, Poir	*	....	....	*
" emarginata, Pursh	*	....	....	*
" palustris, Scop	*	*	*	*
" fruticosa, Linn	*	*	*	*
" tridentata, Sol	*	*	*	*
" anserina, Linn	*	....	*	*
Alchemilla vulgaris, Linn	*	....	....	....
Poterium Canadense, Benth and Hook	*	*	....	....
Rosa Sayi, Schwein	....	....	*	*
Pyrus Americana, DC	*	*	*	*
Amelanchier Canadensis, T. and G., var. oblongifolia, T. and G	....	*	*	....
" " " oligocarpa, T. and G	*	*	*	....
SAXIFRAGACEÆ.				
Saxifraga oppositifolia, Linn	*	....	....	....
" Aizoon, Jacq	*	....	....	....
" cæspitosa, Linn	*	....	....	....
" rivularis, Linn	*	....	....	....
" cernua, Linn	*	....	....	....
" nivalis, Linn	*	....	....	....
" hieracifolia, Waldst. and Kit	*	....	....	....
" Hirculus, Linn	....	....	....	*
" tricuspidata, Retz	*	....	....	*
" aizoides, Linn	*	....	....	*
Mitella nuda, Linn	*	*	*	*
Parnassia palustris, Linn	*	....	*	*
" parviflora, Linn	*	*	....	*
" Kotzebuei, Cham. and Schlecht	*	....	....	*
Ribes oxycanthoides, Linn	....	....	*	*
" lacustris, Poir	....	....	*	*
" rubrum, Linn	....	*	*	*
" prostratum, L'Her	*	*	*	....
CRASSULACEÆ.				
Sedum Rhodiola, DC	*	....	....	....
DROSERACEÆ.				
Drosera rotundifolia, Linn	*	....	*	....
" intermedia, Drev. and Hayne, var. Americana, DC	....	*	*	....

	1.	2.	3.	4.
HALORAGEÆ.				
Hippuris vulgaris, Linn	*	....	*	*
Myriophyllum spicatum, Linn	....	....	....	*
ONAGRACEÆ.				
Circœa alpina, Linn	....	....	....	*
Epilobium spicatum, Lam. (*E. angustifolium*, Linn.)	*	*	*	*
" latifolium, Linn	*	*	....	*
" anagallidifolium, Lam. (*E. alpinum* of Packard's list)	*	....	....	....
" palustre, Linn	*	....	....	*
" lineare, Muhl	*	....	*	....
" adenocaulon, Hausskn. (*E. tetragonum* of Lake Mistassini list)	....	*	*	*
UMBELLIFERÆ.				
Sanicula Marilandica, Linn	..	....	*	...
Sium cicutæfolium, Gmelin	....	....	*	....
Cicuta maculata, Linn	....	....	*	*
" bulbifera, Linn	....	....	*	....
Ligusticum Scoticum, Linn	*	....	....	*
Archangelica atropurpurea, Hoffm	*	...	....	*
" Gmelini, DC	*	....	....	....
Heracleum lanatum, Michx	*	....	*	*
ARALIACEÆ.				
Aralia hispida, Michx	....	....	*	....
" nudicaulis, Linn	....	....	*	....
COMACEÆ.				
Cornus Canadensis, Linn	*	*	*	*
" suecica, Linn	*	*	....	....
" sericea, Linn	....	....	*	*
" stolonifera, Michx	....	*	*	*
CAPRIFOLIACEÆ.				
Sambucus racemosa, Linn., var. pubens, Wat	....	....	*	....
Viburnum pauciflorum, Pylaie	*	*	*	*
Linnæa borealis, Gronov	*	*	*	*
Lonicera involcrata, Banks	....	....	*	*
" cærulea, Linn	*	*	*	....
Diervilla trifida, Mœnch	....	....	*	*
RUBIACEÆ.				
Galium asprellum, Michx	....	....	*	....
" trifidum, Linn	*	*	*	*
" triflorum, Michx	....	....	*	*
" boreale, Linn	....	....	*	*
VALERIANACEÆ.				
Valeriana sylvatica, Rich	....	....	*	....
COMPOSITÆ.				
Eupatorium purpureum, Linn	....	....	*	*
Solidago bicolor, Linn., var. concolor, Torr. and Gray	....	....	*	....

——	1.	2.	3.	4.
COMPOSITÆ—*Continued.*				
Solidago macrophylla, Pursh	*	*	*	....
" multiradiata, Ait	*	....	....	....
" Virgaurea, Linn, var. alpina, Bigel	*	....	....	....
" humilis, Pursh	*	....	....	*
" uliginosa, Nutt	....	....	*	....
" Canadensis, Linn	....	*	*	*
" nemoralis	....	....	*	*
" lanceolata, Linn	....	....	*	*
Aster radula, Ait	*	*	*	....
" " var. strictus, Gray	*	....	....	....
" lævis, Linn	....	....	*	....
" Lindleyanus, T. and G	....	....	*	....
" salicifolius, Ait	....	....	....	*
" puniceus, Linn	....	*	*	*
" paniculatus, Lam	....	....	....	*
" junceus, Ait	....	....	....	*
" nemoralis, Ait	....	....	*	....
" umbellatus, Mill	....	....	*	....
Erigeron, hyssopifolius, Michx	....	....	*	*
" uniflorus, Linn	*	....	....	*
" Philadelphicus, Linn	....	....	*	*
" acris, Linn	*	....	....	*
" " var. Drœbachensis, Blytt	....	....	....	*
" Canadensis, Linn	....	....	*	....
Antennaria plantaginifolia, Hook	....	....	*	....
" dioica, Gærtn	*	....	....	*
" alpina, Gærtn	*	....	....	....
" Carpathica, R. Br	*	....	*	*
Anaphalis margaritacea, Benth. and Hook	....	....	*	*
Gnaphalium Norvegicum, Gunner	*	....	....	....
" supinum, Vill	*	....	....	....
Bidens frondosa, Linn	....	....	....	*
" cernua, Linn	....	....	*	*
Chrysanthemum arcticum, Linn	....	....	....	*
Achillæa Millefolium, Linn	*	*	*	*
Tanacetum Huronense, Nutt	....	....	....	*
Artemisia borealis, Pall., var. spithamœa, T. and G	*	....	....	....
" " " " Wormskioldii, Bess	....	....	*	*
" Canadensis, Michx	....	....	....	*
Petasites palmata, Gray	*	*	*	*
" sagittata, Gray	....	....	*	*
Arnica alpina, Murr	*	....	....	....
Senecio vulgaris, Linn	....	....	....	*
" aureus, Linn	....	....	*	*
" " var. Balsamitæ, Torr. and Gray	....	....	....	*
" " " borealis, Torr. and Gray	*	....	....	....
" " " obovatus, Torr. and Gray	....	....	*	....
" Pseudo-Arnica, Less	*	....	....	*
" frigidus, Less	*	....	....	....
Cnicus muticus, Pursh	....	*	*	*
Hieracium vulgatum, Fries	*	....	....	....
" umbellatum, Linn	....	....	*	*
" scabrum, Michx	....	....	*	....
Taraxacum officinale, Weber	....	....	....	*
" " " var. alpinum, Koch	*	....	....	*
" " " " lividum, Koch	....	*	*	....
Lactuca lencophæa, Gray	....	....	*	....
" pulchella, DC	....	....	....	*
Prenanthes alba, Linn	....	....	*	....
" racemosa, Hook	....	....	*	*

—	1.	2.	3.	4.
LOBELIACEÆ.				
Lobelia Dortmanna, Linn	....	....	*	....
" Kalmii, Linn	....	....	*	*
CAMPANULACEÆ.				
Campanula rotundifolia, Linn	....	*	*	*
" " var. artica, Lange	*	....	....	*
" uniflora, Linn	*	....	....	....
VACCINIACEÆ.				
Vaccinium Pennsylvanicum, Lam	....	....	*	....
" " var. angustifolium, Gray	*	*	....	....
" Canadense, Kalm	....	*	*	....
" uliginosum, Linn	*	*	*	*
" caespitosum, Michx	*	*	....	....
" Vitis-Idæa, Linn	*	*	*	*
" Oxycoccus, Linn. (*Oxycoccus vulgaris*, Pursh.)	*	*	*	*
" macrocarpon, Ait. (*Oxycoccus macrocarpus*, Pursh)	*	....	*	*
Chiogenes hispidula, Torr. and Gray	*	*	*	*
ERICACEÆ.				
Arctostaphylos alpina, Spreng	*	*	....	*
" Uva-ursi, Spreng	....	*	*	....
Cassandra calyculata, Don	*	*	*	....
Cassiope hypnoides, Don	*	....	....	...
" tetargona, Don	*	....	....	....
Epigæa repens, Linn	....	*	*	....
Andromeda polifolia, Linn	*	*	*	*
Loiseleuria procumbens, Desv	*	*	....	....
Bryanthus taxifolius, Gray	*	....	....	....
Kalmia angustifolia, Linn	*	*	*	*
" glauca, Ait	*	*	*	*
Ledum palustre, Linn	*	....	....	....
" latifolium, Ait	*	*	*	...
Rhododendron Rhodora, Don	*	....	....	....
" Lapponicum, Wahl	*	....	....	....
Pyrola minor, Linn	*	....	*	....
" secunda, Linn	....	*	*	*
" " var. pumila, Gray	*	....	....	....
" chlorantha, Swartz	*	....	....	....
" rotundifolia, Linn	....	....	*	*
" " " var. uliginosa, Gray	....	*	*	....
" " " " pumila, Hook	*	....	....	*
Moneses uniflora, Gray	*	*	*	*
DIAPENSACEÆ.				
Diapensia Lapponica, Linn	*	*	....	....
PLUMBAGINACEÆ.				
Armeria vulgaris, Willd	*	....	....	*
PRIMULACEÆ.				
Primula farinosa, Linn	*	....	....	....
" Mistassinica, Michx	*	*	*	*
Egaliksensis, Hornem	*	....	....	*
Trientalis Americana, Pursh	*	*	*	....
Lysimachia stricta, Ait	....	....	*	....

——	1.	2.	3.	4.
APOCYNACEÆ.				
Apocynum androsæmifolium, Linn.	....	....	*	....
GENTIANACEÆ.				
Gentiana serrata, Gunner	....	....	*	*
" Amarella, Linn., var. acuta, Hook.	*	*	*	*
" propinqua, Rich	*	....	....	....
" nivalis, Linn	*	....	....	....
" linearis, Frœl	....	*	*	....
Pleurogyne rotata, Griseb	*	....	....	*
" Carinthiaca, Griseb., var. pusilla, Gray	*	....	....	....
Halenia deflexa, Griseb	*	....	....	....
Menyanthes trifoliata, Linn	*	*	*	*
BORRAGINACEÆ.				
Myosotis verna, Nutt.	....	....	*	....
Mertensia maritima, Don	*	....	....	*
" paniculata, Don.	....	....	....	*
SCROPHULARIACEÆ.				
Mimulus ringens, Linn.	....	....	*	....
Veronica alpina, Linn	*	*	....	....
" scutellata, Linn	....	....	*	....
" Americana, Schwein	....	....	*	....
" peregrina, Linn	....	....	*	....
Castilleia pallida, Kunth.	....	....	*	*
" " var. septentrionalis, Gray	*	....	....	*
Euphrasia officinalis, Linn.	*	*	*	*
" " var. Tartarica, Benth	*	....	....	....
Bartsia alpina, Linn	*	*	....	*
Pedicularis Grœnlandica, Retz.	*	....	....	*
" Lapponica, Linn.	*	....	....	*
" euphrasioides, Stephan.	*	....	....	....
" palustris. Linn., var. Wlassoviana, Bunge.	....	....	*	*
" hirsuta, Linn	*	....	....	*
" flammea, Linn	*	....	....	*
Rhinanthus Crista-galli, Linn.	*	*	*	*
Melampyrum Americanum, Michx	....	...	*	*
LENTIBULARIACEÆ.				
Utricularia vulgaris, Linn., var. Americana, Gray.	....	....	*	....
" intermedia, Hayne	....	....	*	....
Pinguicula, vulgaris, Linn	*	*	*	*
" villosa, Linn	*	....	....	....
" alpina, Linn.	*	....	....	....
LABIATÆ.				
Mentha Canadensis, Linn.	....	*	*	*
" " " var. glabrata, Benth	....	....	*	*
Lycopus sinuatus, Ell.	....	....	*	*
Dracocephalum parviflorum, Nutt	....	....	*	....
Brunella vulgaris, Linn.	....	*	*	....
Scutellaria galericulata, Linn.	....	....	*	*
" lateriflora, Linn.	....	....	*	*
Lamium amplexicaule, Linn	....	....	....	*
Galeopsis Tetrahit, Linn	....	....	...	*
Stachys palustris, Linn	....	....	*	*

	1.	2.	3.	4.
PLANTAGINACEÆ.				
Plantago major, Linn..	....	*	*	*
" eriopoda, Torr.	....	....	....	*
" maritima, Linn.	*	....	....	*
CHENOPODIACEÆ.				
Chenopodium album, Linn.	....	*	*	*
POLYGONACEÆ.				
Polygonum aviculare, Linn	*	*	*	....
" " " var. borealis, Lange. (new to Canada)	....	....	*	*
" amphibium, Linn	....	....	*	....
" cilonode, Michx	....	....	*	*
" Convolvulus, Linn "	....	....	....	*
" viviparum, Linn.	*	....	*	*
" lapathifolium, Ait., var., incanum, Hook	....	....	*	....
Oxyria digyna, Camp	*	....	....	....
Rumex verticillatus, Linn	....	....	....	*
" occidentalis, Wat	*	....	....	*
" maritimus, Linn	....	....	....	*
Kœnigia Islandica, Linn	*	....	....	....
ELÆAGNACEÆ.				
Elæagnus argentea, Pursh..	....	....	...	*
Spehherdia Canadensis, Nutt..	....	....	....	*
SANTALACEÆ.				
Comandra livida, Rich.	*	*	*	*
URTICACEÆ.				
Urtica gracilis, Ait	....	....	*	*
MYRICACEÆ.				
Myrica Gale, Linn.	....	*	*	*
BETULACEÆ.				
Betula lutea, Michx	....	....	*	....
" papyrifera, Michx	*	*	*	*
" pumila, Linn	*	*	*	*
" glandulosa, Michx	*	....	*	....
" nana, Linn.	*	*	....	....
Alnus incana, Willd	....	*	*	....
" viridis, DC.	*	*	*	*
SALICACEÆ.				
Salix adenophylla, Hook	*	....	....	....
" arctica, R. Br...	*	*	....	*
" argyrocarpa, Anders..	*	....	....	....
" balsamifera, Barratt	*	....	....	....
" candida, Willd.	*	....	*	*
" chlorophylla, Anders.	*	....	....	....
" cordata, Muhl..	....	....	*	*
" desertorum, Rich	....	....	*	*
" discolor, Muhl.	....	....	*	*

——	1.	2.	3.	4.
SALICACEÆ.				
Salix glauca, Linn.	*	....	*	....
" herbacea, Linn.	*	....	....	....
" lucida, Muhl.	....	....	*	*
" myrtilloides, Linn	....	....	*	....
" Richardsoni, Hook., var. Macouniana, Bebb.	....	....	....	*
" reticulata, Linn.	*	....	....	....
" rostrata, Rich.	....	....	*	*
" vestita, Pursh.	*	*	....	....
" Uva-ursi, Pursh.	*	*	....	....
Populus tremuloides, Michx.	*	*	*	*
" balsamifera, Linn	....	*	*	*
EMPETRACEÆ.				
Empetrum nigrum, Linn.	*	*	*	*
CONIFERÆ.				
Thuya occidentalis, Linn.	....	....	*	....
Juniperus communis, Linn.	....	*	*	*
" " " var. alpina, Linn.	*	....	....	....
Taxus baccata, Linn., var. Canadensis, Gray	....	*	*	*
Pinus Banksiana, Lamb.	....	*	*	*
Picea alba, Link.	*	*	*	*
" nigra, Link	*	*	*	*
Abies balsamea, Marsh	....	*	*	*
Larix Americana, Michx.	*	*	*	*
ORCHIDACEÆ.				
Calypso borealis, Salisb.	....	....	*	....
Corallorhiza innata, R. Br	....	....	*	....
Listera cordata, R. Br.	*	*	*	....
" convallarioides, Nutt.	....	....	*	....
Spiranthes Romanzoviana, Cham.	....	*	*	*
Goodyera repens, R. Br.	....	....	*	....
Orchis rotundifolia, Gray	....	....	*	*
Habenaria hyperborea, R. Br	*	....	*	*
" obtusata, Rich.	*	....	*	*
" dilatata, Gray.	*	*	*	....
Cypripedium pubescens, Swartz.	....	....	*	....
" acaule, Ait.	....	....	*	....
IRIDACEÆ.				
Iris Hookeri, Penny.	*	*	....	....
" versicolor, Linn.	....	....	*	....
Sisyrinchium mucronatum, Mx.	....	....	*	....
LILIACEÆ.				
Streptopus amplexifolius, DC	*	....	*	....
" roseus, Michx.	*	....	*	....
Smilacina stellata, Desf.	*	....	*	*
" trifolia, Desf.	*	....	*	....
Mianthemum Canadense, Desf. (*M. trifolium* of Mistassini list.)	*	*	*	*
Allium schœnoprasum, Linn	....	....	*	*
Tofieldia borealis, Wahl. (*T. palustris*, Huds.).	*	....	*	*
" glutinosa, Willd.	....	....	*	....
Clintonia borealis, Raf.	*	....	*	....

——	1.	2.	3.	4.
JUNCACEÆ.				
Juncus filiformis, Linn.			*	*
" Balticus, Willd , var. littoralis, Engel.			*	*
" triglumis, Linn.	*			
" effusus, Linn.				*
" castaneus, Smith	*			
" tenuis, Willd.			*	*
" bufonius, Linn				*
" alpinus, Villars, var. insignis, Fries.			*	
" nodosus, Linn.			*	
" Canadensis, J. Gay, var. coarctatus, Engelm.			*	
Luzula spadicea, DC.			*	
" " var. parviflora, Meyer.	*			
" spicata, Desv	*			*
" comosa, Meyer.				*
" arcuata, Meyer.	*			*
TYPHACEÆ.				
Sparganium simplex, Huds.	*		*	
" hyperboreum, Læst., var. Americanum, Beeby	*			*
AROIDEÆ.				
Calla palustris, Linn			*	
LEMNACEÆ.				
Lemna minor, Linn.				*
ALISMACEÆ.				
Sagittaria variabilis, Engelm.			*	*
NAIDACEÆ.				
Triglochin palustre, Linn	*		*	*
" maritimum, Linn.	*		*	
Potamogeton heterophyllus, Schreb. (Includes two varieties of *P. gramineus* in Mistassini list.)			*	
" pauciflorus, Pursh			*	
" pectinatus, Linn.			*	*
" marinus, Linn.			*	
" perfoliatus, Linn			*	
" pusillus, Linn				
" rutilans, Wolfgang				*
" rufescens, Schrad.			*	
Naias flexilis, Rostk			*	
Zannichellia palustris, Linn.			*	
CYPERACEÆ.				
Eleocharis palustris, R. Br.			*	*
Scirups lacustris, Linn. (*S. validus*, Vahl.)			*	
" sylvaticus, Linn., var. digynus, Bœck. (*S. microcarpus*, Presl.)			*	*
" cæspitosus, Linn	*	*	*	*
" atrovirens, Muhl.			*	
Eriophorum alpinum, Linn.			*	*
" cyperinum, Linn				*
" vaginatum, Linn	*		*	
" russeolum, Fries.	*	*	*	

——	1.	2.	3.	3.
CYPERACEÆ—*Continued.*				
Eriophorum capitatum, Host. (*E. Scheuchzeri*, Hoppe.)	*	....	....	*
" polystachyon, Linn	....	*	*	....
" " " var. angustifolium, Gray	*	....	....	....
" gracile, Koch	....	....	*	....
Carex ambusta, Boott	*	....	....	....
" adusta, Boott.	....	....	*	....
" aquatilis, Wahl. (*C. angustata* of Mistassini list.)	....	*	*	*
" alpina, Swartz	....	....	....	*
" arctata, Boott., var. Faxoni, Bailey	....	....	*	....
" atrata, Linn	....	....	*	....
" aurea, Nutt	....	....	*	*
" Buxbaumii, Wahl.	....	....	*	....
" canescens, Linn	*	....	*	*
" " " var. alpicola, Wahl	....	*	*	....
" " " " vulgaris, Bailey	....	....	*	....
" capillaris, Linn	....	*	*	*
" castanea, Wahl. (*C. flexilis*, Rudge.)	....	....	*	....
" chordorhiza, Ehrh	....	....	*	....
" concinna, R. Br.	....	....	*	....
" echinata, Murr	....	....	*	....
" Gmelini, Hook	....	*	....	....
" gyocrates, Wormsk	....	....	....	*
" flava, Linn	....	....	*	....
" lagopina, Wahl.	*	....	....	....
" lanuginosa, Michx	....	*	....	....
" lenticularis, Michx	*	....	*	....
" laxiflora, Lam	....	....	*	....
" limosa, Linn	....	....	*	....
" maritima, Vahl	....	....	....	*
" Magellanica, Lam	*	*	*	....
" microglochin, Wahl	....	....	....	*
" miliaris, Michx	*	....	*	*
" Michauxiana, Bœckl	....	....	*	....
" monile, Tuck	....	....	*	*
" nardina, Fries	....	....	....	*
" Œderi, Ehrh. (*C. flava*, L., var. *viridula*, Bail.)	....	....	*	*
" oligosperma, Michx	*	*	*	....
" polytrichoides, Muhl	....	....	*	....
" pratensis, Dreg	*	....	....	....
" rariflora, Smith	*	....	....	*
" riparia, W. Curtis	....	....	....	*
" rotundata, Wahl	*	....	....	*
" scripoidea, Michx	....	*	....	....
" salina, Wahl	*	....	....	....
" saxatilis, Linn	....	....	....	*
" scoparia, Schk	....	....	*	....
" straminea, Willd	....	....	....	*
" stricta, Lam., var. decora, Bail	....	....	....	*
" teretiuscula, Good	....	....	*	*
" utriculata, Boott. (*C. rostrata* of lists.)	....	*	*	*
" vaginata, Tausch	*	....	*	....
" vulgaris, Fries., var. hyperborea, Boott	*	*	....	....
GRAMINEÆ.				
Beckmannia erucæformis, Host., var. uniflorus, Scrib	....	....	*	*
Panicum dichotomum, Linn	....	....	*	....
Hierochloa alpina, Rœm. and Schultz	*	....	....	*
" borealis, Rœm. and Schultz	....	*	*	*
Alopecurus geniculatus, Linn., var. aristulatus, Munro	....	*	*	....
" alpinus, Smith	....	....	....	*

——	1.	2.	3.	4.
GRAMINEÆ—*Concluded.*				
Stipa Richardsonii, Link	....	....	*	....
Oryzopsis asperifolia, Michx	....	....	*	....
Phleum pratense, Linn	....	....	*	*
" alpinum, Linn	....	....	....	*
Agrostis scabra, Willd	....	....	*	*
Cinna pendula, Trin	....	....	*	....
Calamagrostis Canadensis, Hook	....	....	*	*
" neglecta, Kunth	....	*	*	*
" Langsdorfii, Trin	....	*	*	....
Deschampsia atropurpurea, Scheele	....	....	*	....
" " " var. minor, Varey	....	....	....	*
" cæspitosa, Beauv	....	*	*	....
" alba, Rœm. and Schultz. (*D. flexuosa* of Mistassini list.)	*	*	*	....
Trisetum subspicatum, Beauv., var. molle. Gray	*	....	....	*
Catabrosa aquatica, Beauv	....	....	*	*
Poa alpina, Linn	*	....	....	....
" cæsia, Smith	....	*	....	*
" cenisia, All	*	....	....	*
" glumaris, Trin	....	....	*	*
" pratensis, Linn	....	....	*	*
Glyceria Canadensis, Trin	....	....	*	....
" arundinacea, Kunth	....	....	....	*
" nervata, Trin	....	....	*	*
Festuca ovina, Linn	....	....	....	*
" " " var. brevifolia, Wats	*	....	....	*
Bromus ciliatus, Linn	....	....	*	*
Agropyrum tenerum, Vasey	....	....	*	....
" violaceum, Lange	....	*	....	*
Hordeum jubatum, Linn	....	....	*	*
Elymus mollis, Trin	*	....	....	*
EQUISETACEÆ.				
Equisetum arvense, Linn	*	....	*	*
" pratense, Linn	....	....	*	....
" sylvaticum, Linn	*	*	*	....
" palustre, Linn	....	....	*	....
" scirpoides, Michx	....	....	*	....
OPHIOGLOSSACEÆ.				
Botrychium Lunaria, Swartz	*	....	*	*
" Virginicum, Swartz	....	....	*	....
" ternatum, Swartz., var. lunarioides, Milde	....	....	*	*
FILICES.				
Polypodium vulgare, Linn	....	....	*	....
Pellæa gracilis, Hook	....	....	*	....
Pteris aquilina. Linn	....	....	*	....
Asplenium viride, Huds	....	....	*	....
" Felix-fœmina, Bernh	....	....	*	....
Phegopteris Dryopteris, Fée	*	....	*	....
" " " var. Robertianum, Dav. (*P. calcarea*, Fée.)	....	....	*	....
" polypodioides, Fée	....	....	*	....
Aspidium spinulosum, Swartz., var. dilatatum, Hook	....	....	*	*
Onoclea sensibilis, Linn	....	....	*	....
Cystopteris fragilis, Bernh	*	....	*	....
" montana, Bernh	....	....	*	....

—	1.	2.	3.	4.
FILICES—*Concluded.*				
Woodsia glabella, R. Br.	....	....	*	....
" Ilvensis, R. Br	....	....	*	....
Osmunda regalis, Linn.	....	....	*	....
" Claytoniana, Linn.	....	....	*	....
LYCOPODIACEÆ.				
Lycopodium Selago, Linn	*	....	*	....
" lucidulum, Michx	*	....	....	....
" annotinum, Linn	....	....	*	*
" obscurum, Linn. (*L. dendroideum*, Mx.)	....	....	*	*
" clavatum, Linn	....	....	*	*
" sabinæfolium, Hook	....	....	*	....
" complanatum, Linn	....	...	*	*

APPENDIX VII.

METEOROLOGICAL OBSERVATIONS IN THE LABRADOR PENINSULA, 1893-1894 and 1895 BY D. I. V. EATON.

The barometer used was a small aneroid, but the readings have been corrected, 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 5.

The proportion of the sky covered by clouds is estimated by a scale from 0 to 10; 0 being a cloudless sky, 10 a completely clouded sky. The character of the clouds is denoted by the usual letter or combination of letters referring to Howard's classification.

The letters used in the last column have the following designations: B. blue sky; C. cloudy; R. rain; G. gloomy; F. fog; O. overcast; H. haze.

NOTE—The observations taken between 20th June and 13th August, 1893, were lost through the upset of a canoe. The last thermometer was broken on 18th June, 1894.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1893.	7	2	9		7	2	9
		°	°	°				
Kaniapeskau Lake	Aug. 14	31	70	61	......	28·16	28·16	28·19
Upper Koksoak River	" 15	58	65	61	......	28·19	28·21	28·25
......	" 16	50	70	55	......	28·21	28·35	28·48
......	" 17	40	75	65	......	28·48	28·54	28·62
......	" 18	50	75	65	......	28·62	28·77	28 98
Koksoak River	" 19	36	76	58	......	29·06	29·11	29·12
......	" 20	50	75	62	......	29·17	29·23	29·26
......	" 21	54	68	54	......	29·28	29·41	29·36
......	" 22	44	72	65	......	29·39	29·15	29·22
......	" 23	62	53	50	......	29·16	29·14	29·09
......	" 24	60	63	55	......	......	29·30	29·40
......	" 25	38	64	55	......	29·46	29·44	29·56
......	" 26	64	65	56	......	29·69	29·74	29·68
Fort Chimo	" 27	55	70	64	......	29·46	29·41	29·50
"	" 28	62	70	58	......	29·52	29·56	29·64
"	" 29	46	52	50	......	29·76	29·84	29·94
"	" 30	48	42	40	......	29·89	29·92	29·92
"	" 31	46	......	44	......	29·86	......	29·84
"	Sept. 1	46	66	55	......	29·76	29·66	29·56
"	" 2	49	72	56	......	29·54	29·42	29·42
"	" 3	54	50	40	......	29·46	29·46	29·50
"	" 4	40	61	47	32	29·53	......	29·44
"	" 5	50	59	50	42	29·40	29·39	29·45
"	" 6	46	48	48	......	29·65	29·72	29·76
"	" 7	45	54	40	40	29·84	29·82	29·76
"	" 8	42	56	38	33	29·79	29·83	29·86
"	" 9	36	45	38	......	29·89	29·90	29·91
Ungava Bay	" 10	35	54	......	......	29·92	29·96	29·94
George River Post	" 11	42	44	42	......	30·00	30 04	30·04
"	" 12	54	58	55	......	29·64	29·64	29·41
"	" 13	55	......	54	......	29·41	......	29·54
Ungava Bay	" 14	65	......	48	......	29·42	......	29·40
"	" 15	48	......	43	......	29·18	......	30·02
"	" 16	36	......	43	......	29·87	......	29·80
Fort Chimo	" 17	63	......	64	......	29·72	......	29·62
"	" 18	62	......	......	......	29·62	......	......
Ungava Bay	" 19	55	......	......	......	29·60	......	......
"	" 20	43	......	50	......	29·52	29·55	29·64
Port Burwell	" 21	45	......	43	......	29·64	......	29·81
......	" 22	45	......	40	......	29·70	......	29·61
......	" 23	40	......	42	......	29·25	......	29·25
Nachvak Bay	" 24	42	......	40	......	29·52	......	29·40
......	" 25	46	......	40	......	29·15	......	29·20
......	" 26	43	......	40	......	29·29	......	29·30
Davis Inlet	" 27	45	......	38	......	29·64	......	29·90

Labrador Peninsula, 1893–1894.

Wind. Direction. 7	Wind. Direction. 2	Wind. Direction. 9	Wind. Force. 7	Wind. Force. 2	Wind. Force. 9	Clouds. 7	Clouds. 2	Clouds. 9	Notes on weather during last 24 hours.
N.E.	E.	N.E.	2	3	2	3 K.	2 K.	3 K.+C..	Clear, passing clouds.
......	N.	......	..	2	..	4 K. S...	6 K. S...	9 K. S...	Overcast towards night.
......	S.W.	......	..	1	..	6 K.	5 K. S...	2 K.	C. B.
......	......	S.E.	..	..	2	3 K. S...	3 K.	4 K.	C. B., mist.
S.E.	N.E.	......	2	2	..	3 C.	3 K.	2 K.	B. C.
......	....	......	..	..	..	3 K.	2 K.	3 K. S...	B. C.
......	......	......	..	..	..	....	3 K.	3 K. S...	B. B.
S.E.	N.W.	......	2	3	..	5 C.+K.S.	10 K. S...	1 K.	B., overcast.
......	S.W.	......	..	2	..	3 K.	8 K.+C..	9 K.+C.	C., dull.
S.	......	......	2	..	..	9 C.	N.	N. .. .	Heavy showers, dull and gloomy.
S.	N.	......	1	2	..	N.	10 K. S...	8 K. S...	Rain, overcast and dull.
.....	N.	N.	..	3	2	2 K.	8 K. S...	8 K.	C. B.
.....	S.	....	..	2	..	8 K.	6 K. S...	7 K. S...	O. dull.
E.	S.	...	2	3	..	8 K.+C..	4 C.+3 K	6 K. S...	C. B.
.....	......	E.	..	..	2	5 K. S...	5 K. S...	8 K.	C. B.
E.	......	N.E.	2	..	2	6 K. S...	7 K.	8 K.	Smoky, C.
......	......	.....	..	..	..	5 K. S...	5 K. S...	1 K.	C. B.
.....	......	......	..	..	..	1 K.	1 K.	K.	Bright and clear.
...	......	N.E.	..	..	2	1 K.	1 K.	K.	B.
......	......	N.E.	..	..	3	K.	2 K.	2 K.	B.
.....	N.	N.	..	2	2	....	....	10 K. S...	Hazy, overcast at night.
.....	N.	......	..	..	..	7 K.+C..	....	8 K.+1 C	C. B.
......	......	......	..	..	..	9 K. S...	6 K. S...	10 S	Rain at night.
......	N.W.	N.W.	..	2	2	8 K. S...	6 K. S...	7 K. S...	C. B.
W N W	.....	W.	3	..	2	8 K.	7 K. ...	6 S.+C..	Dull and gloomy.
......	E.	N.E.	..	3	2	8 K.	5 K.	9 K. S..	C. B.
N.	N.	N.	2	1	2	8 K.	7 K.	8 K. S. .	Fog, dull and threatening.
N.E.	N.E.	N.E.	1	2	2	8 K. S...	5 K.	5 K.+C..	C.
N.E.	W.	W.	2	2	2	10 K. ...	10 K.	5 K.	Overcast and dull.
......	.....	S.E.	..	..	1	8 K. S...	6 K.	7 K. S...	C. B.
S.E.	.....	...	2	..	..	7 K. S...	....	4 K. S...	Light showers.
......	.....	S.W.	..	..	2	6 K.	....	7 K.	C.
S.	....	S.E.	2	..	2	10 K.	....	10 K. S...	C. and fog.
.....	.....	......	..	..	..	8 K. S...	....	4 K.	Rain.
S.E.	.....	......	3	..	..	4 K.	....	7 K.	Dull.
S.E.	S.E.	S.E.	2	..	..	10 K.	....	....	Mist.
S.E.	....	......	..	..	..	10 K.	....	6 K. S...	O. dull.
S.E.	....	......	3	..	..	10 K.	....	8 K. S...	O., mist.
S.E.	......	W.	2	..	2	8 K. S...	....	6 K.	O., dull.
S.E.	......	E.	2	..	2	6 K.	....	7 K.	Fog.
S E.	......	S.E.	2	..	3	8 K. S...	....	7 K. S...	Overcast, fog.
S.E.	.....	S.E.	2	..	1	2 K.	....	6 K. S...	B. C.
S.E.	......	S.E.	2	..	2	10 K. S...	....	6 K. S...	Fog, C. B.
N.	......	N.	3	..	3	10 K. S...	....	6 K. S...	C. B.
N.W.	....	N.W.	3	..	2	5 K.	....	4 K.	C. B.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1893.	7	2	9		7	2	9
		°	°	°				
....	Sept. 28....	40	......	42	......	30·04	30·14	30·14
....	" 29....	48	......	40	......	30·14	......	30·15
....	" 30....	45	......	44	......	30·14	......	30·22
Rigolet..............................	Oct. 1....	42	48	40	......	30·32	30·00	29·97
"	" 2....	39	49	40	......	29·91	29·80	29·70
"	" 3....	43	50	41	......	29·65	29·72	29·90
"	" 4....	46	56	41	......	29·87	29·85	29·99
"	" 5....	35	48	39	......	30·00	30·08	30·08
"	" 6....	34	52	40	......	30·01	29·80	29·75
"	" 7....	40	60	41	......	29·90	29·08	29·94
"	" 8....	41	44	42	......	29·75	29·62	29·60
"	" 9....	41	50	43	......	29·60	29·60	29·63
Hamilton Inlet......................	" 10....	44	......	49	......	29·65	......	29·80
"	" 11....	44	45	42	......	29·90	30·00	30·00
"	" 12....	42	48	46	......	30·20	30·12	30·12
Northwest River, Labrador	" 13....	44	......	44	......	29·92	......	30·00
"	" 14....	42	48	43	......	30·00	30·00	30·02
"	" 15....	43	54	51	......	29·56	29·31	29·24
"	" 16....	42	49	44	......	29·31	29·24	29·71
"	" 17....	36	42	36	......	29·90	29·84	29·90
"	" 18....	30	36	31	......	30·10	30·12	30·20
"	" 19....	32	38	32	......	30·20	30·12	30·06
"	" 20....	32	40	39	......	29·85	29·80	29·74
"	" 21....	39	52	55	......	29·60	29·44	29·74
"	" 22....	39	40	42	......	30·10	30·15	30·40
"	" 23....	44	46	32	......	30·70	30·10	30·40
"	" 24....	39	48	49	......	30·22	30·05	29·96
"	" 25....	53	53	48	......	29·66	29·70	29·90
"	" 26....	36	45	43	......	30·00	30·10	30·20
"	" 27....	40	47	32	......	30·40	30·00	30·00
"	" 28....	43	45	41	......	29·89	29·90	29·75
"	" 29....	41	42	40	......	29·62	29·41	29·41
"	" 30....	42	44	34	......	29·72	30·00	30·23
"	" 31....	26	27	24	......	30·32	30·40	30·23
"	Nov. 1....	24	27	22	......	30·20	30·10	30·08
"	" 2....	28	37	38	......	30·00	29·99	29·99
"	" 3....	39	43	45	......	29·92	29 71	29·68
"	" 4....	35	36	23	......	29·77	29·84	30·00
"	" 5....	31	36	28	......	30·00	30·04	30·05
"	" 6....	30	23	33	......	30·00	30·00	29·99
"	" 7....	29	34	32	......	30·16	3 ·24	30·00
"	" 8....	31	35	28	......	29·80	29·60	29·60
"	" 9....	25	33	28	......	29·52	29·52	29·85
"	" 10....	15	20	14	......	30·04	30·10	30·12
"	" 11....	18	25	14	......	30·20	30·10	30·20
"	" 12....	27	27	24	......	30·20	30·20	30·10
"	" 13....	30	36	35	......	29·95	29·92	29·94
"	" 14....	31	31	37	......	29·96	29·92	29·89
"	" 15....	39	40	37	......	29·68	29·50	29·32
"	" 16....	41	40	28	......	29·62	29·50	29·60
"	" 17....	25	27	22	......	29·10	29·22	29·43
"	" 18....	16	33	24	......	29·44	29·31	29·25
"	" 19....	17	19	12	......	29·44	29·50	29·70
"	" 20....	10	17	16	......	30·05	30·00	29·90

Labrador Peninsula, 1893-1894—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
N.W.	......	N.W.	2	..	4	4 K	....	6 K.S....	C. B.
N.W.	......	N.W.	2	..	1	7 K. S...	....	7 K.S....	C. B.
N.W.	......	S.W.	2	..	1	....	....	5 K	B.
......	S.	S.W.	..	..	..	2 K	3 K. S...	5 K	B. C.
W.	......	E.	2	..	2	7 K. C...	6 K. S...	8 K.S+C	C. B.
N.E.	N.	S.W.	2	2	2	9 K	4 K. S...	6 K. S...	C. B.
S.E.	S.	W.	2	3	2	7 K. S...	2 S+c....	2 K	B. C.
N.	N.E.	N.	2	2	2	3 K. S...	3 K+C..	5 K	B. C.
N.E.	N.	......	2	1	..	5 K	4 K. S...	3 K+C..	C. B.
N.E.	......	N.	2	..	2	9 K. C...	5 K. S...	6 K. S...	B. C., aurora.
N.	N.	......	1	½	..	4 K. S...	7 K	6 K	O. dull.
......	......	......	..	..	..	7 K. S...	5 K. S...	6 K. S...	C. B.
......	......	......	..	..	..	N	....	10 K. S...	Rain in morning, C.B.
......	......	......	..	..	..	6 K. S...	N	7 K. S...	O. D., showers.
S.	S.W.	S.W.	2	2	2	8 K. S...	8 K. S...	10 K. S...	C. B., showers.
......	......	N.W.	..	..	2	8 S	....	8 K. S...	C. B.
N.W.	N.W.	N.W.	1	2	2	8 K. S...	6 K. S...	S.K ...	C. B.
......	S.	S.W.	..	3	3	9 K. S...	10 K	8 K	C. B.
S.W.	S.W.	......	3	3	..	7 K	7 K	4 K	B. C.
......	W.	......	..	1	..	7 K. S...	10 K. S...	10 N	C. B., rain at night.
......	......	W.	..	..	2	8 K. S...	8 K	4 K. S...	C. B., snow at 9 p.m.
W.	W.	W.	2	1	2	10 K. S...	9 K	9 K.N...	C. B., 1 inch of snow.
S.W.	......	......	2	..	..	6 K. C...	7 K	9 K	C. B., steady.
S.W.	S.W.	W.	1	1	1	5 K	7 K	....	C. B.
S.W.	......	......	2	..	..	K. S...	....	....	B., bright and starry.
S.W.	S.W.	......	2	1	..	7 K	8 K	9 K. S...	B.
S.	S.	S.W.	2	2	3	8 K	6 K	6 K+C..	C. B., rain in early morning.
W.	S.W.	N.E.	2	1	2	8 K. S...	6 K	7 K+C..	B., fast moving clouds at 9 p.m.
N.	N.	N.E.	2	1	2	5 K. S...	5 K. S...	4 K	C. B., showers.
......	N.	N.W.	2	2	2	6 K. S...	7 K. C...	3 K	C. B.
W.	S.	S.E.	1	2	1	10 K	6 N	10 N	C. B.
N.E.	N.E.	W.	1	2	2	7 K	6 N	5 K+C..	C. B., showers.
W.	N.E.	......	1	3	..	9 K+C..	3 K+C..	9 N	B. C., bright moonlight.
N.W.	N.W.	W.	1	2	1	7 K. S...	6 K	6 K	C. B., snow.
W.	N.	W.	2	2	2	8 K	2 K	2 K	C. B., aurora.
N W.	N.W.	W.	2	1	1	4 C+KS	7 Ks.....	5 K. S...	C. B., ptarmigan seen.
S.	S.	S.	1	2	2	8 K	7 K.S+C	8 K. S...	C. B.
N.W.	N.W.	......	2	2	..	8 K	1 K	....	B.
N.W.	W.	W.	1	1	1	8 K	7 K	8 K. S...	C. B.
W.	....	....	½	..	..	7 K	6 K	8 K.N...	C. B., snow.
N.	N.	......	1	1	..	8 N	7 K. S...	6 K. S...	C. B. R.
S.W.	S.W.	S.W.	1	2	2	10 K. S...	8 N	6 K	Snow, C. B.
W.	N.W.	W.	1	2	2	10 K	8 N	2 K	O. dull.
W.	N.W.	W.	1	2	2	3 K	3 K	K	B.
W.	N.W.	......	1	1	..	2 K	1 K	1 K	B.
W.	W.	......	1	1	..	2 K	2 K	1 K	B., aurora.
N.W.	W.	W.	1	1	1	5 N	6 N	3 N	B. C., mist.
W.	N.W.	......	1	1	..	4 K. S...	4 K	5 K	B. C.
S.E.	S.E.	......	1	1	..	7 K+C..	4 K+C..	8 K	C. B., rain, ptarmigan seen.
N.E.	S.W.	W.	1	2	2	6 K	4 N	3 K	C. B.
W.	W.	W.	3	2	2	6 K	6 K	1 K	B. C.
S.W.	N.	......	1	1	..	10 K	10 N	10 K	C. B., snow.
W.	W.	N.W.	1	1	1	3 K	2 K	....	B. B.
N.W.	N.W.	......	1	1	..	....	8 K	7 K	C. B.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1893	7	2	9		7	2	9
		°	°	°				
Northwest River, Labrador.........	Nov. 21....	25	26	20	......	29·45	29·42	29·60
″	″ 22....	10	25	15	......	30·10	30·20	30·18
″	″ 23....	20	26	24	......	29·80	29·65	29·55
″	″ 24....	22	25	28	......	29·62	29·62	29·42
″	″ 25....	27	27	24½	......	28·82	28·82	29·22
″	″ 26....	20	21	21	......	29·62	29·62	29·80
″	″ 27....	16	24	13	......	30·08	30·10	30·22
″	″ 28....	2	11	12	......	30·33	30·33	30·20
″	″ 29....	30	30	33	......	29·32	29·35	29·24
″	″ 30....	19	22	20	......	29·52	29·50	29·42
″	Dec. 1....	15	22	5	......	29·42	29·40	29·75
″	″ 2....	12	11	0	......	29·84	29·64	29·52
″	″ 3....	10	12	-13	......	30·00	30·12	30·25
″	″ 4....	- 2	5	- 1	......	30·04	29·90	29·85
″	″ 5....	-18	- 4	-10	......	30·40	30·46	30·52
″	″ 6....	-14	2	2	......	30·18	30·00	29·92
″	″ 7....	5	11	5	......	29·82	29·92	29·99
″	″ 8....	7	3	- 8	......	30·00	30·06	30·20
″	″ 9....	-15	- 6	-13	......	30·15	30·05	30·00
″	″ 10....	-15	-12	-12	......	30·00	29·96	29·82
″	″ 11....	- 5	3	7	......	29·55	29·45	29·35
″	″ 12....	15	10	-15	......	29·72	29·80	29·82
″	″ 13....	-25	-10	-25	......	29·95	29·94	29·93
″	″ 14....	-25	-16	-17	......	29·84	29·82	29·86
″	″ 15....	-10	- 9	- 8	......	29·82	29·83	30·02
″	″ 16....	- 6	- 2	- 2	......	30·26	20·25	30·15
″	″ 17....	10	26	25	......	29·30	29·32	29·45
″	″ 18....	21	18	8	......	29·52	29·45	29·42
″	″ 19....	0	0	12	......	29·82	30·00	30·00
″	″ 20....	- 4	0	- 8	......	29·64	29·50	29·41
″	″ 21....	- 6	- 3	- 5	......	29·35	29·30	29·29
″	″ 22....	- 4	- 1	- 3	......	29·50	29·75	29·84
″	″ 23....	-15	- 8	-15	......	30·00	30·00	30·02
″	″ 24....	-20	-13	-30	......	30·00	30·02	30·07
″	″ 25....	-13	- 6	-12	......	29·96	29·90	29·80
″	″ 26....	- 7	- 3	-10	......	29·72	29·71	29·70
″	″ 27....	-10	- 3	- 8	......	29·60	29·55	29·52
″	″ 28....	10	18	18	......	29·42	29·31	29·22
″	″ 29....	28	30	15	......	29·22	29·31	29·52
″	″ 30....	-10	- 7	-17	......	29·90	30·00	30·23
″	″ 31....	-25	-10	-15	......	30·46	30·40	30·30
	1894.							
″	Jan. 1....	-20	-15	-20	......	30·20	30·05	30·00
″	″ 2....	-20	-18	-22	......	29·90	29·92	29·95
″	″ 3....	-25	-18	-20	......	30·12	30·15	30·20
″	″ 4....	-10	- 9	- 8	......	29·90	29·75	29·62
″	″ 5....	0	2	-15	......	29·50	29·60	29·70
″	″ 6....	-15	-18	-20	......	29·90	29·80	29·90
″	″ 7....	-30	-22	-25	......	29·90	29·78	29·96
″	″ 8....	-35	-18	-26	......	29·90	29·82	29·82
″	″ 9....	-30	-10	-18	......	29·82	29·82	29·84
″	″ 10....	-24	-15	-20	......	29·90	30·00	30·02
″	″ 11....	-25	-17	-35	......	30·10	30·09	30·04

Labrador Peninsula, 1893-1894—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
N.	N.W.	W.	1	2	1	8 K....	8 N.....	4 K.....	C. B., rain which soon turns to snow
W.	W.	W.	1	1	1	....	1 K.....	3 K.....	B.
N.W.	N.W.	......	1	1	..	6 K.....	8 K. S...	10 N.....	C. B., snow.
W.	N.W.	W.	1	1	2	1 K.....	8 K. S...	10 K.....	C. B.
N.W.	N.W.	W.	2	2	2	10 N.....	10 N.....	7 K.....	Snow, one foot of snow on ground.
W.	W.	W.	1	2	1	6 K.....	7 K.....	8 K.....	C. B.
N.W.	W.	W.	1	1	1	5 K.....	8 K. S...	2 K.....	C. B., Goose Bay frozen.
S.W.	S.W.	......	1	1	..	2 K.....	8 K.....	10 N.....	C. B., snow.
N.W.	N.W.	......	1	1	..	8 N.....	10 N.....	8 K.....	C. B., rain.
S.W.	S.W.	......	1	..	..	1 K.....	6 K.....	8 K.N...	B. C. C., ice floating in river.
N.W.	N.W.	N.	1	1	2	2 K.....	10 N.....	....	B., snow at noon.
W.	N.W.	N.W.	2	1	3	8 K.....	9 N.....	6 K. S...	Snow and squalls.
W.	W.	......	2	2	..	....	2 K.....	....	B., clear and calm.
S.W.	N.W.	N.W.	1	1	2	6 N.....	2 K.....	....	Snow in morning.
N.W.	N.W.	W.	2	2	1	3 K.....	2 K.....	1 K.....	C. B., aurora.
S.W.	W.	W.	1	1	1	4 K. C...	8 K. S...	10 N.....	C. B., snow, trout and smelt caught
S.W.	S.W.	......	1	1	..	5 K. S...	4 K.....	....	C. B., aurora, river frozen over.
W.	W.	W.	1	2	4	4 K. S...	....	2 K. S...	B. C., aurora.
S.W.	S.W.	W.	3	1	1	4 K. S...	10 N.....	....	C. B., snow at noon, aurora.
S.W.	S.W.	......	1	1	..	7 K.....	7 K. S...	1 K.....	C. B., river open.
N.W.	S.W.	S.W.	1	1	1	6 K.....	8 K.....	8 N.....	C. B., snow at night.
N.W.	W.	W.	1	1	3	10 N.....	3 K.....	....	Snow, C. B.
N.	N.W.	N.W.	2	1	3	10 S.....	6 K.....	4 S.....	C. B.
N.	W.	W.	2	3	1	5 K.....	4 K. S...	3 K.....	C. B., river half open and ice floating
W.	W.	W.	2	2	2	4 S.....	6 K. S...	4 S+C..	C. B., much drifting.
W.	W.	......	2	1	..	4 K. S...	3 K.....	6 K. S...	C. B.
......	N.E.	N.E.	..	2	2	6 K. S...	8 N.....	8 N.....	Snow.
S.W.	S.W.	W.	1	1	2	8 K.....	6 K.....	....	C. B.
S.W.	S.W.	W.	2	1	1	9 K.....	....	....	C. B., river open at rapid.
N.W.	N.W.	......	2	2	..	8 N.....	N.....	N.....	Snow.
W.	W.	W.	1	1	1	7 K.....	4 K.....	2 K. S...	C. B., river frozen.
W.	W.	N.W.	2	1	1	6 K.....	3 K. S...	2 K.....	C. B.
W.	W.	W.	2	2	2	2 K.....	1 K.....	1 K.....	B.
N.W.	S.W.	W.	1	1	1	4 K.....	2 S.....	....	B.
W.	W.	W.	1	1	1	2 K.....	3 K.....	....	B.
W.	W.	W.	2	1	1	1 K.....	1 K.....	....	B., aurora.
W.	W.	W.	2	2	1	1 K.....	....	1 K.....	B., aurora.
S.	S.	S.	2	1	2	2 K.....	4 S.....	7 N.....	C. B., snow, river open.
S.W.	S.W.	S.W.	1	1	1	8 N.....	8 N.....	9 N.....	Drifting, aurora.
W.	N.W.	W.	1	1	2	8 N.....	6 S.....	....	C. B.
S.W.	S.W.	W.	1	1	2	3 K.....	5 K.....	....	C. B.
S.W.	S.W.	W.	2	1	2	7 N.....	4 N.....	....	B., at 9 p.m. aurora.
W.	W.	W.	2	3	2	3 K.....	....	....	B., brilliant aurora.
W.	W.	W.	2	1	1	2 K.....	....	1 K.....	B., brilliant aurora.
N.W.	N.W.	N.W.	1	1	1	6 K. S...	7 N.....	8 N.....	Snow.
N.W.	N.W.	N.W.	1	1	2	7 N.....	6 N.....	5 K.....	C. B., snow.
W.	W.	W.	2	3	2	2 K.....	2 K. S...	....	B.
W.	S.W.	S.W.	1	2	1	....	2 K. S...	....	C.B.
W.	W.	W.	1	1	1	1 K.....	1 K.....	....	B.
......	W.	W.	..	1	1	6 K. S...	1 K.....	1 K.....	B.
W.	W.	W.	3	2	3	....	....	....	B.
W.	W.	W	1	1	1	....	....	....	B., brilliant aurora.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1894.	7	2	9		7	2	9
		°	°	°				
Northwest River, Labrador	Jan. 12	-20	0	-10	......	29·70	29·70	29·70
"	" 13	-10	16	10	......	29·65	29·55	29·60
"	" 14	18	20	10	......	29·82	29·82	29·95
"	" 15	-10	10	0	......	29·80	29·85	29·90
"	" 16	- 2	2	-15	......	29·99	30·05	30·35
"	" 17	-23	- 3	-10	......	30·62	30·60	30·60
Traverspin	" 18	-10	17	30	......	30·30	......	30·50
	" 19	30	11	0	......	30·50	......	30·48
Muskrat Falls	" 20	0	8	- 3	......	30·72	......	30·82
"	" 21	0	20	10	......	30·61	......	30·20
	" 22	30	33	10	......	29·90	29·70	29·64
Gull Lake	" 23	0	- 2	- 5	......	30·20	30·20	30·20
"	" 24	0	5	0	......	30·25	30·30	30·50
"	" 25	9	13	- 3	......	30·49	30·49	30·47
"	" 26	-20	-12	-22	......	30·45	30·45	30·45
Muskrat Falls	" 27	-20	- 5	-25	......	30·42	30·40	30·40
	" 28	-32	0	18	......	30·44	30·52	30·58
	" 29	20	- 3	-10	......	30·70	30·56	30·70
	" 30	- 8	0	- 3	......	30·70	30·70	30·60
Northwest River	" 31	2	5	0	......	30·60	30·50	30·48
"	Feb. 1	0	- 2	-10	......	30·30	30·25	30·20
"	" 2	-20	-12	-20	......	30·10	30·12	30·11
"	" 3	-10	0	- 6	......	30·05	28·98	29·80
"	" 4	-12	0	-10	......	29·75	29·80	29·86
"	" 5	-20	- 8	-23	......	30·20	30·18	30·15
"	" 6	8	12	10	......	30·00	29·96	29·92
"	" 7	20	22	- 8	......	29·80	29·92	30·00
"	" 8	-10	0	-12	......	30·50	30·51	30·52
"	" 9	- 8	4	-10	......	30·50	30·45	30 50
"	" 10	-10	3	-10	......	30·56	30·50	30·30
"	" 11	0	10	-10	......	30·10	30·08	30·09
"	" 12	-30	-24	-24	......	30·20	30·10	30·42
"	" 13	-30	-17	-20	......	30·40	30·30	30·30
"	" 14	-17	0	- 3	......	30·22	30·08	30·10
"	" 15	- 5	13	- 5	......	30·05	30·02	29·99
"	" 16	- 0	5	- 5	......	29·42	29·60	29·72
"	" 17	26	-15	-19	......	30·22	30·35	30·50
"	" 18	-16	- 3	0	......	30·15	29·95	29·62
"	" 19	6	8	- 8	......	29·95	30·15	30·35
"	" 20	- 7	0	- 5	......	30·20	29·85	29·65
"	" 21	-12	- 5	-13	......	29·96	30·07	30·15
"	" 22	- 9	- 7	- 2	......	30·20	30·17	30·10
"	" 23	- 8	8	0	......	30·08	29·92	29·92
"	" 24	-24	-10	-26	......	30·00	30·08	30·08
"	" 25	-30	- 8	-12	......	30·22	30·19	30·20
"	" 26	-29	8	- 5	......	30·10	30·02	30·10
Rabbit Island	" 27	-20	0	- 6	......	30·46	30·50	30·52
Traverspin	" 28	-13	0	0	......	30·32	30·20	30 10
	Mar. 1	- 5	5	10	......	30·32	30·20	30·12
Muskrat Falls	" 2	32	50	25	......	30·02	30·21	30·36
	" 3	21	29	5	......	30·36	30·31	30·42
	" 4	5	35	30	......	30·22	30·20	30·12
	" 5	32	30	25	......	25·95	30·00	30·25
	" 6	20	35	30	......	30·40	30·20	30·10

Labrador Peninsula, 1893-1894—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
W.	W.	W.	1	1	..	7 K.	10 K.	N.	C. B.
N.W.	N.W.	N.W.	1	1	1	8 N.	10 N.	4 K.	Snow.
N.W.	N.W.	...	1	1	..	8 N.	6 K. S.	...	C. B.
W.	W.	N.W.	1	2	2	2 K. S.	4 K. S.	6 K.	C. B.
N.W.	W.	W.	3	2	1	8 K.	4 K.	6 K. S.	C. B., heavy drift.
...	W.	W.	..	1	1	6 K.	2 K.	...	B.
W.	S.W.	S.W.	1	1	2	1 K.	9 K. S.	10 S	Soft, mild.
S.W.	W.	N.W.	1	3	3	8 S.+C.	9 S	...	Drift.
...	N.	...	..	1	..	...	...	6 K.	B.
W.	...	W.	2	..	1	7 K. N.	8 K.	8 S.	C. B.
S.	S.W.	W.	3	1	..	8 K. S.	8 K. S.	7 K. S.	B. C.
W.	N.W.	S.W.	3	2	2	6 K.	...	7 S.	B.
S.W.	W.	S.E.	2	2	1	3 K. S.	10 N.	9 N.	B., snow at night.
W.	W.	N.W.	1	2	2	10 N.	10 K. S.	10 N.	Snow.
N.W.	N.W.	N.	3	2	3	3 K.	...	...	B., aurora.
W.	W.	N.W.	2	1	1	8 S.	5 K.	6 K. S.	C. B.
N.W.	W.	N.W.	1	1	1	6 S.	3 K. S.	6 K. S.	C. B.
W.	N.W.	W.	2	2	1	...	...	2 K.	B., aurora.
W.	E.	N.	2	1	1	5 K. S.	9 S. K.	4 K.	B.
S.E.	...	S.W.	2	..	1	6 S	8 S. K.	...	C. B.
S.W.	S.W.	...	2	1	..	6 K. S.	3 K. S.	...	C. B., aurora.
S.W.	...	...	1	..	..	...	...	...	B., briillant aurora.
S.W.	...	S.W.	2	..	1	3 K. S.	7 S.	7 K. S.	C. B.
N.W.	N.W.	W.	2	2	2	8 K. N.	8 K. S. N.	9 K.	Snow drift all day.
W.	W.	...	2	1	..	2 K.	2 K.	...	B., aurora.
W.	W.	W.	1	2	2	...	8 S.	...	C. B.
S.W.	S.	S.W.	2	2	1	8 K.	10 K. C.	K.	Dull.
W.	W.	W.	2	1	2	3 S.	3 C.	...	C. B.
...	...	W.	..	..	1	4 S. K.	3 S.	2 K.	B.
W.	W.	...	1	1	..	3 K.	1 K.	...	B.
N.	N.	N.W.	1	2	4	6 K.	4 K. S.	...	C. B.
N.W.	N.W.	N.W.	5	3	3	3 K.	...	...	B.
N.W.	W.	W.	2	2	1	3 K. S.	7 K. S.	...	C. B.
S.W.	S.W.	S.W.	2	3	2	2 K. S.	6 K.	...	B.
W.	W.	W.	2	1	2	8 N.	6 K.	6 K.	C. B.
N.E.	N.E.	N.E.	2	1	2	5 K.	...	...	B.
N.W.	N.	N.W.	2	2	1	10 N.	10 N.	10 N.	Snow.
N.W.	N.E.	N.E.	1	1	1	6 K. S.	4 K. S	...	C. B., drift.
N.W.	N.W.	W.	3	2	2	10 N.	10 N.	10 N.	Snow.
N.W.	.	N.W.	2	..	3	3 K.	10 N.	...	B. R., drift, at night aurora.
N.W.	W.	W.	3	2	2	2 K.	1 K.	3 S.	B. Dull.
W.	S.W.	S.W.	2	2	3	2 K.	2 K.	3 S.	B.
W.	N.E.	N.E.	1	1	2	3 K.	6 K. S.	10 N.	B. C., aurora.
N.	N.	N.W.	2	2	2	6 K.	4 K.	...	B. C., drift.
N.W.	N.	W.	2	1	2	...	...	...	C. B., aurora.
W.	S.W.	W.	1	1	1	3 K.	7 K.	...	B. C.
W.	W.	W.	1	1	2	...	...	4 K. S.	C. B.
...	S.	S.	..	2	2	6 K. S.	10 N.	8 K. S.	Drift and snow.
...	S.W.	S.	..	2	2	2 K.	3 K.	10 K.	C. B.
S.	S.	S.	2	2	2	7 K. S.	6 K. S.	2 K.	C. B.
W.	W.	W.	2	2	1	2 K.	1 K.	...	B.
S.	S.W.	S.W.	1	1	1	7 K. S.	6 K.+C.	5 S.	C. B.
S.	S.	E.	2	2	2	10 N.	6 S.	...	Rain in a.m., C. B.
W.	E.	E.	2	2	2	2 K.	9 K.+C.	10 K.	O., rain and snow.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1894.	7	2	9		7	2	9
		°	°	°				
....	Mar. 7....	25	28	20	......	29·76	29·76	29·70
....	" 8....	10	20	5	......	30·20	30·20	30·22
....	" 9....	0	10	0	......	30·30	30·30	30·40
....	" 10....	– 3	15	25	......	30·45	30·20	30·12
....	" 11....	29	40	40	......	30·02	29·90	29·62
....	" 12....	35	31	31	......	29·32	29·52	29·82
....	" 13....	1	......	0	......	29·82	.....	29·92
....	" 14....	–12	......	– 4	......	30·05	......	29·85
....	" 15....	– 5	......	0	......	29·92	......	29·82
....	" 16....	10	......	0	......	29·89	......	29·82
....	" 17....	12	20	20	......	29·92	30·05	30·15
Minipi River........................	" 18....	0	20	5	......	30·22	30·42	30·39
....	" 19....	–10	......	15	......	30·25	......	29·94
....	" 20....	17	25	12	......	30·08	30·10	30·25
....	" 21....	– 1	10	– 5	......	30·35	30·30	30·05
....	" 22....	–18	5	– 2	......	30·04	29·50	29·54
....	" 23....	–15	9	– 3	......	29·74	29·68	29·58
....	" 24....	– 5	28	10	......	29·55	29·44	29·52
....	" 25....	– 9	30	12	......	29·66	29·47	29·34
....	" 26....	5	15	10	......	29·34	29·20	28·84
....	" 27....	15	12	10	......	28·44	28·57	28·70
Winokapau Lake......................	" 28....	– 5	10	2	......	29·02	29·05	29·18
"	" 29....	– 8	25	25	......	29·25	29·08	28·92
"	" 30....	10	28	0	......	28·90	28·90	28·85
"	" 31....	–12	11	3	......	29·05	29·06	29·09
"	April 1....	10	23	20	......	28·70	28·36	28·35
"	" 2....	– 3	15	8	......	28·60	28·54	28·72
"	" 3....	0	12	0	......	29·00	29·02	29·18
"	" 4....	– 8	30	0	......	29·46	29·36	29·42
"	" 5....	0	30	22	......	29·42	29·32	29·42
"	" 6....	14	30	20	......	29·45	29·42	29·40
"	" 7....	8	20	20	......	29·60	29·62	29·65
"	" 8....	10	33	21	......	29·85	29·82	29·95
"	" 9....	5	33	21	......	29·95	29·45	29·92
"	" 10....	5	40	33	......	29·92	29·80	29·84
"	" 11....	15	52	38	......	29·76	29·74	29·76
"	" 12....	18	58	38	......	29·92	29·86	29·85
"	" 13....	12	52	45	......	29·82	29·62	29·62
"	" 14....	20	54	48	......	29·60	29·50	29·52
"	" 15....	25	52	42	......	29·58	29·62	29·48
"	" 16....	25	53	45	......	29·56	29·50	29·56
Hamilton River, below Grand Falls..	" 17....	27	34	37	......	29·83	29·77	29·72
" " ..	" 18....	33	45	38	......	29·51	29·30	29·26
" " ..	" 19....	36	39	35	......	29·30	29·45	29·45
" " ..	" 20....	30	40	38	......	29·56	29·48	29·40
" " ..	" 21....	33	38	25	......	29·26	29·16	29·45
" " ..	" 22....	20	41	40	......	29·62	29·66	29·61
" " ..	" 23....	25	45	42	......	29·56	29·22	29·14
" " ..	" 24....	31	31	26	......	29·35	29·45	29·54
" " ..	" 25....	15	42	38	......	29·50	29·24	29·22
" " ..	" 26....	26	47	39	......	29·22	29·23	29·10
" " ..	" 27....	23	42	36	......	29·35	29·26	29·42
" " ..	" 28....	14	26	18	......	29·60	29·62	29·78
" " ..	" 29....	10	27	25	......	29·86	29·92	29·94

Labrador Peninsula, 1893–1894—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
..	E.	W.	..	2	2	10 C.	10 N.	8 K.	Snow and rain.
W.	W.	W.	2	2	2	1 K.	6 K. +C.	4 K. S.	C. B.
W.	W.	W.	1	1	1	..	6 K. S.	..	B.
W.	W.	W.	2	2	3	4 K.	2 K.	2 K.	B.
S.W.	S.	S.	2	1	1	6 K.	7 S. +C.	6 S. +C.	C. B.
S.	W.	W.	2	2	2	10 S. K	..	..	B. C.
W.	W.	..	1	2	..	..	3 K.	..	B. B.
W.	..	W.	1	..	2	..	..	6 K.	B.
..	..	..	..	..	..	7 K. S.	..	8 K. S.	C. B.
S.	..	S.	1	..	1	10 K. S.	..	7 K. S.	O. G.
S.	W.	..	1	1	..	6 K.	7 K. S.	4 K. S.	O. D.
W.	W.	W.	1	1	1	..	..	..	B. B. B., aurora.
W.	S.	W.	3	2	1	8 K. S.	..	8 N.	C. B., snow.
W.	S.W.	W.	1	1	2	7 K. S.	4 K.	..	C. C. B.
N.W.	N.W.	W.	3	2	1	..	..	..	B. B., aurora.
..	N.W.	..	..	3	..	3 K.	..	..	B. B., aurora.
..	W.	..	..	1	..	..	2 C.	2 K.	B., hazy.
..	..	N.	..	..	1	2 K. S.	8 K. +C.	6 K.	C. B.
..	W.	..	..	2	..	3 K.	Mist.	..	C. B., haze.
W.	S.	S.	1	1	2	..	8 N.	10 N.	Snow and rain.
N.	N.	N.	3	3	3	7 N.	7 N.	4 N.	Drift and snow.
N.	N.	N.	3	3	3	4 K. S.	6 K.	..	B. Dull.
W.	W.	S.W.	1	2	1	..	5 K. +C.	2 K.	B. C.
W.	W.	W.	2	3	4	3 C.	4 S. +C.	5 S. +C.	C., drift.
N.W.	N.W.	..	4	4	..	3 K.	4 K.	..	B., brilliant aurora.
E.	E.	E.	2	3	2	10 N.	10 N.	10 N.	Snow and rain.
N.W.	N.W.	N.W.	2	5	5	4 K.	7 K. +C.	10 haze.	C. B.
N.W.	N.W.	N.W.	3	3	3	..	4 K.	..	Drift and haze.
N.W.	W.	..	3	2	..	4 K. +C.	3 K.	4 K. S.	B.
E.	E.	S.	1	2	2	5 K.	9 K. +C.	8 S. K.	O. Dull.
S.	E.	..	2	2	..	10 K.S+C	3 S.	..	C. B., aurora.
E.	E.	..	1	2	..	..	4 S. K.	6 S. K.	B. B.
..	S.E.	..	..	2	..	7 K. S.	4 K.	..	B., aurora.
W.	W.	W.	1	1	1	..	..	..	B. B. B.
..	W.	W.	..	2	1	1 K.	1 K.	..	B. B.
W.	..	S.	1	..	2	1 K.	4 K. +C.	..	B. B.
..	..	..	..	..	..	1 K.	..	..	B. B.
..	W.	E.	..	1	1	..	1 K.	..	B. B.
..	..	..	..	..	..	..	3 C. +K.	3 C.	Aurora, B. B.
..	S.	..	..	2	..	4 K.	4 K. +C.	8 K. +C.	B. C., haze at night.
..	S.	..	..	2	..	4 S	..	2 S.	B. B.
N.E.	E.	..	2	2	..	7 K. S.	4 K. S.	2 K	C. B.
E.	S.E.	..	2	2	..	10 K	10 K	6 K. S.	O. Dull.
N.W.	N.W.	..	2	1	..	5 K. S.	6 K. S.	4 K. S.	C. B.
..	E.	E.	..	2	1	9 K. S.	9 K. S.	10 K. S.	O. Dull.
..	..	N.W.	..	..	3	10 N	10 N	4 K. S.	Snow and rain, at night clouds.
N.W.	..	..	2	..	..	6 K	..	3 K	B. C.
..	S.E.	..	..	1	..	1 K	10 N	10 N	Rain.
..	S.E.	..	..	2	..	8 N	8 K. S.	10 K. S.	C. B.
N.W.	S.W.	S.W.	3	2	1	3 K+C.	4 C	6 C	C. B.
E.	E.	S.	2	1	1	8 K.	8 K+C.	10 N	C. B., rain.
N.W.	W.	S.W.	3	2	2	6 K+C.	1 K	10 K	C. B. O.
N.W.	N.W.	N.W.	2	2	2	..	7 K. S.	10 N	Snow, bald eagle seen.
N.W.	N.W.	W.	2	2	1	6 K. S.	3 K	2 K.	B. C.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1894.	7	2	9		7	2	9
		°	°	°				
Hamilton River, below Grand Falls..	April 30....	3	49	42	......	29·95	29·60	29·55
On tableland	May 1....	36	66	54	......	29·46	28·71	28·68
Grand Falls	" 2.. .	37	41	32	......	28·58	28·42	28·55
"	" 3....	21	33	29	...	28·76	28·82	28·82
"	" 4....	24	34	33	.....	28·76	28·53	28·46
"	" 5....	32	34	28	....	28·52	28·45	28·72
"	" 6....	18	42	38	.....	28·72	28·70	28·55
Big Hill, Portage route..............	" 7....	31	37	32	......	28·46	28·22	28·01
"	" 8....	30	34	31	.....	27·87	27·95	28·03
"	" 9....	30	36	29	.....	28·18	28·18	28·31
"	" 10....	30	38	25	.....	28·48	28·50	28·95
"	" 11....	22	48	41	......	28·87	28·52	28·52
"	" 12....	32	62	50	......	28·58	28·46	28·40
"	" 13 ...	48	32	30	......	28·25	28·36	28·46
"	" 14....	28	30	29	......	28·46	28·48	28·46
"	" 15....	30	37	32	.....	28·48	28·46	28·40
"	" 16....	35	37	35	....	28·32	28·32	28·30
"	" 17....	36	52	46	.....	28·26	28·33	28·42
"	" 18....	30	58	44	.....	28·44	28·60	28·66
Grand Falls, Spring Camp..........	" 19....	39	49	46	...	28·74	28·83	28·92
"	" 20....	42	54	48	......	28·96	29·00	28·95
"	" 21....	46	44	36	......	28·93	28·92	28·86
"	" 22....	35	44	35	......	28·88	28·82	28·63
"	" 23....	38	60	39	......	28·59	28·51	28·48
"	" 24....	35	58	40	......	28·50	28·48	28·52
"	" 25....	30	60	48	....	28·48	28·52	28·50
"	" 26....	30	65	45	.....	28·52	28·50	28·54
"	" 27....	44	54	43	......	28·50	28·54	28·54
"	" 28....	44	60	45	......	28·52	28·48	28·46
"	" 29....	38	54	44	.....	28·50	28·45	28·56
"	" 30.. .	38	57	48	.....	28·60	28·47	28·46
....	" 31....	40	58	48	......	28·48	28·48	28·49
Hamilton River, above Grand Falls..	June 1....	37	59	48	.....	28·50	28·40	28·36
" " ..	" 2....	48	56	52	......	28·30	28·13	28·13
" " ..	" 3....	49	65	48	.....	28·08	28·04	27·94
" " ..	" 4....	45	65	47	......	27·88	27·83	27·83
" " ..	" 5....	46	40	35	....	27·76	27·92	28·05
" " ..	" 6....	37	45	37	......	28·10	28·14	28·24
....	" 7....	......	45	40	......	28·24	28·23	28·21
....	" 8....	31	54	46	......	28·24	28·10	28·04
....	" 9....	50	52	38	....	28·05	28·12	28·22
....	" 10....	37	42	36	......	28·30	28·29	28·35
....	" 11....	35	42	34	......	28·35	28·50	28·52
....	" 12....	37	46	37	......	28·60	28·56	28·56
....	" 13....	37	......	......	.....	28·63	28·62	28 51
Sandy Lake...........................	" 14....	58	.....	50	....	28·42	28·50	28·32
"	" 15....	44	59	50	.....	28·30	28·24	28·02
....	" 16....	44	58	48	....	28·02	28·06	28·06
....	" 17....	52	60	44	.....	28·02	28·26	28·35
....	" 18....	42	......	......	......	28·46	28·34	28·26

Labrador Peninsula, 1893-1894.—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
...	S.E.	E.	..	2	1	1 K	8 K. S.	6 K. S.	C. B., O. dull.
S.E.	...	...	1	..	..	10 K+C	4 K	1 K	O. dull, B., thunder, black ducks seen.
...	...	...	..	..	..	7 K. S.	10 N	10 N	Rain and snow, a butterfly and several moths seen.
N.W.	W.	...	2	2	..	10 K. S.	4 K. S.	1 K	C. B. B., rose-breasted grosbeck seen.
S.	S.	S.W.	2	1	1	10 K. S.	10 N	10 S.	Snow and rain, Canada goose seen.
...	...	...	..	..	..	9 S.K	6 K. S.	1 S	Showers, C. B.
...	...	...	..	..	..	...	1 S.	3 S+C	C. B., haze.
S.	S.E.	S.E.	2	2	2	10 N	10 N	10 N	Rain and snow.
S.E.	...	S.E.	1	..	2	10 N	10 S+N	10 N	Snow and rain.
S.E.	E.	N.	2	2	2	10 N	10 N	10 N	Snow.
W.	W.	...	2	1	..	8 K. S.	2 K	2 K	C. B. B.
S.E.	S.E.	S.	2	2	1	10 K. S.	10 S.	10 S+C	C. B., showers.
S.W.	S.E.	...	2	1	..	7 S. K.	4 K	10 S.	O. dull, showers; robins seen.
...	N.W.	W.	..	2	2	10 N	10 N	10 S.	Snow.
N.W.	N.W.	N.W.	2	2	3	10 N	10 N	10 N	Snow, a black bear and gray geese seen.
N.W.	N.E.	N.	3	2	2	10 S.	10 S.	10 N	O. dull, snow.
N.	N.	N.	2	2	1	10 N	7 S.N	10 S.	C. B., snow and rain; rusty grackle seen.
...	N.W.	...	..	1	..	10 N	10 N	7 K	Snow and rain.
...	E.	...	..	1	..	3 S.	5 K. S.	7 K+C	C. B., gulls seen.
S.E.	S.E.	E.	1	2	2	10 K+C	7 K. S.	8 S	C. O. dull.
E.	S.E.	S.	2	2	2	10 S.	7 S.	10 S.	C. B.
S.	W.	W.	1	1	1	10 N	8 S.	10 S.	Rain, C. B.
...	W.	W.	..	1	1	7 S.	6 S.	2 K	C. B.
...	W.	N.W.	..	2	1	...	...	...	B. B. B.
N.W.	W.	W.	1	1	1	1 K	...	1 K	B. B., mosquitoes in numbers.
...	S.	...	..	1	..	2 K	1 K	2 K	B. B., swallows seen.
..	S.E.	S.E.	..	1	1	...	3 K	3 S.	B. B.
S.W.	W.	W.	1	1	1	2 S.	3 K	2 K	B. B.
...	...	S.W.	..	..	..	10 K. S.	2 K	1 K	C. B.
N.E.	N.E.	...	1	1	..	6 K. S.	5 K. S.	4 K. S.	C. B., ice formed last night.
...	S.	S.	..	1	1	3 K. S.	10 K. S.	7 K. S.	C. B., ice formed last night.
S.E.	S.E.	...	1	2	..	8 K. S.	6 S.	7 K. S.	C. B.
...	...	S.W.	..	.	1	2 K. S.	5 K. S.	7 K+C	B. C.
S.W.	S.W.	S.W.	2	1	1	10 N	6 S.	7 S.	Rain, C. B.
...	...	...	..	..	..	9 S.	6 S.	7 K. S.	C. B.
...	S.W.	...	..	2	..	1 K	7 S.	7 S+C	C. B., ice formed last night; thunder shower.
N.	N.	N.	1	2	2	10 S	10 N	10 N	C. C., rain and snow.
N.	N.	...	2	2	..	10 N	10 N	9 S.	C. B., severe snow storm.
S.W.	S.W.	S.W.	1	2	1	10 N	7 S.	8 K. S.	Rain, C. B., robin's nest found having fœtus well developed and partly feathered.
S.	S.	S.W.	1	2	1	7 K. S.	3 S.	...	B., ice formed.
S.	S.	N.	2	2	2	10 S.	6 K	4 S.	C. B., Viola canina in bloom.
N.	N.W.	N.W.	3	2	2	7 S.	5 K. S.	7 K. S.	B. C., snow; partridge nest eggs partly hatched.
N.	N.	...	3	3	..	10 K. S	7 K. S.	8 K+C	C., snow and hail; young woodpecker hatched.
...	N.W.	...	..	2	..	10 K+C	10 S.	2 S.	C. B., Osprey's eggs found.
...	N.W.	N.W.	..	3	1	10 S	7 S.	4 S.	C. B.
W.	S.W.	S.W.	2	3	1	6 S+C	3 S.	8 C+K	C. B., unbroken ice still in lakes in some places.
...	N.E.	...	..	2	..	4 K. S.	6 C+K	8 C+S	C. B., slight frost last night.
S.	E.	E.	2	2	1	7 S+C	10 haze	10 S+C	O. dull, showers.
S.W.	S.W.	S.W.	1	2	1	10 S.	6 K. S.	6 K	C. B., showers.
S.	S.	...	2	2	..	2 S.	2 K. S.	7 C+S	C. B., thermometer broken.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1894.	7	2	9		7	2	9
	June 19					28·27	28·30	28·31
	" 20					28·34	28·32	28·31
	" 21					28·34	28·32	28·26
Dyke Lake	" 22					27·94	28·05	28·24
	" 23					28·45	28·44	28·45
Petitsikapau Lake	" 24					28·55	28·52	28·25
"	" 25					27·90	27·82	27·89
"	" 26					27·82	28·08	27·95
"	" 27					27·92	28·05	28·10
"	" 28					28·45	28·52	28·54
"	" 29					28·62	28·64	28·42
"	" 30					28·35	28·32	28·35
"	July 1					28·46	28·45	28·42
"	" 2					28·35	28·26	28·16
	" 3					28·12	28·15	28·05
Ashuanipi Branch	" 4					27·82	27·76	27·78
"	" 5					27·78	27·72	27·78
"	" 6					27·72	27·92	27·92
"	" 7					28·16	28·16	28·16
	" 8					28·26	28·29	28·32
	" 9					28·40	28·42	28·39
Highest point reached on Hamilton River on Ashuanipi Branch	" 10					28·45	28·42	28·37
	" 11					28·34	28·24	28·12
	" 12					28·02	27·92	27·76
	" 13					27·76	27·77	27·82
	" 14					27·82	27·95	28·04
	" 15					28·08	28·14	28·24
	" 16					28·26	28·27	28·26
Sandy Lake	" 17					28·32	28·34	28·32
	" 18					28·34	28·32	28·30
	" 19					28·30	28·32	28·22
	" 20					28·02	28·02	28·03
Michikaman Lake	" 21					28·32	28·40	28·32
"	" 22					28·22	28·12	28·23
"	" 23					28·40	28·42	28·44
"	" 24					28·36	28·32	28·32
"	" 25					28·15	28·12	28·14
"	" 26					28·24	28·32	28·41
	" 27					28·52	28·46	28·42
	" 28					28·26	28·12	28·12
	" 29					28·15	28·12	28·19
Sandy Lake	" 30					28·22	28·24	28·03
"	" 31					28·04	28·04	28·06
"	Aug. 1					28·05	28·20	28·32
"	" 2					28·30	28·36	28·38
Osokmanowan Lake	" 3					28·44	28·42	28·32
"	" 4					28·18	28·02	27·96
"	" 5					27·92	28·02	28·14
"	" 6					28·12	28·04	28·12
Attiomiskonak Lake	" 7					28·14	28·14	28·00
"	" 8					28·02	28·04	28·06
"	" 9					28·21	28·25	28·25
Romaine River	" 10					28·26	28·26	28·32

Labrador Peninsula, 1893-1894.—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
S.W.	S.W.	S.W.	2	2	2	6 K. S...	4 K. S...	10 K+C..	B. C.
N.W.	......	N.W.	2	..	2	4 C+K..	7 K. S...	3 K	C. B.
......	......	......	..	..	..	3 K. S...	4 S......	10 N	C. B., rain.
....	W.	N.W.	..	2	2	10 S......	10 N	10 N	Rain, thunder and lightning.
N.W.	N.	......	3	2	..	10 S......	3 K. S...	2 K. S...	O. dull, C. B.
N.W.	N.W.	N.	1	1	1	1 K	3 S+C ..	6 S+C ..	B. B., ice formed last night.
N.W.	E.	N.W.	1	1	2	10 N	10 Ks.....	6 K. S...	Rain, C. B.
N.W.	S.	......	2	2	..	10 K. S...	8 K.S+C	10 N	Rain.
N.W.	N.W.	N.W.	2	2	3	10 N	10 K. S...	7 K. S...	Rain, O. dull.
N.W.	...	......	2	..	..	10 K. S...	7 K. S...	8 K. S...	C. B., ice formed, a flurry of snow at 7 a.m.
.....	......	N.E.	..	..	1	1 K. S...	1 K	2 K	B., ice formed last night.
E.	S.	S.	3	2	2	10 S......	9 S.	4 K. S...	O. dull.
E.	....	......	1	..	..	10 S......	10 K. S...	4 K. S...	C. B.
S.E.	S.	......	2	2	..	10 S......	10 S......	10 N	O. dull, rain.
S.	S.	......	1	2	..	7 K. S...	7 K. S...	10 S......	C. B.
S.W.	S.W.	......	1	2	..	10 S	10 K. S...	7 S+C ..	C. B., passing showers.
S.W.	W.	S.W.	2	2	2	10 S......	10 S......	7 K. S...	C. B., passing showers.
S.W.	S.W.	......	2	2	..	10 K. S ..	10 S......	8 K.S+C	C. B., passing showers.
S.E.	......	E.	2	..	1	6 K. S...	4 S.. ...	8 K. S...	B.
E.	E.	E.	1	1	1	10 N	8 K.S ...	10 S......	C. B.
....	E.	......	..	1	..	10 S......	10 S+K ..	7 S......	C. B., showers.
.....	.....	......	..	..	..	10 S+K. .	8 S......	10 S......	C. B., thunder shower.
S.	S.	S.	1	2	2	10 K. S...	10 K. S...	7 S.....	C. B., showers.
N.	N.	....	1	2	..	10 K. S...	6 S	8 K. S...	C. B., showers.
N.W.	N.W.	N.W.	2	2	2	8 K. S...	7 S... .	7 S.....	C. B., showers.
N.W.	N.W.	.... .	2	2	..	8 K. S...	6 S......	10 N	C. B., rain.
N.W.	N.W.	.....	2	2	..	10 N	10 S......	7 S	C. B., rain.
N.W.	N.W.	......	2	2	..	6 S......	6 S......	2 S......	C. B., hail and showers.
......	N.W.	N.W.	..	2	1	1 S.	6 S......	....	C. B.
......	......	......	..	..	..	3 K	2 S. K...	5 S	B. C., thunder showers.
......	W.	W.	..	2	2	10 S	6 S......	8 K. S...	Fog, C. B.
W.	W.	W.	2	3	2	10 N	6 K. S...	8 N	C. B., showers at intervals during night.
N.W.	N.W.	... .	2	2	..	10 S......	3 Ks.....	7 K. S...	C. B.
S.	S.	W.	2	2	2	3 K. S...	10 K. S...	10 N	C. B., rain.
N.W.	N.W.	.. ....	3	3	..	6 K. S...	3 K. S...	6 N	C. B., rain.
S.W.	S.W.	S.W.	2	3	3	7 K. S...	4 K. S...	6 K. S...	C. B., ptarmigan in full summer plumage
S.	S.	S.W.	2	2	2	10 N	10 N	10 N	Steady rain.
N.W.	N.W.	N.W.	2	3	2	7 K. S...	10 N	3 K	Showers.
N.W.	N.W.	......	1	2	..	2 K. S...	4 K. S...	3 K. S...	B., heavy frost last night.
E.	E.	......	1	1	..	6 K. S...	10 N.	8 K. S. +C	C. B., rain, showers.
E.	E.	......	3	2	..	7 S......	10 N.	8 N.	C. B., rain.
E.	E.	N.E.	1	2	3	10 N.	10 S......	10 N.	R. R., heavy showers.
S.W.	S.W.	S.W.	2	2	2	10 S......	10 S......	9 S ...	C. C., showers.
S.W.	S.W.	N.W.	2	2	1	10 N.	10 K. S...	6 K. S...	C. R. R., heavy rain.
N.W.	N.W.	......	2	2	..	10 N.	9 K. S...	9 S......	Rain, C.
......	S.	N.W.	..	2	1	....	5 S. K...	10 K. S...	C. C.
......	S.W.	S.W.	..	1	2	10 K. S...	10 N.	9 S.. ..	Rain.
N.W.	N.W.	N.W.	2	2	2	10 S.....	9 K. S...	7 S......	C. C., showers.
W.	S.	......	1	2	..	10 S......	10 K.	10 S.....	Mist, much rain, thunder and lightning.
......	S.W.	S.W.	..	2	2	1 K.	10 S......	10 S.....	C., gales, rain, thunder and lightning.
N.W.	S.W..	S.W.	2	2	2	5 K.	10 S.... .	10 S ...	C., rain.
W.	N.W.	......	2	2	..	10 K. S...	8 S......	10 S......	C. C.
......	N.	N.W.	..	2	2	10 K. S...	10 K. S...	7 K. S...	C. B., ice formed.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1894.	7	2	9		7	2	9
Romaine River	Aug. 11					28·36	28·34	28·37
"	" 12					28·42	28·48	28·44
"	" 13					28·42	28·47	28·52
"	" 14					28·52	28·55	28·54
"	" 15					28·52	28·46	28·42
"	" 16					28·36	28·18	28·19
"	" 17					28·26	28·25	28·42
"	" 18					28·40	27·98	27·78
"	" 19					27·78	28·08	28·12
St. John River	" 20					28·15	28·20	28·94
St. John Village	" 21					28·94	29·35	29·55
"	" 22					29·55	29·62	29·84
Mingan	" 23					29·84	29·80	29·70
"	" 24					29·75	29·86	29·83

Labrador Peninsula, 1893-1894—*Continued.*

Wind.						Clouds.			Notes on weather during last 24 hours.
Direction.			Force.						
7	2	9	7	2	9	7	2	9	
......	N.	N.	..	2	1	4 S......	2 S	3 S......	B.
....	N.W.	......	..	1	..	1 S......	2 K.	2 K.	B. B.
S.	S.	S.	2	2	2	3 S	2 S ...	7 S......	C. B.
S.	S.	... .	3	3	..	6 K. S...	7 K. S...	10 N.	C. B., showers.
S.	S.	S.	1	1	1	10 N.	10 N.	10 N.	Rain.
S.	S.	N.E.	1	1	1	10 N.	10 N.	10 N. . ..	Steady rain.
.....	......	......	..	..	..	10 S.....	9 S......	2 K	C. C. to C. B.
......	W.	N.W.	..	2	1	10 K.	3 K. S...	2 K.	C. B.
W.	W.	.. ..	2	1	..	10 N.	7 S......	3 S......	C., rain.
N.	N.	....	2	1	..	4 C.+S .	10 N.	10 S......	C., rain, C.
......	N.	N.	..	2	1	10 S......	5 S	7 S.. ..	C. to C. B.
......	...	..	..	..	..	7 S......	5 S......	8 S.....	C. B.
S.	S.E.	W.	1	1	1	5 K. S...	8 K. S...	10 N.	C. B., rain.
W.	W.	W.	1	2	2	10 K.	7 K.	2 K.	C. B., showers.

APPEN

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1895.	7	2	9		7	2	9
		°	°	°				
River St. Lawrence at mouth of Manicuagan River	July 1	....	65	53	43	30·00	29·95	29·95
" " "	" 2	53	69	64	42	30·09	30·22	29·94
Manicuagan River	" 3	52	80	69	50	29·95	29·96	29·87
"	" 4	60	80	70	59	29·96	29·92	29·78
"	" 5	54	95	72	......	29·79	29·74	29·64
"	" 6	60	75	75	......	29·65	29·62	29·52
"	" 7	65	85	65	64	29·47	29·42	29·31
"	" 8	62	88	67	55	29·42	29·32	29·32
"	" 9	60	85	68	......	29·32	29·32	29·29
"	" 10	52	65	50	46	29·49	29·49	29·49
Manicuagan Lake	" 11	38	80	60	32	29·56	29·92	29·85
Lake Mouchalagan	" 12	50	68	62	49	29·90	29·84	29·65
"	" 13	59	60	60	56	29·64	29·75	29·76
"	" 14	53	71	59	......	29·86	29·86	29·85
"	" 15	53	80	60	43	29 89	29·75	29·70
Upper Manicuagan River	" 16	65	80	58	60	29·71	29·71	29·66
"	" 17	59	74	56	55	29·65	29·51	29·46
"	" 18	55	65	51	......	29·29	29·35	29·44
"	" 19	50	60	48	45	29·61	29·60	29·62
Cache at foot of portage route	" 20	48	60	55	35	29·60	29·55	29·55
"	" 21	60	65	60	......	29·60	29·60	29·55
Portage route	" 22	52	65	50	46	29·54	28·80	28·75
"	" 23	55	65	62	50	28·76	28·50	28·45
"	" 24	60	68	52	50	28·46	28·48	28 48
"	" 25	50	65	50	40	28·39	28·06	27·94
"	" 26	55	67	40	48	27·95	27·92	27·84
"	" 27	40	65	40	33	27·72	27·86	27·86
"	" 28	50	60	48	40	27·84	27·80	27·80
"	" 29	48	58	52	45	27·69	27·70	27·86
"	" 30	48	60	45	32	27·90	27·92	27·94
"	" 31	48	65	52	45	27·92	27·94	27·96
"	Aug. 1	48	65	48	42	27·94	27·97	28·06
"	" 2	48	60	50	45	28·10	28·10	28·16
"	" 3	45	62	51	35	28·24	28·26	28·30
Attikopi Lake	" 4	55	65	60	45	28·30	28·30	28·35
"	" 5	50	65	56	50	28·32	28·32	28·36
Little Attikopi Lake	" 6	45	77	57	40	28·40	28·38	28·46
"	" 7	53	60	57	50	28·46	28·42	28·20
Height of Land, Nichicun River	" 8	57	60	55	56	28·05	28·00	27·98
Naokokan Lake	" 9	55	57	50	52	28·14	28·30	28·42
"	" 10	45	72	42	42	28·46	28·36	28·46
Little Attikopi Lake	" 11	45	65	62	42	28·42	28·42	28·35
"	" 12	52	60	52	52	28·35	28·32	28·11
River above	" 13	52	60	55	52	28·04	28·04	28·11
Watershed Lake	" 14	53	60	52	49	28·14	28·14	28·24
"	" 15	52	60	50	48	28·26	28·28	28·24
Manicuagan River below Watershed Lake	" 16	48	54	40	42	28·30	28·32	28·35
" " "	" 17	40	65	50	32	28·30	28·26	28·26
" " "	" 18	54	60	51	52	28·05	28·10	28·10
" " "	" 19	49	55	38	42	28·08	28·24	28·30

DIX VII.

Labrador Peninsula, 1895.

Wind. Direction. 7	2	9	Force. 7	2	9	Clouds. 7	2	9	Weather. 7	2	9	Remarks.
......	N.E.	......	..	2	..	....	6 N ..	......	...	R.....	B	Passing showers.
......	N.	......	..	3	..	2 K	3 S...	2 S...	B	B	B	
.....	W.	W.	..	2	2	3 K	10 H ..	3 K ..	B	B	B	
W.	W.	W.	1	2	1	H	H ..	4 K ..	B	B	B	
W.	W.	S.	1	1	2	....	3 K ..	7 K ..	B	B	C.B ..	
S.	S.	......	2	2	..	6 H	4 H ..	3 K ..	H	B	B	
S.	S.	...	2	2	..	4 K. S...	6 K ..	4 K ..	B	B	B	
......	......	......	..	..	..	10 N	4 K ..	4 K ..	R.....	B	B	
......	S.	S.	..	2	2	10 K. S...	10 N ..	7 S...	C. B..	R	C. B..	
N.W.	N.W.	N.W.	3	3	2	7 S.....	6 S...	8 K.S.	C. B..	C. B..	C. B..	
W.	W.	W.	1	2	1	....	8 K.S.	10 K.S.	B. B..	C. B..	C. B..	Rain in passing showers.
W.	S.	....	1	2	..	1 K	7 K.S.	8 S...	B	C. B..	C. B..	
......	S.	S.	..	2	1	10 K	10 N.S.	7 K.S.	C. B..	C. B..	C. B..	
S.	S.E.	......	1	2	..	6 K	10 K.S.	7 S...	B	C. B..	C. B..	
....	S.	S.	..	2	1	10 H	3 K ..	10 S...	C. B..	B	C. B..	
S.	S.E.	S.	1	1	1	4 S......	2 S...	4 S...	C. B..	B	C. B..	Showers.
S.	S.	S.	2	2	2	6 K. S...	8 K.S.	10 K.S.	C. R..	C. B..	C. B..	"
S.	N.	N.	1	1	1	10 N	7 S...	10 S...	C. B..	C. B..	C. B..	"
N.	N.	N.	1	2	1	7 S	7 K.S.	8 K.S.	C. B..	C. B..	B	
N.	N.	S.	1	2	2	10 K. S...	10 S...	10 S...	C. B..	C. B..	C. B..	
.....	S.W.	......	..	2	..	4 S......	4 S...	5 S...	B	B	C. B..	
......	S.	......	..	2	..	3 S	7 S...	10 N ..	B	C.B ..	R.....	Thunder; heavy rain.
......	N.W.	N.W.	..	2	2	8 S.	10 S...	7 K.S.	C. B..	C. B..	C. B..	Showers and heavy rain.
......	N.W.	N.W.	..	2	1	....	10 K.S.	7 S...	C. B..	C.B.R	R.....	
......	N.W.	N.W.	..	2	1	10 K	7 K.S.	8 K.S.	C. B..	C. B..	C. B..	
S.	S.	S.	1	1	2	10 K. S...	7 S...	7 K.S.	C. B..	C. B..	C. B..	Passing showers.
S.	S.	S.	2	2	2	8 K	8 K.S.	10 K.S.	C. B..	C. B..	C. B..	Rain.
....	S.W.	....	..	2	..	10 N	10 S...	8 K ..	R. R..	C. B..	C. B..	Heavy rain.
N.	N.	N.	2	2	1	10 N	10 N ..	10 N ..	R.....	R.....	R. C..	Rain.
......	E.	E.	..	1	2	10 H	10 K.S.	10 N ..	C. B..	C. B..	C. B..	"
E.	E.	W.	2	2	2	10 N	10 N...	6 K.S.	C. B..	R.....	R.....	"
W.	W.	W.	2	1	2	9 H	8 K.S.	7 K.S.	D. H.	C. B.	C. B..	Heavy showers.
E.	E.	......	2	2	..	10 K. S...	10 K.S.	5 S...	D. H.	C. B..	R	Showers passing.
......	N.W.	N.W.	..	2	1	7 S......	8 N ..	4 S...	B. C..	S.....	C. B..	"
S.E.	S.E.	S.E.	1	2	2	8 S......	7 N ..	4 K ..	C. B..	R.....	C. B..	"
...	S.E.	S.E.	..	2	2	10 H	10 K.S.	7 S...	C. B..	R.....	C. B..	"
......	W.	N.E.	..	2	2	10 H	6 S.K.	7 K.S.	C. B..	B	C. B..	
N.E.	N.	N.	1	1	2	8 K. S...	10 N .	10 N .	C. B..	C. B..	R.....	"
N.	S.W.	S.W.	2	2	2	10 N	10 N ..	10 S...	R.....	R.....	C. B..	"
S.W.	S.W.	W.	1	2	2	10 K. S...	10 K.S.	10 K.S.	C	C	C. B..	"
......	S.W.	......	..	2	..	10 K. S...	7 K ..	10 K.S.	C	C	C. B..	"
S.W.	....	S.W.	2	..	2	7 K. S...	4 K.S.	8 K.S.	C	C	C	"
S.	S.	S.	2	2	2	10 N	10 K.S.	10 K.S.	R.....	C. B..	R.....	"
......	....	......	..	..	..	10 N	7 N ..	8 N ..	R.....	R.....	R.....	Heavy showers.
......	S.	N.W.	..	2	1	10 N	10 N ..	6 K.S.	R.....	R.....	C	Heavy showers passing.
S.	S.	....	2	2	..	7 S.	7 K.S.	......	C	C	C. B..	Showers.
......	S.	......	..	2	..	10 K	10 K.S.	4 K ..	C	C	C	"
......	N.W.	N.W.	..	2	2	6 K	6 S...	7 S...	F	R. R.	C. B..	[and lightning
....	S.W.	S.W.	..	1	2	10 N	7 K.S.	7 K.S.	R. R.	C	C	Heavy rain; thunder
S.W.	S.W.	W.	2	2	3	10 K. S...	7 K.S.	4 S...	C	C	C. B..	Showers.

METEOROLOGICAL OBSERVATIONS in the

Place.	Date.	Thermometer.			Minimum.	Barometer.		
	1895.	7	2	9		7	2	9
		°	°	°				
Manicuagan River below Watershed Lake	Aug. 20	40	50	41	32	28·29	28·24	28·25
" " "	" 21	40	54	43	37	28·34	28·42	28·64
" " "	" 22	36	51	45	32	28·70	28·83	28·96
" " "	" 23	50	54	50	......	28·70	28·65	28·75
" " "	" 24	50	65	55	......	28·86	28·94	29·00
Cache at foot of Portage route	" 25	45	65	45	......	28·96	29·24	29·24
......	" 26	40	65	40	35	29·35	29·24	29·62
Mouchalagan Lake	" 27	34	60	48	31	29·68	29·62	29·35
"	" 28	45	55	45	....	29·15	29·35	29·46
......	" 29	38	62	40	34	29·59	29·72	29·76
......	" 30	40	65	58	35	29·82	30·28	30·42
Aux Outardes River	" 31	50	60	50	48	30·28	29·95	29·85
River St. Lawrence at mouth of Aux Outardes River	Sept. 1	51	60	52	....	29·95	30·43	30·43
" " "	" 2	48	......	...	......	30·50	......	......

Labrador Peninsula, 1895—*Continued.*

Wind.						Clouds.			Weather.			Remarks.
Direction.			Force.									
7	2	9	7	2	9	7	2	9	7	2	9	
W.	W.	W.	2	3	3	3 S . . .	10 N . .	7 S. . .	C	R.	R.	Showers.
W.	W.	. . . . . .	2	2	. .	8 K. S. . .	10 K.S.	7 S. . .	C. B. .	C. B. .	C. B. .	Passing showers.
N.W.	N.W.	N.W.	2	2	2	6 K. S. . .	7 K . .	6 K . .	C. B. .	C. B. .	C. B. .	"
W.	W.	. . . . .	2	2	. .	10 N	10 N . .	10 K.S.	R.	R.	C. B. .	"
W.	W.	. . . . . .	2	2	. .	8 K. S. . .	6 K.S.	7 K.S.	C. B. .	C	C	"
W.	W.	W.	2	2	2	8 K. S. . .	10 N . .	7 N . .	C. B. .	R. R. .	R. L. .	"
. . . . . .	W.	. . . . .	. .	2	. .	6 K. S. . .	10 N . .	6 K . .	C. B. .	R.	C. B. .	"
. . . . . .	S.	S.	. .	2	3	10 K	7 K . .	10 N . .	F	C. B. .	R. R. .	"
S.W.	S.W.	S.W.	2	3	2	10 N	7 K.S.	4 C. . .	R.	C. B. .	C. B. .	"
S.W.	. . . . . .	. . . .	2	. .	. .	7 C.	10 K . .	1 K . .	C. B. .	C	B	
. . . . . .	S.	S.	. .	3	2	7 K	6 S. . .	4 K.S.	C. B. .	R.	C. B. .	"
S.	S.W.	S.W.	3	3	1	10 K. S. . .	6 C. . .	10 N . .	C. B. .	C. B. .	R. R. .	"
S.W.	S.W.	S.W.	2	3	2	7 K. S. . .	6 K.S.	3 K.S.	C. B. .	C. B. .	C. B. .	"
S.W.	. . . .	. . . . .	2	. .	. .	4 K.S.+C	. . . .	. . . .	C. B.	. . . . .	. . . . .	

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY

BY

G. CHRISTIAN HOFFMANN, LL.D., F.I.C., F.R.S.C.,
Chemist and Mineralogist to the Survey.

Assistants

F. G. Wait, M.A., F.C.S.
R. A. A. Johnston.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1897

To

G. M. Dawson, C.M.G., LL.D., F.R.S.,

Director of the Geological Survey of Canada.

Sir,—The report which I herewith beg to lay before you, embraces such portion of the work carried out in the Laboratory of this Survey, as has been deemed of sufficient general interest to merit publication. It contains, as may be seen, among other matter, a reference to several highly interesting and, in some instances valuable minerals, of the occurrence of which, in Canada, we were hitherto not cognizant.

I have the honour to be,

Sir,

Your obedient servant,

G. CHRISTIAN HOFFMANN.

Ottawa, 29th March, 1897.

TABLE OF CONTENTS.

REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY

MISCELLANEOUS MINERALS.

1. Scheelite.

This is the material referred to in my last report (Rep. Geol. Surv. Can., N. S., vol. vii., p. 14 R, 1894) as having been found, associated with a little arsenopyrite and pyrite, in a quartz-lead intersecting the main auriferous vein, at the Ballou or old American mine, Malaga gold mining district, Queens county, in the province of Nova Scotia.

It is compact, massive, with an uneven fracture, has a light smoke-gray colour, a vitreous lustre, and is sub-translucent. Its specific gravity, at 15·5°C., was found to be 6·002.

Analyses by Mr. R. A. A. Johnston, gave as follows:—

	1.	2.	Mean.
Tungsten trioxide	78·95	79·08	79·01
Calcium monoxide	19·75	19·85	19·80
Carbon dioxide	0·73	0·70	0·71
Insoluble matter	0·10	0·12	0·11
			99·63

Deducting the carbon dioxide as calcium carbonate, as likewise the insoluble matter, and recalculating the remaining constituents for one hundred parts, we obtain, as representing the composition of the mineral—

Tungsten trioxide	80·70
Calcium monoxide	19·30
	100·00

2. Tetradymite.

Of this species—a mineral hitherto not known to occur in Canada—the sulphurous variety has been identified by Mr. R. A. A. Johnston, as occurring, in conjunction with a little hessite, intermixed with the altaite found some six miles north of Liddel Creek, Kaslo River, in the West Kootenay district of the province of British Columbia, of which mention was made in one of my previous reports (Rep. Geol. Surv. Can., N.S., vol. vi., p. 29 R, 1892-93).

It has a foliated structure; a lead-gray, inclining to steel-gray colour, with occasionally a pale yellow tarnish; a metallic lustre; and affords a black streak. Its specific gravity, at 15·5° C., was found to be, after correction for a little intermixed quartz, 7·184.

Analyses made by Mr. Johnston, upon apparently pure material, afforded the following results:—

	1.	2.	Mean.
Tellurium	35·964	36·064	36·01
Sulphur	4·315	4·280	4·30
Selenium	trace.	trace.	trace.
Bismuth	51·766	51·940	51·85
Lead	3·576	3·420	3·50
Silver	0·939	0·880	0·91
Thallium	trace.	trace.	trace.
Insoluble residue (quartz)	3·496	3·540	3·52
			100·09

From this it will be seen that, notwithstanding that the material was selected with the utmost care, it nevertheless contained small quantities of intermixed quartz and of the associated minerals, altaite and hessite.

Deducting the quartz, and recalculating the remaining constituents for one hundred parts, we obtain:

Tellurium	37·29
Sulphur	4·45
Selenium	trace.
Bismuth	53·69
Lead	3·63
Silver	0·94
Thallium	trace.
	100·00

If from this we subtract the lead and silver together with an amount of tellurium, sufficing to form with these respectively altaite and hessite, the remaining figures afford a ratio closely corresponding to the formula, $2\ Bi_2\ Te_3 . Bi_2\ S_3$.

3. Altaite.

This very rare mineral, which had hitherto been recognized as occurring in but one locality in Canada (Rep. Geol. Surv. Can., N.S., vol. vi., p. 29 R, 1892-93), has since been met with by Messrs. H. A. and G. A. Guess, associated with hessite, fine to coarse native gold, thin plates of native copper and, apparently, native tellurium, in a segregated quartz vein carrying chalcopyrite, pyrite, pyrrhotite, and chalcocite, at the Lakeview claim, on the north side of Long Lake, a small sheet of water some thirteen miles north-north-east of the mouth of Boundary Creek, Kettle River, Yale district, in the province of British Columbia. The above named gentlemen very kindly placed a portion of their material at my disposal, with permission to examine it more fully, and the following are the results of the investigation.

The mineral is massive, of a tin-white colour, with here and there, a bronze-yellow tarnish, and has a metallic lustre. Its specific gravity, at 15·5° C., was found to be, after correction for a little intermixed quartz, 8·081.

Analyses made by Mr. R. A. A. Johnston, upon carefully selected material, gave :—

	1.	2.	Mean.
Tellurium	39·664	39·474	39·57
Lead	49·689	49·751	49·72
Silver	2·057	2·131	2·09
Iron	0·599	0·657	0·63
Gold, free	0·010	0·010	0·01
Insoluble residue (quartz)	7·841	7·837	7·84
			99·86

Subtracting the quartz and free gold, and recalculating the remaining constituents for one hundred parts, we obtain :—

Tellurium	43·01
Lead	54·04
Silver	2·27
Iron	0·68
	100·00

This would correspond to 87·46 per cent of altaite, 3·62 per cent of hessite, and an excess of 8·24 per cent of tellurium, which may be present in the native state. Thus showing the material examined to have consisted of altaite with a small proportion of intermixed hessite and, apparently, some native tellurium.

4. HESSITE.

This species, not previously recognized as occurring in Canada, has been identified by the Messrs. H. A. and G. A. Guess, as occurring with altaite, fine to coarse native gold, thin plates of native copper and apparently, native tellurium, in a segregated quartz vein carrying chalcopyrite, pyrite, pyrrhotite, and chalcocite, at the Lakeview claim, on the north side of Long Lake (referred to under 'altaite'), Yale district, in the province of British Columbia; and, associated with native gold, chalcopyrite, pyrite, and galena, in a parallel quartz vein, at the North Star claim, on the south side of this lake. These gentlemen have likewise observed this mineral as occurring, with petzite, native gold, et cetera, in a vein composed of quartz and coarsely crystalline siderite, at the Calumet claim, Kruger Mountain, on the western shore of Osoyoos Lake—also in the district of Yale. An analysis by them, of a specimen of the mineral from the Lakeview claim, gave—Tellurium 37·33, silver 60·68, gold 2·29 = 100·30.

5. Petzite.

The occurrence of this rare mineral in Canada, was for the first time pointed out by the Messrs. H. A. and G. A. Guess, who identified it as occurring with hessite, native gold, et cetera, in a vein, the exact nature and extent of which has not yet been determined, composed of quartz and coarsely crystalline siderite, at the Calumet claim, Kruger Mountain, on the western shore of Osoyoos Lake, Yale district, in the province of British Columbia; and, at a point some forty miles east by north of this, in the same district, they also recognized it as occurring, in association with free gold, galena, and pyrite, in a quartz vein at the Enterprise claim, on the south side of Long Lake—a locality referred to under 'altaite.' Their analysis of a specimen of the mineral from the Calumet claim, Kruger Mountain, showed it to contain 23·10 per cent of gold; and that of a specimen from the Enterprise claim, Long Lake, afforded them 18·79 per cent of gold.

6. Stromeyerite.

Among other specimens brought by Mr. R. G. McConnell on his return from his last season's geological investigations in the West Kootenay district of the province of British Columbia, was one which has been identified by Mr. R. A. A. Johnston as being the species stromeyerite—a mineral not previously recognized as occurring in Canada. It was found at the Silver King mine, on Toad Mountain, in the above mentioned district, where it occurs associated with bornite, chalcopyrite, pyrite, tetrahedrite, galena, sphalerite, and argentite, distributed through a gangue composed of a grayish felspathic rock with a little quartz and calcite, in a replacement vein traversing the schistose eruptive rocks of the district.

The mineral is massive, compact; has a dark steel-gray colour, a metallic lustre, breaks with a sub-conchoidal fracture, and affords a dark-gray shining streak. Mr. Johnston found it to have a specific gravity, at 15·5°C., of 6·277, and, conformably with the results of his analyses—conducted upon carefully selected material—the undermentioned composition :—

	1.	2.	Mean.
Sulphur	15·775	15·714	15·74
Silver	52·236	52·307	52·27
Copper	31·530	31·668	31·60
Iron	0·180	0·170	0·17
			99·78

7. Danaite.

A specimen, of what on analysis proves to be this mineral, was obtained by Mr. R. G. McConnell at the Evening Star mine, on the east slope of Monte Cristo Mountain, Trail Creek, in the West Kootenay district of the province of British Columbia, where it occurs accompanying pyrrhotite, ordinary mispickel, and pyrite.

The material consists of arsenopyrite distributed through a gangue composed of fine to coarse-crystalline calcite with a little intermixed quartz, which is, in parts, coated with ferric hydrate and the earthy peach-blossom red variety of erythrite. The metalliferous portion constituting, approximately, forty-five per cent, by weight, of the whole.

The mineral, which sometimes exhibits an indistinct crystalline structure, is of a silver-white colour, brittle, breaks with an uneven fracture, and affords a grayish-black streak. Its specific gravity, at 15·5°C., was found by Mr. R. A. A. Johnston to be, after correction for a little intermixed quartz, 6·166. Analyses by him, conducted upon carefully prepared material, gave as follows :—

	1.	2.	Mean.
Arsenic	46·475	46·347	46·41
Sulphur	19·174	19·256	19·21
Iron	28·831	28·989	28·91
Cobalt	3·009	2·937	2·97
Insoluble residue (quartz)	3·888	3·827	3·86
			101·36

Deducting the insoluble matter, and recalculating the remaining constituents for one hundred parts, we obtain, as representing the composition of the mineral—

Arsenic	47·60
Sulphur	19·70
Iron	29·65
Cobalt	3·05
	100·00

This mineral had not previously been met with in Canada, at other than the locality mentioned in one of my previous reports—Ann. Rep. Geol. Surv. Can., N.S., vol. v., p. 19 R, 1890-91.

MINERALOGICAL NOTES.

1.—Allanite. Very good specimens of a massive, pitch-black allanite, with strong resino-vitreous lustre, have been received, which were obtained in the township of Hagarty, Renfrew county, province of Ontario, where it apparently occurs in some quantity.

2.—Bismite. This species, not hitherto identified as occurring in Canada, has been recognized by Mr. R. A. A. Johnston as constituting a light grayish-white, earthy incrustation on some specimens of bismuthinite from the township of Lyndoch, Renfrew county, in the province of Ontario.

3.—Bismuthinite. Fine examples of this mineral, in the form of lead-gray lamellar masses, have been met with, accompanying beryl, in a coarse granite vein in the township of Lyndoch, Renfrew county, in the province of Ontario.

4.—Kaolin. White, or all but white, friable masses of kaolin, containing a somewhat large amount of intermixed coarse colourless quartz sand, has been met with on the fifth lot of the sixth range of the township of Amherst, Ottawa county, in the province of Quebec.

5.—Molybdenite. Has been found in some abundance, in the form of foliated masses, which are sometimes of large dimensions, and occasionally more or less thickly coated with molybdite or molybdic ochre, in the township of Egan, Pontiac county, in the province of Quebec; and Mr. J. McEvoy has obtained some very fine specimens of this mineral at a point three miles south-west of Grande Prairie, Yale district, province of British Columbia, where it occurs, accompanying chalcopyrite, in a gangue composed of a massive clove-brown to reddish-brown andradite with a light greenish fine-granular pyroxene.

6.—Smithsonite. A mineral not previously known to occur in Canada, has been recognized by Mr. R. A. A. Johnston, in a sample of ore from the Alamo mine, at the head of Hauser Creek, West Kootenay district, in the province of British Columbia, where it is found accompanying sphalerite, galena, siderite, tetrahedrite and pyrite, also some pyrargyrite, in a gangue composed of crushed and brecciated slate, calcite, and quartz.

LIMESTONES AND DOLOMITES.

Continued from page 35 R of the Annual Report of this Survey (vol. vi.) for 1892-93.

The analyses of the following stones, were all conducted by Mr. F. G. Wait.

1.—Limestone. From a quarry at Green Head, Narrows of the St. John River, parish of Portland, St. John county, province of New Brunswick. Geological position—Laurentian. Received from Mr. E. T. P. Shewen.

A dark bluish-gray, fine-crystalline, massive, limestone, through which was disseminated an occasional speck of iron-pyrites. It was found to have the following composition :—

(After drying at 100°C.—Hygroscopic water = 0·09 per cent.)

Carbonate of lime		95·60
" magnesia		0·44
" iron		0·13
Alumina	0·11	4·27
Silica, soluble	0·16	
Insoluble mineral matter	3·54	
Organic matter	0·46	
		100·44

This stone is chiefly, if not exclusively, used for the manufacture of lime.

2.—Limestone. From Stetson's quarry, Indiantown, St. John City, St. John county, province of New Brunswick. Geological position —Laurentian. Received from Mr. E. T. P. Shewen.

A light and dark bluish-gray, banded, somewhat coarse-crystalline, massive, limestone. Its analysis afforded the following results :—

(After drying at 100° C.—Hygroscopic water = 0·04 per cent.)

Carbonate of lime		99·05
" magnesia		0·88
" iron		0·05
Alumina	0·01	0·26
Silica, soluble	0·09	
Insoluble mineral matter	0·14	
Organic matter	0·02	
		100·24

This stone is chiefly, if not exclusively, used for the manufacture of lime.

3.—Limestone. From a quarry on Lawlor's Lake, parish of Portland, St. John county, province of New Brunswick. Geological position—Laurentian. Received from Mr. E. T. P. Shewen.

A bluish-gray, somewhat coarse-crystalline, massive, limestone. The results of its analysis are as follows :—

(After drying at 100° C.—Hygroscopic water = 0·05 per cent.)

Carbonate of lime		98·39
" magnesia		0·71
" iron		0·05
Alumina	0·02	
Silica, soluble	0·04	1·19
Insoluble mineral matter	0·82	
Organic matter	0·31	
		100·34

This stone is chiefly, if not exclusively, used for the manufacture of lime.

4.—Dolomite. From Limehouse, township of Esquesing, Halton county, province of Ontario. This stone occurs in a band nine feet thick, in beds varying from three to seven inches. Geological position—Clinton formation, Silurian. Collected by Dr. R. Bell.

A bluish-gray, yellowish-brown weathering, very fine-crystalline, compact dolomite. Its analysis afforded the following results :—

(After drying at 100° C.—Hygroscopic water = 0·27 per cent.)

Carbonate of lime			48·07
" magnesia			39·63
" iron			0·69
Sulphate of lime			0·10
Alumina		0·21	
Silica, soluble		0·37	
Insoluble matter, consisting of—			11·60
Silica	7·60		
Alumina	2·07		
Ferric oxide	0·40		
Lime	0·05	11·02	
Magnesia	0·19		
Potassa	0·53		
Soda	0·18		
			100·09

This stone has been wrought to a considerable extent, and yields a good hydraulic lime. The cement sets slowly and hardens during several weeks, after which it is said to possess great strength.

5.—Dolomite. From the Priest's quarry, on the bank of the river Speed, township of Guelph, Wellington county, province of Ontario. Geological position—Guelph formation, Silurian.

A light cream-yellow, yellowish-brown weathering, very fine-crystalline, compact dolomite. Its composition was found to be as follows:—

(After drying at 100° C.—Hygroscopic water = 0·02 per cent.)

Carbonate of lime		53·97
" magnesia		45·37
" iron		0·16
Sulphate of lime		0·68
Alumina	trace	0·03
Insoluble matter	0·03	
		100·21

6.—Dolomite. From the Wellington quarry, south half of the twenty-ninth lot, of the Gore of the township of Puslinch, Wellington county, province of Ontario. Geological position—Guelph formation, Silurian.

A light-gray, fine-crystalline, massive, dolomite. It was found to have the following composition:—

(After drying at 100° C.—Hygroscopic water = 0·05 per cent.)

Carbonate of lime		54·25
" magnesia		45·17
" iron		0·22
Sulphate of lime		0·34
Alumina	trace	0·08
Insoluble matter	0·08	
		100·06

7.—Dolomite. From a quarry at Christie's Siding, west half of the third lot, of the sixth concession, of the township of Nassagaweya, Halton county, province of Ontario. Geological position—Niagara formation, Silurian.

A light bluish-gray, fine-crystalline, massive, dolomite. Its analysis afforded the following results:—

(After drying at 100° C.—Hygroscopic water = 0·10 per cent.)

Carbonate of lime		54·12
" magnesia		45·45
" iron		0·58
Sulphate of lime		0·17
Alumina	trace	0·30
Insoluble matter	0·30	
		100·62

COALS.

Continued from p. 15 R of the Annual Report of this Survey for 1894.

87.—Coal from the Sheep Creek coal mines, South Fork of Sheep Creek, section 2, township 20, range 3, west of the fifth initial meridian, district of Alberta, North-west Territory. Seam said to average about four feet in thickness. Geological position—Cretaceous. Received from Mr. H. Grüner.

Structure, for the most part, very fine lamellar, with occasional interstratified, more or less disconnected, lenticular layers of dense, pitch-black, highly lustrous coal—compact: in parts, shows traces of slickensides; hard and firm; does not soil the fingers; is, here and there, intersected by thin plates of calcite; colour, black; lustre, on the whole, resinous; fracture, uneven—occasionally more or less conchoidal; colour of powder, blackish-brown; it communicates a very pale brownish-yellow colour to a boiling solution of caustic potash.

A proximate analysis, by fast coking, gave:—

Hygroscopic water	3·08
Volatile combustible matter	39·37
Fixed carbon	54·50
Ash	3·05
	100·00
Coke, per cent	57·55
Ratio of volatile combustible matter to fixed carbon	1 : 1·38

It yields, by fast coking, a firm, compact coke. The gases evolved during coking burnt with a yellow, luminous, smoky flame. The ash has a brownish-yellow colour,—exposed to a bright red heat it does not become agglutinated, at a most intense red heat, it becomes more or less fritted.

Experiments have been made, on a large scale, in the preparation of coke from the above coal, employing a Coppée's coke-oven, and with very encouraging results—the product being of excellent quality. The sample sent for examination, has a steel-gray colour and bright lustre; is hard and dense and, apparently, capable of supporting a considerable pressure without crumbling, and may be regarded as a most useful metallurgical fuel. It was found to contain—moisture 0·17 per cent, ash 10·70 per cent.

IRON ORES.

The analyses of these, were all conducted by Mr. F. G. Wait.

1.—Magnetite. From the sixteenth lot, of the eleventh concession, of the township of Bagot, Renfrew county, province of Ontario.

A fine-granular, massive magnetite, through which was disseminated a little calcite and actinolite. Determinations of the more important constituents gave :

Ferric oxide	61·11	per cent.
Ferrous oxide	27·20	"
Titanium dioxide	none.	
Phosphoric acid	none.	
Sulphur	0·10	"
Insoluble matter	4·85	"
Metallic iron, total amount of	63·93	"
Phosphorus	none.	
Sulphur	0·10	"

2.—Magnetite. From the, at present unsurveyed, township of Airy, district of Nipissing, province of Ontario. Examined for Mr. W. A. Allan.

A compact, massive magnetite. A partial analysis gave as follows :

Ferric oxide	64·81	per cent.
Ferrous oxide	31·57	"
Titanium dioxide	none.	
Phosphoric acid	none.	
Sulphur	0·27	"
Insoluble matter	1·66	"
Metallic iron, total amount of	69·92	"
Phosphorus	none.	
Sulphur	0·27	"

3.—Magnetite. From the Zanesville or Glendower mine, lot six, concession three, of the township of Bedford, Frontenac county, province of Ontario. This, and the following thirty specimens were collected by Mr. E. D. Ingall.

A somewhat coarsely crystalline magnetite, through which was disseminated small quantities of iron-pyrites, pyroxene, calcite and quartz. It contained :

Metallic iron	61·350	per cent.
Phosphorus	0·004	"
Sulphur	undet.	
Titanium dioxide	none.	
Insoluble matter	11·110	"

4.—Magnetite. Also from the Zanesville or Glendower mine.

The specimen consisted of magnetite in a gangue composed of white calcite and yellowish-green serpentine. Determinations gave:

Metallic iron	44·570	per cent.
Phosphorus	0·006	"
Sulphur	undet.	
Titanium dioxide	none.	
Insoluble matter	16·250	"

5.—Hematite. From the second lot, of the seventh concession, of the township of Bedford, Frontenac county, province of Ontario.

It consisted of specular iron, with which was associated small quantities of white felspar and yellowish-brown mica. Analysis gave:

Metallic iron	64·970	per cent.
Phosphorus	0·010	"
Sulphur	undet.	
Titanium dioxide	none.	
Insoluble matter	6·610	"

6.—Magnetite. From the Bygrove mine, lot three, concession one, of the township of South Sherbrooke, Lanark county, province of Ontario.

A massive magnetite, containing, in parts, a little iron-pyrites and small quantities of a calcareous gangue. It was found to contain:

Metallic iron	62·950	per cent.
Phosphorus	0·007	"
Sulphur	undet.	
Titanium dioxide	none.	
Insoluble matter	6·590	"

7.—Magnetite. From the Fournier mine, lot fourteen, concession one, of the township of South Sherbrooke, Lanark county, province of Ontario.

A coarsely cleavable, massive magnetite, associated with a small amount of gangue composed of white quartz, black pyroxene, and white mica. Determinations gave:

Metallic iron	60·890	per cent.
Phosphorus	0·002	
Sulphur	undet.	
Titanium dioxide	none.	
Insoluble matter	10·010	"

8.—Magnetite. From the sixteenth lot, of the seventh concession, of the township of South Sherbrooke, Lanark county, province of Ontario.

Consisted of magnetite, through which was disseminated a small quantity of gangue, composed of quartz and pyroxene. It contained:

Metallic iron	67·640 per cent.
Phosphorus	0·008 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	2·720 "

9.—Magnetite. From the thirteenth lot, of the eighth concession, of the township of South Sherbrooke, Lanark county, province of Ontario.

It consisted of magnetite, containing, in parts, a little white translucent quartz. Analysis gave:

Metallic iron	67·690 per cent.
Phosphorus	0·012 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	3·100 "

10.—Magnetite. From the ninth lot, of the ninth concession, of the township of South Sherbrooke, Lanark county, province of Ontario.

A massive magnetite, with which was associated a little yellowish-brown mica. It was found to contain:

Metallic iron	62·120 per cent.
Phosphorus	0·008 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	10·250 "

11.—Magnetite. From Geo. Farrell's lot, near Christie's Lake, in the township of South Sherbrooke, Lanark county, province of Ontario.

Consisted of a massive magnetite, through which was disseminated a small quantity of gangue composed of pyroxene and calcite. Determinations gave:

Metallic iron	59·810 per cent.
Phosphorus	0·010 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	9·120 "

12.—Magnetite. From the Yankee mine, lot one, concession six, of the township of North Crosby, Leeds county, province of Ontario.

The specimen consisted of magnetite, through which was disseminated very appreciable quantities of iron-pyrites, and a somewhat large amount of gangue composed of a grayish-white felspar. Analysis gave:

Metallic iron	36·710 per cent.
Phosphorus	0·012 "
Sulphur	undet.
Titanium dioxide	trace.
Insoluble matter	41·400 "

13.—Magnetite. From the north half of the twenty-first lot, of the eighth concession of the township of Bagot, Renfrew county, province of Ontario.

An association of crystalline magnetite and iron-pyrites with some intermixed quartzose gangue. It contained:

Metallic iron	49·780 per cent.
Phosphorus	0·050 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	9·320 "

14.—Magnetite. Also from the north half of the twenty-first lot, of the eighth concession of the township of Bagot, Renfrew county, province of Ontario.

A massive magnetite, in parts coated with ferric hydrate. It was found to contain:

Metallic iron	64·430 per cent.
Phosphorus	0·012 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	2·240 "

15.—Magnetite. From the east half of the sixteenth lot, of the ninth concession of the township of Bagot, Renfrew county, province of Ontario.

Magnetite, with which was associated small quantities of pyroxene and mica. Determinations gave:

Metallic iron	58·180 per cent.
Phosphorus	0·004 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	7·310 "

16.—Magnetite. From the twenty-third lot, of the tenth concession of the township of Bagot, Renfrew county, province of Ontario.

A fine-granular magnetite, with, here and there, a little iron-pyrites and small quantities of a quartzose gangue. It contained:

Metallic iron	48·780 per cent.
Phosphorus	0·090 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	5·860 "

17.—Magnetite. From the sixteenth lot, of the eleventh concession of the township of Bagot, Renfrew county, province of Ontario.

A fine-granular, massive magnetite, with which was associated small quantities of green pyroxene. Analysis gave:

Metallic iron	62·430 per cent.
Phosphorus	0·020 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	4·550 "

18.—Magnetite. From the same locality as the preceding specimen.

A fine-granular magnetite, through which was disseminated a little iron-pyrites and small quantities of greenish-gray pyroxenite and green talcose mineral. It was found to contain:

Metallic iron	51·380 per cent.
Phosphorus	0·004 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	7·960 "

19.—Magnetite. From the eighteenth lot, of the eleventh concession of the township of Bagot, Renfrew county, province of Ontario.

A slightly weathered magnetite. Determinations gave:

Metallic iron	66·600 per cent.
Phosphorus	0·008 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	2·000 "

20.—Magnetite. From the twenty-second lot, of the eleventh concession of the township of Bagot, Renfrew county, province of Ontario.

A fine-granular magnetite, with which was associated small quantities of calcite, quartz and pyroxene. It contained:

Metallic iron	51·890 per cent.
Phosphorus	0·016 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	15·960 "

21.—Hematite. From lot one, of the ninth concession of the township of Palmerston, Frontenac county, province of Ontario.

Consisted of hematite, through which was disseminated a white translucent quartz. It was found to contain :

Metallic iron	51·630 per cent.
Phosphorus	0·106 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	9·060 "

22.—Magnetite. From the third lot, of the ninth concession of the township of Palmerston, Frontenac county, province of Ontario.

The specimen consisted of magnetite associated with some white and pinkish-white calcite and dark green pyroxene. Analysis gave :

Metallic iron	56·680 per cent.
Phosphorus	0·046 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	9·530 "

23.—Magnetite. From the fourth lot, of the ninth concession of the township of Palmerston, Frontenac county, province of Ontario.

A fine-granular magnetite, distributed through a greenish-gray pyroxenite. Determinations gave :

Metallic iron	37·780 per cent.
Phosphorus	0·040 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	43·610 "

24.—Magnetite. From the eight lot, of the tenth concession of the township of Palmerston, Frontenac county, province of Ontario.

Consisted of magnetite, with some intermixed quartz. It contained :

Metallic iron	57·620 per cent.
Phosphorus	0·088 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	13·720 "

25.—Magnetite. From the twenty-seventh and twenty-eighth lots, of the eleventh concession of the township of Palmerston, Frontenac county, province of Ontario.

A fine-granular magnetite, with which was associated a little white calcite. It was found to contain:

Metallic iron	52·390 per cent.
Phosphorus	0·010 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	16·720 "

26.—Hematite. From the second lot, of the fourth concession of the township of Bathurst, Lanark county, province of Ontario.

Consisted of hematite, in association with small quantities of calcite and a few scales of graphite. Determinations gave:

Metallic iron	51·890 per cent.
Phosphorus	0·005 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	21·240 "

27.—Magnetite. From the eleventh lot, of the eighth concession of the township of Bathurst, Lanark county, Province of Ontario.

A massive magnetite, through which was disseminated small quantities of calcite, quartz, pyroxene and brown mica. Analysis gave:

Metallic iron	62·020 per cent.
Phosphorus	trace.
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	6·670 "

28.—Hematite. From the twenty-third lot of the eleventh concession of the township of Bathurst, Lanark county, province of Ontario.

It consisted of specular iron in a gangue composed of quartz and calcite. It contained:

Metallic iron	47·840 per cent.
Phosphorus	0·016 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	22·820 "

29.—Hematite. From the twentieth lot, of the tenth concession of the township of Storrington, Frontenac county, province of Ontario.

An association of specular iron and brown hematite, together with a little white calcite. It was found to contain:

Metallic iron	51·120 per cent.
Phosphorus	0·300 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	19·850 "

30.—Hematite. From the fourth lot, of the ninth concession of the township of Portland, Frontenac county, province of Ontario.

Consisted of specular iron in a quartzose gangue. Determinations gave:

Metallic iron	52·260 per cent.
Phosphorus	0·004 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	24·570 "

31.—Magnetite. From the west half of the fifth lot, of the thirteenth concession of the township of Portland, Frontenac county, province of Ontario.

The specimen consisted of magnetite, through which was distributed a small quantity of quartzose gangue. It contained:

Metallic iron	46·250 per cent.
Phosphorus	undet.
Sulphur	undet.
Titanium dioxide	4·400 "
Insoluble matter	10·350 "

32.—Magnetite. From the west half of the twenty-fifth lot of the fifth concession of the township of Darling, Lanark county, province of Ontario.

A fine-granular magnetite, through which was disseminated a little iron-pyrites, calcite, and green pyroxene. Analysis gave:

Metallic iron	62·420 per cent.
Phosphorus	0·010 "
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	9·110 "

33.—Magnetite. From the fourth lot, of the twelfth concession of the township of Lavant, Lanark county, province of Ontario.

It consisted of magnetite, with which was associated small quantities of a yellowish-green serpentine and white tremolite. It was found to contain:

Metallic iron	60·320 per cent.
Phosphorus	trace.
Sulphur	undet.
Titanium dioxide	none.
Insoluble matter	7·970 "

34.—Magnetite. From a vein of some thirty feet in width, at the mouth of Kildella River, Rivers Inlet, district of New Westminster, province of British Columbia. Examined for Mr. H. Saunders.

An iron-black, fine to somewhat coarse-crystalline magnetite, through which was disseminated small quantities of actinolite, garnet and quartz, and, here and there, small aggregations of green apatite. An analysis of a fair average of the sample received, which weighed one pound twelve ounces, gave :

Metallic iron	65·52	per cent.
Phosphorus	0·21	"
Sulphur	0·33	"
Titanium dioxide	none.	
Insoluble matter	4·06	"

35.—Magnetite. Described as coming from about a mile west of the Chicoutimi extension of the Quebec and Lake St. John Railway, near Lake Kenogami, province of Quebec. Examined for Mr. J. G. Scott.

It was only examined for titanium dioxide. Of this it contained, approximately, 15 per cent.

36.—Magnetite. From what was described as the John A. Wright lot, parish of Lepreau, Charlotte county, province of New Brunswick. Examined for Mr. C. W. Wetmore.

A massive, fine-granular magnetite, through which was disseminated a little hornblende and quartz. Determinations gave:

Metallic iron	66·71	per cent.
Nickel	trace.	
Cobalt	trace.	
Phosphorus	undet.	
Sulphur	undet.	
Titanium dioxide	none.	
Insoluble matter	4·36	"

37.—Magnetite. From the same locality as the preceding specimen, and which had been examined for Mr. Wetmore on a previous occasion with special reference to its content of phosphorus and sulphur—contained :

Metallic iron	59·90	per cent.
Phosphorus	none.	
Sulphur	0·04	"
Titanium dioxide	none.	
Insoluble matter	13·85	"

NICKEL AND COBALT.

Estimation of, in pyrrhotite from the undermentioned localities in the province of British Columbia—Continued from page 21 R of vol. vii., 1894, of the Annual Reports of this Survey

1.—From the Monte Cristo claim, Trail Creek, Columbia River—West Kootenay district.

The material consisted of an association of pyrrhotite with a little copper-pyrites and small quantities of a quartzose gangue. The pyrrhotite, carefully freed from its associations, was found by Mr. Wait to contain:

Nickel	0·13 per cent.
Cobalt	strong trace.

2.—From the Iron Colt claim, Trail Creek, Columbia River—West Kootenay district.

An intimate association of an exceedingly fine-grained pyrrhotite with a little copper-pyrites, through which was disseminated a small quantity of a quartzose gangue. An analysis by Mr. Wait showed it to contain:

Nickel	0·20 per cent.
Cobalt	strong trace.

The gangue constituted 14·50 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·234 per cent of nickel.

3.—From the Bunbury claim, near Lac le Bois—Interior plateau region.

A dark-gray to grayish-white felspathic rock, carrying small quantities of pyrrhotite.

A selected portion of the material was examined by Mr. Wait, and found to contain:

Nickel	0·065 per cent.
Cobalt	trace.

The gangue, in the material employed, constituted 17·83 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·08 per cent of nickel.

4.—From the Humphrey claim, near Lac le Bois—Interior plateau region.

A grayish-white quartzo-felspathic rock, carrying small quantities of pyrrhotite. It was examined by Mr. Wait and found to contain:

Nickel	0·04 per cent.
Cobalt	trace.

The gangue constituted 59·20 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·10 per cent of nickel.

The results of the examination of a cobaltiferous mispickel from the Evening Star mine, on the east slope of Monte Cristo Mountain, Trail Creek, in the West Kootenay district of the province of British Columbia, are given under 'danaite,' on page 13, ante.

GOLD AND SILVER ASSAYS.

These were all conducted by Mr. R. A. A. Johnston.

As explanatory of the numerous instances in which no trace of either gold or silver was found, it may be mentioned that in nearly all these cases the assay was carried out by special request. The conglomerates and conglomeritic rocks, numbered respectively 11, 13, 19, 28, 29, 37, 39, 62, 63, 69, 75, 76 and 121, were selected and subjected to assay for the purpose of ascertaining whether any of them contained gold, like the well known 'blanket' of the Transvaal.

Province of Nova Scotia.

1.—Tailings, consisting of quartz with some mispickel, from the Malaga mine, Queen's county. Collected by Mr. W. H. Prest.

They contained neither gold nor silver.

Tin was also sought for, and found to be absent.

2.—Described as coming from a vein in close proximity to a rich gold-bearing quartz vein at Cow Bay, Halifax county. Examined for Dr. W. H. Weeks.

A weathered schistose rock. The sample, consisting of a single fragment, weighed five ounces.

It contained neither gold nor silver.

Province of New Brunswick.

3.—Described as occurring on the Buchanan place, near Westfield Station, on the line of the Canadian Pacific Railway, in the parish of Westfield, King's county. Examined for Mr. C. D. Jones.

It consisted of an association of a gray quartzo-felspathic rock with a dark-gray gneiss, carrying small quantities of iron-pyrites. Weight of sample, one pound nine ounces.

It contained neither gold nor silver.

4.—From a mine on the flank of Wolf Mountain, parish of Alma, Albert county. Examined for the Hon. Pascal Poirier.

An association of white sub-translucent quartz with a little dark grayish-green chloritic schist, in parts coated with green carbonate of copper, carrying somewhat large quantities of more or less highly tarnished chalcocite. Weight of sample, four pounds ten ounces. It was found to contain:

Gold	trace.
Silver..................	2·683 ounces to the ton of 2,000 lbs.

PROVINCE OF QUEBEC.

5.—From the Grand Rapids on the Mouchoulagan River. Collected by Mr. A. P. Low.

A weathered iron-pyrites. It contained:

Gold..	trace.
Silver..	none.

6.—A sample of the so-called black sand from Moisie, Saguenay county. Examined for Mr. S. J. Dawson.

It contained neither gold nor silver.

7.—From the fourteenth lot of the tenth range of the township of Ditton, Compton county. This, and the five following specimens were collected by Mr. R. Chalmers.

An association of white sub-translucent quartz with a little gray chloritic schist, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, three pounds four ounces.

It contained neither gold nor silver.

8.—From the fourteenth lot of the ninth range of the township of Ditton, Compton county.

An association of a white sub-translucent quartz with a little dark gray chloritic schist, in parts coated with hydrated peroxide of iron. Weight of sample, one pound nine ounces.

It contained neither gold nor silver.

9.—From the same locality as the preceding specimen.

A white sub-translucent quartz, in parts coated with hydrated peroxide of iron. Weight of sample, one pound seven ounces.

It contained neither gold nor silver.

10.—From the fortieth lot of the ninth range of the township of Ditton, Compton county.

An association of a white sub-translucent quartz with a little gray chloritic schist, in parts stained and coated with hydrated peroxide of iron. Weight of sample, two pounds fifteen ounces.

It contained neither gold nor silver.

11.—From the Harrison gold mine, lot one of the sixth range of the township of Westbury, Compton county. Geological position—Pre-Cambrian.

An arkose rock, consisting of an intimate association of white quartz, grayish-white felspar and white talc, carrying a little iron-pyrites. The sample, which was, in parts, stained with hydrated peroxide of iron, weighed one pound four ounces. It was found to contain:

Gold............ 0·350 of an ounce to the ton of 2,000 lbs.
Silver........... none.

12.—From the Falls, Bras River, Beauce county.

An association of white sub-translucent quartz with small quantities of a gray felspathic rock, more or less coated with hydrated peroxide of iron, carrying some iron-pyrites. Weight of sample, three pounds ten ounces. It contained:

Gold.................................... trace.
Silver.................................. none.

13.—From the east shore of Lake Temiscamingue, lot five of the second range of the township of Guigues, Pontiac county. Geological position—Huronian. Collected by Mr. A. E. Barlow.

A somewhat coarse conglomerate, consisting of a cementation of pebbles of greenstone and red and white quartz, carrying small quantities of iron-pyrites. Weight of sample, three pounds.

It contained neither gold nor silver.

14.—From an island on the coast of Labrador, north-east of Kayaksuatilik, in latitude 55° 24′ north and longitude 59° 58′ west. Examined for the Hon. Robert Bond.

An association of somewhat coarsely crystalline white limestone with gray and white quartz and a little dark gray chloritic schist, carrying small quantities of iron-pyrites and copper-pyrites. The sample, which was in parts stained and coated with hydrated peroxide of iron and blue and green carbonate of copper, weighed fifteen pounds. Submitted to assay, it was found to contain:

Gold........... trace.
Silver.......... 0·233 of an ounce to the ton of 2,000 lbs.

NORTH-EAST TERRITORY.

15.—From the Red Fall, Waswanipi River. This, and the three following specimens were collected by Dr. R. Bell.

Quartz with a little white mica, carrying somewhat large quantities of iron-pyrites. Weight of sample, seven ounces.

It contained neither gold nor silver.

16.—From Outlet Portage on what is called by the Indians 'big river.

An association of white translucent quartz with a dark gray felspathic rock. Weight of sample, nine ounces.

It contained neither gold nor silver.

17.—From the east side of what is called by the Indians 'big' river, opposite the head of an island eighteen miles above Mataggami Lake.

A grayish-white sub-translucent quartz with, here and there, a few scales of white mica, and specks of iron-pyrites. Weight of sample, seven ounces.

It contained neither gold nor silver.

18.—From the second fall, foot of the Long Stretch, on what is called by the Indians 'big' river.

White translucent quartz, carrying small quantities of copper-pyrites. Weight of sample, three ounces. Assay gave:

Gold........... none.
Silver.......... 0·117 of an ounce to the ton of 2,000 lbs.

PROVINCE OF ONTARIO.

19.—From fifteen hundred paces on Happy-at-last Portage, West Bay, west side of Lake Nipissing. Geological position—Huronian. Collected by Dr. R. Bell.

A white and grayish-white brecciated quartz conglomerate. Weight of sample, three ounces.

It contained neither gold nor silver

20.—From mining location 10, east side of Lake Wahnapitae, district of Nipissing. Examined for Mr. M. Morin.

A grayish-white quartzite in association with a dark gray mica-schist. The sample, which was, in parts, coated with hydrated peroxide of iron, weighed two pounds eleven ounces. It contained:

Gold........... 0·058 of an ounce to the ton of 2,000 lbs.
Silver........... none.

21.—From the seventh lot, of the third concession of the township of Street, district of Nipissing. This, and the following specimen were examined for Mr. D. O'Connor.

An association of grayish-white translucent quartz with a little light gray dolomite, carrying small quantities of iron-pyrites. Weight of sample, four pounds thirteen ounces. Assays gave:

Gold .... trace.
Silver .... none.

22.—From the same locality as the preceding specimen.

A rust-coated gray translucent quartz, carrying very small quantities of iron-pyrites. Weight of sample, four pounds twelve ounces.

It contained neither gold nor silver.

23.—From the east side of Lake Wash-ki-gamog, claim No. 255, W. D. 67, township of Davis, district of Nipissing. Examined for Mr. Z. J. Fowler.

An association of white sub-translucent quartz with a very little grayish-white dolomite, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, fifteen ounces. It was found to contain:

Gold .... 0·058 of an ounce to the ton of 2,000 lbs.
Silver .... none.

24.—From the eleventh lot, of the first concession of the township of Blezard, district of Nipissing. Examined for Mr. D. O'Connor.

An association of white translucent quartz with a little yellowish-white calcite, carrying small quantities of iron-pyrites and coarsely crystalline galena. Weight of sample, three pounds eight ounces. It contained:

Gold .... none.
Silver .... 0·058 of an ounce to the ton of 2,000 lbs.

25.—From the fourth lot, of the fifth concession of the township of Snider, district of Algoma. Examined for Mr. W. Levesque.

An association of white sub-translucent quartz with some greenish-black chloritic schist, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, three pounds five ounces.

It contained neither gold nor silver.

26.—From the fourth lot, of the second concession of the township of Saulter, district of Algoma. Examined for Mr. J. B. White.

A bluish-white translucent quartz, in parts coated with hydrated peroxide of iron, carrying very small quantities of iron-pyrites. Weight of sample, three ounces and a half. It was found to contain :

Gold............ trace.
Silver........... 0·350 of an ounce to the ton of 2,000 lbs.

27.—From the Balfour mine, south half of lot six, in the first concession of the township of Balfour, district of Algoma. Examined for Mr. L. A. Morrison.

It consisted of a gneissoid rock, carrying somewhat large quantities of iron-pyrites and zinc-blende. Weight of sample, one pound fifteen ounces. Assays gave :

Gold.................. trace.
Silver....... .... 2·742 ounces to the ton of 2,000 lbs.

28.—From four miles and a half west of Cartier Station, on the main line of the Canadian Pacific Railway, township of Hess, district of Algoma. Geological position—Huronian. This, and the following specimen were collected by Dr. R. Bell.

A white and grayish-white quartz conglomerate. Weight of sample, one pound ten ounces.

It contained neither gold nor silver.

29.—From eight miles east of Cartier Station on the main line of the Canadian Pacific Railway, township of Cartier, district of Algoma. Geological position—Huronian.

An association of grayish-white sub-translucent quartz with a little green chloritic schist, carrying small quantities of pyrrhotite.

It contained neither gold nor silver.

30.—From the ninth lot of the sixth concession of the township of Denison, district of Algoma. Examined for Mr. P. J. Loughrin.

A slightly weathered gray mica-schist, carrying small quantities of iron-pyrites. Weight of sample, fourteen ounces.

It contained neither gold nor silver.

31.—From the south half of the second lot, of the fifth concession of the township of North Sherbrooke, Lanark county. Examined for Mr. Joseph Sergeant.

An association of white translucent quartz with a little black tourmaline, in parts stained and coated with hydrated peroxide of iron, carrying some iron-pyrites. Weight of sample, one pound eleven ounces. It contained :

Gold.... .... trace.
Silver............ .... none.

32.—From the fourth lot of the thirteenth concession of the township of Rawdon, Hastings county. Examined for Mr. A. W. Carscallen.

A somewhat fine crystalline galena, together with small quantities of iron-pyrites and zinc-blende, in a gangue composed of white crypto-crystalline quartz and white crystalline calcite. The gangue constituted but a small proportion, by weight, of the whole. Weight of sample, one pound seven ounces. It was found to contain:

Gold....	none.
Silver.....	51·042 ounces to the ton of 2,000 lbs.

33.—From the twenty-sixth lot of the eighth concession of the township of Clarendon, Frontenac county. Examined for Mr. Jno. Critchley.

An association of grayish-white sub-translucent quartz with small quantities of felspar, mica and crystalline calcite, carrying a little iron-pyrites. Weight of sample, one pound ten ounces.

It contained neither gold nor silver.

34.—From the same locality as the preceding specimen. Also examined for Mr. Jno. Critchley.

A white translucent quartz, more or less stained and coated with hydrated peroxide of iron. Weight of sample, one pound thirteen ounces.

It contained neither gold nor silver.

35.—From the thirtieth lot of the third concession of the township of Clarendon, Frontenac county. Examined for Mr. John Dack.

An association of white sub-translucent quartz with a little greenish-gray pyroxene, carrying small quantities of iron-pyrites. Weight of sample, one pound nine ounces.

It contained neither gold nor silver.

36.—From the same locality as the preceding specimen. Also examined for Mr. John Dack.

A white translucent quartz, carrying very small quantities of pyrrhotite and iron-pyrites. The sample, which was in parts coated with hydrated peroxide of iron, weighed one pound six ounces.

It contained neither gold nor silver.

37.—From the B mine, Babcock farm, west half of the fourth lot of the ninth concession of the township of Portland, Frontenac county. Geological position—basal beds of the Potsdam sandstone, Cambrian. Collected by Mr. E. D. Ingall.

A somewhat fine quartz conglomerate. Weight of sample, two pounds fourteen ounces.

It contained neither gold nor silver.

38.—From the twenty-fourth lot of the seventh concession of the township of Cartwright, Durham county. Examined for Mr. John Brown.

A white crypto-crystalline quartz, in parts thickly coated with hydrated peroxide of iron, carrying iron-pyrites. Weight of sample, four ounces.

It contained neither gold nor silver.

39.—From Eagle Point, Lake Huron. Geological position—Huronian. Collected by Mr. T. C. Weston.

A compact, white and reddish-gray quartzite with a few included pebbles of red jasper. Weight of sample, one pound six ounces.

It contained neither gold nor silver.

40.—From lot R. 570, near Pays Plat River, district of Thunder Bay. Examined for Mr. Maynard Rogers.

An association of white sub-translucent quartz with some white calcite, purple and green fluorite, and a little yellow serpentine, carrying small quantities of yellowish to blackish-brown zinc-blende, copper-pyrites, and a very little native silver. It was found to contain:

Gold..............	distinct trace.
Silver..............	57·837 ounces to the ton of 2,000 lbs.

41.—From a property adjoining mining claim 233 T, just outside the township of McIntyre, district of Thunder Bay. Examined for Mr. Thomas McLea.

A banded white and dark gray quartzite, carrying small quantities of iron-pyrites. Weight of sample, an ounce and three-quarters.

It contained neither gold nor silver.

42.—From location 313 and 314 X., east side of Sawbill Lake, district of Rainy River. Examined for Mr. F. S. Wiley.

A white and reddish-white sub-translucent quartz, carrying small quantities of iron-pyrites, copper-pyrites, and a very little zinc-blende. Weight of sample, twelve ounces. Assays gave:

Gold..............	5·425 ounces to the ton of 2,000 lbs.
Silver..............	2·047 " "

43.—From the Indian Joe vein, claim S. 94, the property of the Yum-yum Gold Mining Company, south side of Bag Bay, Shoal Lake, district of Rainy River. This, and the following specimen were examined for Mr. E. Seybold.

A grayish-white quartz, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, one pound one ounce.

It contained neither gold nor silver.

44.—From the so-called No. 2 vein, claim S. 94, the property of the Yum-yum Gold Mining Company, south side of Bag Bay, Shoal Lake, district of Rainy River.

An association of white sub-translucent quartz with some yellowish-gray mica schist, carrying small quantities of iron-pyrites. Weight of sample, nine ounces.

It contained neither gold nor silver.

45.—From a point on Bad Vermilion Creek, outlet of Bad Vermilion Lake, district of Rainy River. Examined for Mr. W. A. Allan.

An association of white sub-translucent quartz with some gray mica-schist and a little reddish-gray gneiss, in parts stained and coated with hydrated peroxide of iron and a little green carbonate of copper, carrying small quantities of iron-pyrites and copper-pyrites. Weight of sample, eight pounds two ounces. It was found to contain:

Gold	trace.
Silver	none.

46.—From mining location H. P. 222, Lower Manitou Lake, district of Rainy River. This, and the following specimen were received from Sir John Schultz.

A white crypto-crystalline quartz, in parts stained and coated with hydrated peroxide of iron, through which was disseminated a few small particles of iron-pyrites. Weight of sample, one pound fifteen ounces. Submitted to assay it was found to contain:

Gold	1·983 ounce to the ton of 2,000 lbs.
Silver	none.

47.—Another specimen from this location, consisting of a grayish-white crypto-crystalline quartz, more or less stained with hydrated peroxide of iron, with, here and there, a few scales of mica and an occasional crystal of iron-pyrites, was found to contain:

Gold	2·217 ounces to the ton of 2,000 lbs.
Silver	none.

48.—From mining location D. 140, south-west shore of Upper Manitou Lake, district of Rainy River. Examined for Mr. C. W. Mitchell.

An association of white translucent quartz with a little gray gneiss, stained and coated with hydrated peroxide of iron, through which was disseminated a few particles of iron-pyrites. Weight of sample, three pounds.

It contained neither gold nor silver.

49.—From mining location S. 28, just west of Mud Lake, two miles north of Upper Manitou Lake, district of Rainy River. This, and the six following specimens were examined for Mr. John McDonald.

An association of white sub-translucent quartz with a little white felspar and green chloritic mineral matter, in parts coated with hydrated peroxide of iron, carrying very small quantities of iron-pyrites. Weight of sample, one pound three ounces. Assays gave:

Gold.................	1·983 ounce to the ton of 2,000 lbs.
Silver................	0·175 " "

50.—From mining location S. 25, which adjoins that from which the preceding specimen was taken.

A white sub-translucent quartz, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, one pound. It contained:

Gold.................	1·283 ounce to the ton of 2,000 lbs.
Silver................	0·117 " "

51.—From mining location S. 31, south-west shore of Upper Manitou Lake, district of Rainy River.

An association of reddish to yellowish-white quartz with a little green actinolite. Weight of sample, one pound six ounces.

It contained neither gold nor silver.

52.—From mining location S.—A. B., Upper Manitou Lake, district of Rainy River.

A white translucent quartz, more or less stained and coated with hydrated peroxide of iron and a little green carbonate of copper. Weight of sample, one pound nine ounces.

It contained neither gold nor silver.

53.—From mining location H. P. 366, between Mud Lake and Upper Manitou Lake, district of Rainy River.

A white sub-translucent quartz, more or less thickly coated with hydrated peroxide of iron, through which was disseminated a few particles of iron-pyrites. Weight of sample, one pound two ounces. It was found to contain:

Gold...........	0·117 of an ounce to the ton of 2,000 lbs.
Silver...........	none.

54.—From mining location H. P. 376, which adjoins mining location S. 28—above, west of Mud Lake, district of Rainy River.

A grayish and reddish-white to white translucent quartz, with, here and there, a few specks of iron-pyrites. Weight of sample, six pounds. Assays showed it to contain:

Gold..	trace.
Silver..	none.

55.—From mining location H. P. 409, adjoining mining location S. 28—above, west of Mud Lake, district of Rainy River.

A white translucent quartz, more or less thickly coated with hydrated peroxide of iron. Weight of sample, one pound four ounces.

It contained neither gold nor silver.

56.—From a point twenty-five miles from Wabigoon tank on the line of the Canadian Pacific Railway, district of Rainy River. Examined for Mr. W. A. Allan.

A white translucent quartz, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, four pounds two ounces. It was found to contain:

Gold..	trace.
Silver..	none.

57.—From vein A., near Windigo Point, north side of Eagle Lake, district of Rainy River. This, and the following specimen were collected by Mr. Wm. McInnes.

An association of white sub-translucent quartz with a gray schistose rock, carrying small quantities of pyrrhotite and iron-pyrites. Weight of sample, eight pounds fifteen ounces.

It contained neither gold nor silver.

58.—From vein B, near Windigo Point, north side of Eagle Lake, district of Rainy River.

A weathered felspathic rock, carrying large quantities of iron-pyrites. Weight of sample, one pound four ounces.

It contained neither gold nor silver.

District of Keewatin.

59.—This, and the two following specimens, are from quartz veins in the Huronian belt north of the western end of Lac Seul. They were examined for Mr. J. Williams.

A white translucent quartz, in parts coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of samples, three ounces.

It contained neither gold nor silver.

60.—An association of white translucent quartz with a little white dolomite, carrying small quantities of tetrahedrite and a few particles of iron-pyrites. Weight of sample, six ounces. Assays gave:

Gold.... .... 0·175 of an ounce to the ton of 2,000 lbs.
Silver........... None.

61.—A grayish-white crypto-crystallline quartz, in parts coated with hydrated peroxide of iron, through which were disseminated a few particles of iron-pyrites. Weight of sample, nine ounces.

It contained neither gold nor silver.

North-west Territory.

62.—From Schultz Lake, latitude 64° 37′, longitude 87° 45′. Geological position—Athabasca sandstones, Cambrian. This, and the following specimen were collected by Mr. J. B. Tyrrell.

A mottled red and white quartz conglomerate. Weight of sample, five ounces.

It contained neither gold nor silver.

63.—From Point south-east of Black Bay, Lake Athabasca. Geological position—Athabasca sandstones, Cambrian.

A white quartz conglomerate, in parts coated with hydrated peroxide of iron. Weight of sample, eight ounces.

It contained neither gold nor silver.

64.—Described as having been taken from a vein on the North Saskatchewan River, in the second range of the Rocky Mountains, district of Alberta. Examined for Mr. J. W. Peterson.

A grayish-white quartz, seamed with white calcite and associated with small quantities of black carbonaceous schist. Weight of sample, two pounds ten ounces.

It contained neither gold nor silver.

65.—Described as having been taken from a point on the North Saskatchewan River, in the second range of the Rocky Mountains, district of Alberta. Examined for Mr. A. D. McPherson.

A grayish-white quartzo-felspathic rock, thinly seamed with black carbonaceous matter and carrying small quantities of iron-pyrites. Weight of sample, one pound.

It contained neither gold nor silver.

66.—From the Miette River, a tributary of the Athabasca River, district of Athabasca. Examined for Mr. Jas. McDonald.

A white sub-translucent quartz, in parts thickly coated with hydrated peroxide of iron. Weight of sample, three pounds nine ounces.

It contained neither gold nor silver.

67.—From west slope of mountain east of Castle Mountain, Rocky Mountains—township 27, range 14, west of the fifth initial meridian, district of Alberta. Examined for Mr. P. McCarthy.

An association of dark gray to yellowish and milk-white dolomite with some milk-white quartz, here and there stained with hydrated peroxide of iron and green carbonate of copper, carrying small quantities of iron-pyrites and copper-pyrites. Weight of sample, one pound twelve ounces.

It contained neither gold nor silver.

68.—From the South Fork of Red Deer River, district of Alberta. Examined for Mr. J. R. Costigan.

Consisted of brown zinc-blende disseminated through a grayish-white dolomite. Weight of sample, three pounds four ounces. It was found to contain:

Gold.................... none.
Silver.................. 6·358 ounces to the ton of 2,000 lbs.

69.—From one mile east of summit of Kicking Horse Pass, Rocky Mountains, district of Alberta. Geological position—Bow River series, Cambrian. Collected by Dr. G. M. Dawson.

A grayish-white quartz conglomerate. Weight of sample, one pound.

It contained neither gold nor silver.

Province of British Columbia.

Of the following—

Specimens Nos. 70— 78 are from the East Kootenay district.
" 79—111 " West Kootenay district.
" 112—130 " Interior plateau region.
" 132—145 " Coast ranges and coast region; whilst specimen No. 131, is from the Cariboo district.

70.—From near watershed, vicinity of Vermilion Pass, in the Rocky Mountains—East Kootenay district. Examined for Mr. A. McDougall.

A very much honeycombed quartz, thickly coated with hydrated peroxide of iron. Weight of sample, twelve ounces.

It contained neither gold nor silver.

71.—From Salmon River, about a mile and a half from its entry into the Columbia—East Kootenay district. Examined for Mr. C. A. Watt.

Quartz, thickly coated with hydrated peroxide of iron. Weight of sample, twelve ounces.

It contained neither gold nor silver.

72.—From a point on Bluewater Creek, a tributary of the Columbia River, about fifteen miles northerly from Donald—East Kootenay district. Examined for Mr. Thos. Clark.

An association of white crypto-crystalline quartz with gray mica-schist and a grayish-white dolomite, in parts coated with hydrated peroxide of iron, carrying small quantities of coarsely crystalline galena and a little iron-pyrites. Weight of sample, one pound one ounce. Assays gave:

Gold	none.
Silver	0·175 of an ounce to the ton of 2,000 lbs.

73.—From the vicinity of Otter Tail Creek—East Kootenay district.

Consisted of galena and tennantite together with very small quantities of iron-pyrites and copper-pyrites, in a gangue composed of quartz with a little dolomite and a few scales of silvery-white mica. Weight of sample, ten ounces. It was found to contain:

Gold	0·729 of an ounce to the ton of 2,000 lbs.
Silver	37·187 ounces to the ton of 2,000 lbs.

74.—From a vein ten feet in width, on Rover Creek, Kootenay River—East Kootenay district.

A white sub-translucent schistose quartz-rock, carrying small quantities of magnetite and iron-pyrites. Weight of sample, ten ounces. Assays showed it to contain:

Gold	trace.
Silver	none.

75.—From vicinity of Glacier House, Canadian Pacific Railway, Selkirks—East Kootenay district. Geological position—Selkirk series, Cambrian. Collected by Dr. G. M. Dawson.

A grayish-white quartz-mica schist, with small cavities filled with hydrated peroxide of iron. Weight of sample, one pound two ounces.

It contained neither gold nor silver.

76.—From a tenth of a mile east of the 448 mile-post, Canadian Pacific Railway, Selkirks—East Kootenay district. Geological position—Selkirk series, Cambrian. Collected by Dr. G. M. Dawson.

A grayish-white, fine-grained, quartz conglomerate. Weight of sample, two pounds three ounces.

It contained neither gold nor silver.

77.—From the Lake View claim, five miles east of St. Mary's Lake, and six miles from the White Grouse Mountain—East Kootenay district. This, and the following specimen were examined for Mr. R. Yuile.

A grayish-white quartz, carrying small quantities of pyrrhotite, magnetite, and iron-pyrites. Weight of sample, seven ounces. It was found to contain:

Gold.................. distinct trace.
Silver.................. 4·375 ounces to the ton of 2,000 lbs.

78.—Also from the Lake View claim.

An association of grayish-white quartz with small quantities of a white talcose schist, carrying a little iron-pyrites. Weight of sample, five ounces.

It contained neither gold nor silver.

79.—From the Nickel Plate mine, Trail Creek, Columbia River—West Kootenay district. This and the nine following specimens were collected by Mr. R. G. McConnell.

An intimate association of pyrrhotite and copper-pyrites, through which was disseminated small quantities of a quartzose gangue. Weight of sample, one pound. Assays gave:

Gold............ 1·283 of an ounce to the ton of 2,000 lbs.
Silver............ 3·383 ounces " "

80.—From the Le Roi mine, taken from the surface, Trail Creek, Columbia River—West Kootenay district.

An intimate association of pyrrhotite and copper-pyrites, through which was disseminated a small quantity of a calcareous gangue. Weight of sample, two pounds nine ounces. It was found to contain:

Gold............ 0·875 of an ounce to the ton of 2,000 lbs.
Silver............ 2·392 ounces " "

81.—From the Le Roi mine, taken from the bottom of the shaft—300 feet, Trail Creek, Columbia River—West Kootenay district.

An intimate association of pyrrhotite and copper-pyrites, through which was disseminated a trifling quantity of a calcareous gangue. Weight of sample, two pounds. Assays showed it to contain:

Gold............	0·117 of an ounce to the ton of 2,000 lbs.	
Silver......	2·333 ounces	" "

82.—From the War Eagle mine, Trail Creek, Columbia River—West Kootenay district.

An intimate association of pyrrhotite and copper-pyrites, through which was disseminated a trifling quantity of a quartzose gangue. Weight of sample, two pounds fifteen ounces. It contained:

Gold............	0·292 of an ounce to the ton of 2,000 lbs.	
Silver...........	0·642	" "

83.—From the Cliff mine, Trail Creek, Columbia River—West Kootenay district.

An intimate association of pyrrhotite with a little copper-pyrites, through which was disseminated a small quantity of a quartzose gangue. Weight of sample, four pounds twelve ounces. Assays gave:

Gold............	0·058 of an ounce to the ton of 2,000 lbs.	
Silver...........	0·233	" "

84.—From the Monte Cristo claim, Trail Creek, Columbia River—West Kootenay district.

An intimate association of pyrrhotite with a little copper-pyrites and small quantities of a quartzose gangue. Weight of sample, two pounds nine ounces. It contained:

Gold............	trace.
Silver..	trace.

85.—From the Kootenay claim, Trail Creek, Columbia River—West Kootenay district.

A very fine grained pyrrhotite with small quantities of intermixed copper-pyrites, associated with a little gangue composed of a grayish-white crypto-crystalline quartz and a fine granular limestone. Weight of sample, two pounds three ounces. It was found to contain:

Gold...........	0·467 of an ounce to the ton of 2,000 lbs.
Silver..........	none.

86.—From the Ohio claim, Ten-mile Creek, Slocan Lake—West Kootenay district.

An association of grayish-white quartz with a little greenish-white steatite and white dolomite, through which was disseminated a small quantity—approximately ten per cent, by weight, of the whole—of a very finely crystalline galena. Weight of sample, seven ounces. Assays gave:

Gold................	trace.
Silver....	1·823 ounce to the ton of 2,000 lbs.

87.—From the Silver King mine, Toad Mountain—West Kootenay district.

A compact, massive tetrahedrite, containing, in parts, a little white translucent quartz. The tetrahedrite, freed from gangue, was found to contain:

Gold....	none.
Silver.....	0·2133 per cent, or at the rate of 62·212 ounces to the ton of 2,000 lbs.

88.—From mine below Pilot Bay, Kootenay Lake—West Kootenay district.

An association of white felspar with small quantities of white sub-translucent quartz and a few scales of mica. Weight of sample, two pounds seven ounces.

It contained neither gold nor silver.

89.—From between Carnes Creek and Downie Creek, Columbia River—West Kootenay district. Examined for Mr. John D. Boyd.

A grayish-white to white quartz, more or less coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, ten ounces.

It contained neither gold nor silver.

90.—From the north-east arm of Upper Arrow Lake, about half a mile from the head, on the south-east side—West Kootenay district. This, and the following specimen were examined for Mr. James W. Vail.

An association of white opaque quartz with a little green chromiferous mica-schist, carrying small quantities of iron-pyrites. Weight of sample, six ounces. Assays gave:

Gold	trace.
Silver..........	0·117 of an ounce to the ton of 2,000 lbs.

91.—From the Gold Hill claim, about seven miles north-east of Illecillewaet on the line of the Canadian Pacific Railway—West Kootenay district.

A more or less weathered, coarsely crystalline galena with which was associated small quantities of a white sub-translucent quartz. Weight of sample, seven ounces. It was found to contain:

Gold..............	none.
Silver.......... .. .	12·396 ounces to the ton of 2,000 lbs.

92.—From Surprise No. 2 claim, on Glacier Creek, about three miles from Upper Kootenay Lake—West Kootenay district.

A white sub-translucent quartz, in parts stained with hydrated peroxide of iron and blue carbonate of copper, carrying small quantities of vitreous copper ore. Weight of sample, eight ounces. It contained:

Gold......	distinct trace.
Silver......	37·917 ounces to the ton of 2,000 lbs.

93.—From Gold Dollar claim, on Glacier Creek, about eight miles from Upper Kootenay Lake—West Kootenay district.

White sub-translucent quartz, more or less coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. Weight of sample, four ounces. It contained:

Gold...	none.
Silver....	0·117 of an ounce to the ton of 2,000 lbs.

94.—From the Spotted Horse mine, nineteen miles south of Nelson—West Kootenay district. Examined for Mr. W. J. H. McKernan.

An association of white translucent quartz with a little grayish-white ankerite, in parts thickly coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites and pyrrhotite. Weight of sample, three pounds.

It contained neither gold nor silver.

95.—From a claim four miles west of Kaslo, west side of Kootenay Lake—West Kootenay district. Examined for Mr. Edward Baum.

An association of white quartz, grayish-white felspar, dark gray chloritic schist and a little green talcose mineral, carrying small quantities of iron-pyrites. Weight of sample, ten pounds.

It contained neither gold nor silver.

96.—From a claim about a mile above Roseberry, on the east shore of Slocan Lake—West Kootenay district. Examined for Mr. W. Thomlinson.

Consisted of an association of a dark green diorite with some black chloritic schist and a little white calcite, through which was disseminated small quantities of pyrrhotite. Weight of sample, five ounces.

It contained neither gold nor silver.

97.—From Jordan River, about twelve miles north of Revelstoke—West Kootenay district. Examined for Messrs. Righley and Frisby.

A white quartzo-felspathic rock, carrying small quantities of iron-pyrites, galena and stibnite. Weight of sample, fourteen ounces. It was found to contain:

Gold..................	trace.
Silver.....	1·458 ounce to the ton of 2,000 lbs.

98.—From Jordan River, a tributary of the Columbia, about twenty miles west of Revelstoke—West Kootenay district. Examined for Mr. Thomas Horn.

It consisted of zinc-blende with a little iron-pyrites, in a gangue of white translucent quartz. The specimen, which was, in parts, coated with hydrated peroxide of iron, weighed one pound one ounce. Assays showed it to contain:

Gold.......	none.
Silver............	0·406 of an ounce to the ton of 2,000 lbs.

99.—From the Nancy Hanks claim, Kaslo-Slocan mining camp—West Kootenay district. This, and the following specimen were examined for Mr. J. Mahoney.

A slightly weathered gray dolomitic schistose rock, carrying small quantities of iron-pyrites. Weight of sample, four pounds twelve ounces. It contained:

Gold	none.
Silver............	0·117 of an ounce to the ton of 2,000 lbs.

100.—Also from the Nancy Hanks claim.

A gray dolomitic schistose rock, carrying small quantities of iron-pyrites. Weight of sample, four pounds thirteen ounces. Assays gave:

Gold........... .	none.
Silver.....	0·117 of an ounce to the ton of 2,000 lbs.

101.—From the Gray Copper mine, southern slope of Reco Mountain, about one mile north of the South Fork of Carpenter Creek, Kaslo-Slocan mining camp—West Kootenay district. Examined for Mr. J. A. Whittier.

An association of brownish-black zinc-blende with a very little coarsely crystalline galena, traversed by thin seams of white calcite. Weight of sample, ten ounces. It was found to contain:

Gold.................	none.
Silver......	45·208 ounces to the ton of 2,000 lbs.

102.—From the Noonday claim, Bird Creek, Kootenay River, about eleven miles below Nelson—West Kootenay district. Examined for Mr. Michael Egan.

An association of white sub-translucent quartz with iron-pyrites and a few specks of magnetite. Weight of sample, thirteen ounces. It was found, on assay, to contain:

Gold............	trace.
Silver...........	0·175 of an ounce to the ton of 2,000 lbs.

103.—From about two miles from the Silver King mine, Toad Mountain—West Kootenay district. Examined for Mr. J. J. Driscoll.

An association of white sub-translucent quartz with some dark gray, fine to coarse crystalline limestone and a little dark green chloritic schist, carrying very small quantities of pyrrhotite and iron-pyrites. Weight of sample, two pounds.

It contained neither gold nor silver.

104.—From Keystone Creek, Columbia River, about forty-two miles above Revelstoke—West Kootenay district. This, and the following specimen were examined for Mr. A. W. McIntosh.

A gneissoid rock, carrying somewhat large quantities of pyrrhotite and iron-pyrites. Weight of sample, five ounces.

It contained neither gold nor silver.

105.—Described as coming from a ledge some forty miles up the Columbia River from Revestoke—West Kootenay district.

A white quartzo-felspathic rock, in parts stained and coated with hydrated peroxide of iron, carrying some iron-pyrites and coarsely crystalline galena. Weight of sample, one pound one ounce. It was found to contain:

Gold.................	none.
Silver...............	4·842 ounces to the ton of 2,000 lbs.

106.—From the King Solomon mine, two miles west of Kaslo, Kaslo-Slocan mining camp—West Kootenay district. This, and the following specimen were examined for Mr. H. E. Porter.

A compact, massive pyrrhotite, with which was associated a small amount of white sub-translucent quartz. Weight of sample, two pounds eleven ounces. It contained:

Gold..	trace.
Silver	none.

107.—Also from the King Solomon mine.

A compact, massive pyrrhotite. Weight of sample, nine ounces. Assays showed it to contain:

Gold..................	1·808 ounce to the ton of 2,000 lbs.
Silver..................	none.

108.—From the Little Giant claim, Duncan River—West Kootenay district. Examined for Mr. W. Billings.

A white crypto-crystalline quartz, in parts coated with hydrated peroxide of iron and a little green carbonate of copper, carrying small quantities of iron-pyrites and a few particles of copper-pyrites. Weight of sample, six ounces. Assays gave:

Gold.............	none.
Silver............	0·233 of an ounce to the ton of 2,000 lbs.

109.—From the Highland claim, Rock Creek, about six miles north of Rossland—West Kootenay district. Examined for Mr. Jay Benn.

It consisted of iron-pyrites and copper-pyrites with some pyrrhotite and a very little dark brown zinc-blende, in a quartzose gangue. Weight of sample, six pounds six ounces. It was found to contain:

Gold..	0·058 of an ounce to the ton of 2,000 lbs.
Silver...........	0·583 " "

110.—From the Mollie Hughes claim, Slocan Lake, Kaslo-Slocan mining camp—West Kootenay district. This, and the following specimen were examined for Mr. Felix Hughes.

An association of white sub-translucent quartz with a little white crystalline calcite, in parts stained and coated with hydrated peroxide of iron, carrying small quantities of galena and a few particles of iron-pyrites and copper-pyrites. Weight of sample one pound five ounces. It contained:

Gold.........	0·700 of an ounce to the ton of 2,000 lbs.
Silver..	379·050 ounces " "

111.—Also from the Mollie Hughes claim.

A white sub-translucent quartz, here and there coated with hydrated peroxide of iron, carrying small quantities of galena, a very little zinc-blende, and a few particles of iron-pyrites. Weight of sample, one pound eight ounces. Assays gave:

Gold..........	0·408 of an ounce to the ton of 2,000 lbs.
Silver.........	137·108 ounces " "

112.—From the Bunbury claim, near Lac le Bois—Interior plateau region.

A dark gray to grayish-white felspathic rock, carrying small quantities of pyrrhotite. Weight of sample, twelve ounces.

It contained neither gold nor silver.

113.—From the Humphrey claim, near Lac le Bois—Interior plateau region.

A grayish-white quartzo-felspathic rock, carrying small quantities of pyrrhotite. Weight of sample, four ounces. It contained:

Gold	trace.
Silver	none.

114.—From Jamieson Creek, North Thompson River—Interior plateau region. Collected by Dr. G. M. Dawson.

A somewhat fine-grained, slightly weathered granite. Weight of sample, twelve ounces.

It contained neither gold nor silver.

115.—From Fairview—Interior plateau region. Examined for Mr. W. T. Thompson.

A compact, massive, slightly weathered pyrrhotite. Weight of sample, two ounces. It was found to contain:

Gold	trace.
Silver	none.

116.—From the west side of Copper Creek valley, about four miles up from the north shore of Kamloops Lake—Interior plateau region. Examined for Mr. Samuel Macartney.

An association of weathered felsitic rock with a little dolomite, carrying small quantities of iron-pyrites and magnetite. Weight of sample, seven ounces.

It contained neither gold nor silver.

117.—From Iron Mountain, at the junction of the Coldwater and Nicola rivers—Interior plateau region. This, and the following specimen were examined for Mr. John Mackie.

A white quartz, in parts coated with hydrated peroxide of iron and blue and green carbonate of copper, carrying small quantities of copper-pyrites, pyrrhotite, specular iron and earthy hematite. Weight of sample, two pounds three ounces. Assays showed it to contain:

Gold	0·350 of an ounce to the ton of 2,000 lbs.
Silver	0·700 " "

118.—From the same locality as the preceding specimen.

Consisted of quartz thickly coated with hydrated peroxide of iron and green carbonate of copper. Weight of sample, two pounds. It was found to contain:

Gold	trace.
Silver	none.

119.—From a well-defined vein, seven feet in width, on Twenty-Mile Creek, Similkameen River—Interior plateau region. Examined for Mr. H. B. Cameron.

A massive pyrrhotite, through which was disseminated a small amount of quartzose gangue. Weight of sample, nine ounces.

It contained neither gold nor silver.

120.—From the South Fork of the Similkameen River—Interior plateau region. Examined for Mr. John Mackie.

An association of a reddish-gray to grayish-white quartzo-felspathic rock with a little calcite, carrying small quantities of magnetite and a few grains of iron-pyrites. Weight of sample, two pounds.

It contained neither gold nor silver.

121.—From south-west of Savonas on the line of the Canadian Pacific Railway—Interior plateau region. Geological position—Lower Tertiary. Collected by Dr. G. M. Dawson.

A coarse conglomerate. Weight of sample, one pound thirteen ounces. Assays showed it to contain:

Gold	trace.
Silver	none.

122.—From township 45, East Riding of Yale district—Interior plateau region. This, and the two following specimens were examined for Mr. Felix Bonneau.

A schistose rock, consisting of an intimate association of a granular white felspar with scales of brown mica. Weight of sample, four ounces.

It contained neither gold nor silver.

123.—From township 3, East Riding of Yale district—Interior plateau region.

A white sub-translucent quartz, carrying large quantities of iron-pyrites. Weight of sample, three ounces and a half. Assays gave:

Gold	trace.
Silver	none.

124.—From township 45, East Riding of Yale district—Interior plateau region.

A white sub-translucent quartz, more or less thickly coated with hydrated peroxide of iron. Weight of sample, one pound two ounces.

It contained neither gold nor silver.

125.—From Scotch Creek, Shuswap Lake—Interior plateau region. This, and the four following specimens were collected by Mr. J. McEvoy.

A white sub-translucent quartz, in parts stained and coated with hydrated peroxide of iron. Weight of sample, thirteen ounces.

It contained neither gold nor silver.

126.—From McGillvray Creek, Louis Creek, North Thompson River—Interior plateau region.

An association of white sub-translucent quartz with a little white felspar, seamed with hydrated peroxide of iron. Weight of sample, one pound three ounces.

It contained neither gold nor silver.

127.—From Harry's Creek, White Valley, east of Vernon—Interior plateau region.

A white cavernous quartz, stained and coated with hydrated peroxide of iron, with here and there, a few minute particles of iron-pyrites. Weight of sample, fifteen ounces.

It contained neither gold nor silver.

128.—From near Mara, Shuswap and Okanagan Railway—Interior plateau region.

An association of white sub-translucent quartz with some white calcite, in parts stained with hydrated peroxide of iron, through which were disseminated a few particles of iron-pyrites. Weight of sample, one pound two ounces.

It contained neither gold nor silver.

129.—From near Shuswap and Okanagan Railway, between Enderby and Mara—Interior plateau region.

A fine-grained grayish-white granite, stained and coated with hydrated peroxide of iron. Weight of sample, one pound seven ounces.

It contained neither gold nor silver.

130.—From Sullivan Creek, North Thompson River—Interior plateau region. Collected by Dr. G. M. Dawson.

A somewhat fine-grained light gray granite. Weight of sample, thirteen ounces.

It contained neither gold nor silver.

131.—From Shepherd Creek, about eight miles north-east of Barkerville, on Williams Creek—Cariboo district.

A concretionary nodule of iron-pyrites, weighing four ounces and a half.

It contained neither gold nor silver.

These nodules of pyrite are very plentifully met with in washing for gold on the creek in question.

132.—From a vein some thirty-six feet wide, on claim 58367, Phillips Arm—Coast ranges and coast region. This, and the following specimen were examined for Mr. R. W. Gordon.

The sample consisting of a finely powdered white siliceous rock, weighed four ounces. It was found to contain:

Gold............ 0·117 of an ounce to the ton of 2,000 lbs.
Silver............ none.

133.—Another sample of finely crushed material from this vein, weighing a little over four ounces, was found to contain:

Gold............ 0·175 of an ounce to the ton of 2,000 lbs.
Silver............ none.

134.—From the so-called Iron Ledge No. 10, Deer Creek, Clayoquot, Vancouver Island—Coast ranges and coast region. Examined for Mr. F. Jacobsen.

A massive iron-pyrites, with which was associated small quantities of copper-pyrites. Weight of sample, two pounds two ounces. Assays gave:

Gold............ none.
Silver........... 0·117 of an ounce to the ton of 2,000 lbs.

135.—From vicinity of, or near, Victoria—Coast ranges and coast region.

An association of black hornblende and white felspar, carrying small quantities of iron-pyrites. Weight of sample, eight ounces.

It contained neither gold nor silver.

136.—From Boothroyd's Flat, thirty-four miles above Yale, on old wagon road—Coast ranges and coast region. This, and the following specimen were examined for Mr. H. B. Monroe.

An association of grayish-white quartz with a little gray chloritic schist, stained and coated with hydrated peroxide of iron. Weight of sample, thirteen ounces.

It contained neither gold nor silver.

137.—From the same locality as the preceding specimen.

Consisted of a dark gray, slightly weathered quartzo-felspathic rock. Weight of sample, six ounces. It contained:

Gold..........................	distinct trace.
Silver..........................	none.

138.—From Lawn Hill, near the entrance to Skidegate Inlet, Queen Charlotte Islands—Coast ranges and coast region.

A specimen of the volcanic tufa of this locality was examined, at the special request of Mr. A. L. Poudrier, and with the following result:

It contained neither gold nor silver.

139.—From a vein, ten feet in width, on Princess Royal Island—Coast ranges and coast region. This, and the two following specimens were examined for Mr. John Rood.

It consisted of iron-pyrites in a gangue composed of an association of white sub-translucent quartz with a little grayish-white serpentine. Weight of sample, one pound eight ounces. Assays showed it to coutain:

Gold...........	0·467 of an ounce to the ton of 2,000 lbs.
Silver.........	0·292 " "

140.—From the same vein as the preceding specimen.

A slightly weathered copper-pyrites. Weight of sample, twelve ounces. Submitted to assay, it was found to contain:

Gold..............	none.
Silver..............	2·100 ounces to the ton of 2,000 lbs.

141.—From a vein, seventy-five feet in width, on Banks Island—Coast ranges and coast region.

A massive pyrrhotite, inclosing large cubic crystals of iron-pyrites, some fragments of translucent quartz, and fine filaments of actinolite. Weight of sample, nine ounces.

It contained neither gold nor silver.

142.—From the Victoria claim, Texada Island—Coast ranges and coast region. Examined for Mr. J. H. Munson.

A grayish-white sub-translucent quartz, carrying small quantities of iron-pyrites. Weight of sample, one pound. Assays gave:

Gold..........................	trace.
Silver..........................	none.

143.—From the upper waters of the Tulameen River—Coast ranges and coast region. Examined for Mr. H. B. Cameron.

An association of white quartzo-felspathic rock with some gray mica-schist, carrying galena, pyrrhotite, and brownish-black zinc-blende. Weight of sample, ten ounces. It contained:

Gold................	trace.
Silver...........	4·812 ounces to the ton of 2,000 lbs.

144.—From Bear River, Clayoquot, Vancouver Island—Coast ranges and coast region. Examined for Mr. F. Jacobsen.

A grayish-white quartz, carrying small quantities of iron-pyrites and copper-pyrites. Weight of sample, one pound. It was found to contain:

Gold................	none.
Silver	1·458 ounce to the ton of 2,000 lbs.

145.—From Eburne, Lulu Island—Coast ranges and coast region. Received from Mr. Albert J. Hill.

A fine light-gray sand. Weight of sample, four ounces.

It contained neither gold nor silver.

NATURAL WATERS.

1.—From a spring on the west bank of the Manicouagan River, about five miles from its mouth, Saguenay county, province of Quebec.

The sample received for examination, contained a very small quantity of flocculent organic matter in suspension—this was removed by filtration. The filtered water was colourless and odourless; taste, mildly saline; reaction, neutral. Its specific gravity, at 15·5° C., was found to be 1·007. Boiling produced a slight precipitate, consisting of carbonate of lime with a little carbonate of magnesia.

Agreeably with the results of an analysis conducted by Mr. F. G. Wait, 1000 parts, by weight, of the filtered water, at 15·5° C., contained:

Potassa....................................	0·100
Soda..	3·877
Lime	0·174
Magnesia	0·261
Ferrous oxide.............................	trace.
Chlorine	4·533
Sulphuric acid..............................	0·519
Carbonic acid..............................	0·315
Silica..	0·005
Organic matter	trace.
	9·784
Less oxygen, equivalent to chlorine	1·021
	8·763

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Chloride of potassium	0·158
" sodium	6·669
" magnesium	0·550
Sulphate of soda	0·786
" lime	0·128
Carbonate of lime	0·218
" magnesia	0·063
" iron	trace.
Silica	0·005
Organic matter	trace.
	8·577
Carbonic acid, half-combined	0·129
" free	0·057
	8·763

Total dissolved solid matter, by direct experiment, dried at 180° C., 8·600.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallisation.)

Chloride of potassium	11·137
" sodium	470·098
" magnesium	38·769
Sulphate of soda	55·405
" lime	9·023
Bi-carbonate of lime	22·134
" magnesia	6·767
" iron	trace.
Silica	0·352
Organic matter	trace.
	613·685
Carbonic acid, free	4·018
	617·703

The water was examined for lithium, barium, strontium, bromine and iodine, but no evidence of the presence of either of these was obtained.

2.—Water from a spring in New Town, Lunenburg county, province of Nova Scotia. Examined for Mr. J. A. Hirtle.

The sample received, contained a trifling amount of flocculent organic matter in suspension. This was removed by filtration. The filtrated water was bright, colourless, odourless, and devoid of any marked taste. Reaction, neutral—both before and after concentration. It contained only 0·06 parts of dissolved saline matter.

dried at 180° C., in 1,000 parts, by weight, of the water—equivalent to 4·20 grains per imperial gallon.

A qualitative analysis by Mr. Wait, showed it to contain :

Soda	strong traces.
Lime	very small quantity.
Magnesia	traces.
Chlorine	strong traces.
Sulphuric acid	very small quantity.
Carbonic acid	traces.
Organic matter	faint traces.

Boiling produced no perceptible precipitate. This water closely resembles, in its general character, that obtained from what was described as a neighbouring spring, the results of the examination of which are given in the Annual Report of this survey for 1894—vol. vii., p. 59 R.

3.—Water from a well in the village of Wakefield, township of Wakefield, Ottawa county, province of Quebec.

The sample sent for examination, contained a small amount of reddish-brown flocculent matter in suspension. This was removed by filtration. It consisted of hydrated peroxide of iron with a little organic matter. The filtered water was devoid of any marked colour, or odour. Taste, somewhat insipid—flat Reaction neutral—both before and after concentration.

Agreeably with the results of a qualitative analysis, conducted by Mr. F. G. Wait, it contained :

Soda	small quantity.
Lime	small quantity.
Magnesia	small quantity.
Ferrous oxide	trace.
Chlorine	small quantity.
Sulphuric acid	trace.
Carbonic acid	small quantity.
Organic matter	faint trace.

The total dissolved saline matter, dried at 180° C., amounted to 0·23 parts per 1,000—equivalent to 16·1 grains per imperial gallon. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

4.—Water, town supply, from Rossland, West Kootenay district, province of British Columbia.

The sample received for examination, contained a trifling amount of sedimentary matter—this was removed by filtration. The filtered water was bright; had a faint greenish-yellow tinge; was odourless, and devoid of any marked taste. Reaction, neutral—both before and after concentration. It was found to contain 0·046 parts of dissolved saline matter, dried at 180° C., in 1,000 parts, by weight, of the water—equivalent to 3·22 grains in the imperial gallon.

A qualitative analysis by Mr. Wait, showed it to contain:

Soda	trace.
Lime	very small quantity.
Magnesia	very small quantity.
Alumina	faint trace.
Ferrous oxide	trace.
Chlorine	trace.
Sulphuric acid	small quantity.
Carbonic acid	trace.
Silica	trace.
Organic matter	faint trace.

Boiling produced a very slight precipitate, consisting of carbonates of lime and magnesia with a trace of hydrated peroxide of iron.

5.—Water, town supply, from Nelson, West Kootenay district, province of British Columbia.

The sample sent for examination, contained a small quantity of sedimentary matter, which was removed by filtration. It consisted of hydrated peroxide of iron with a trifling amount of white, flocculent, organic matter. The filtered water had a faint greenish-yellow tinge; was odourless, and devoid of any marked taste. Reaction, neutral—both before and after concentration. It was found to contain 0·144 parts of dissolved saline matter, dried at 180° C., in 1,000 parts, by weight, of the water—equivalent to 10·08 grains per imperial gallon.

A qualitative analysis, conducted by Mr. Wait, showed it to contain:

Soda	very small quantity.
Lime	rather small quantity.
Magnesia	small quantity.
Alumina	trace.
Ferrous oxide	very small quantity.
Chlorine	very small quantity.
Sulphuric acid	somewhat large quantity.
Carbonic acid	small quantity.
Silica	trace.
Organic matter	trace.

Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia with a little hydrated peroxide of iron.

MISCELLANEOUS EXAMINATIONS.

1.—Carbonaceous shale. From near Bryden's Mill, Benacadie Glen, Cape Breton county, province of Nova Scotia. Examined for Mr. F. E. Carié.

The composition of this material was found to be, as follows—Graphitic carbon 34·5, rock matter 59·9, water 5·6 = 100·0. On incineration, the graphitic carbon burns off slowly, leaving a light dull reddish-brown coloured residue.

2.—Carbonaceous shale. From Fisherman Creek, eight miles up the North Fork of Kettle River, Yale district, province of British Columbia. Examined for Mr. J. H. Featherston.

Its examination afforded the following results—Carbonaceous matter 28·3, rock matter 65·4, water 6·3 = 100·0.

3.—Coal. From a seam on Rock Creek, one mile above its mouth, Kettle River, Yale district, province of British Columbia.

This was, at the request of Mr. J. H. Clems, examined in regard to its content of inorganic matter. The sample received, left on incineration 16·53 per cent of a brownish-red coloured ash.

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

SECTION OF

MINERAL STATISTICS AND MINES

ANNUAL REPORT

FOR

1895

ELFRIC DREW INGALL

Associate of the Royal School of Mines, England,
Mining Engineer to the Geological Survey
of Canada

L. L. BROPHY

Statistical Assistant

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1896

To Dr. G. M. Dawson, C.M.G., F.R.S., &c.,
Director Geological Survey of Canada.

Sir,—I beg herewith to hand you the detailed statistical report of the mineral industry of Canada for 1895. The preliminary summary statement for that year was completed 22nd February, 1896. Nothing but the figures are given in this issue, as it has been found impossible, for the past two years, with the lessened staff of the Section, to keep up with the various branches of the work. For that period there has been but one officer to do all the technical work, which to be done efficiently, necessitates not only the collection, sifting and compilation, of all that pertains to the various mineral industries of the whole Dominion for the current year, but also includes the preparation of memoranda on metallurgical and mining questions, in supplying such information to many inquirers; the systematic collection and filing away of the same for future reference and many such duties. Besides this it is necessary that special work in mining districts should be undertaken from time to time and special reports issued. Being single handed in this work covering so great an area and so wide a variety of subjects, my own efforts have necessarily been divided among too many interests to give any adequate or prompt result in any one direction.

With the additional assistance lately provided in this Section, it will, it is hoped, be possible to carry on the work with greater completeness, and if any arrangement can be effected to enable the accumulation of routine to be dealt with, we may hope to perform the duties of the Section for the future with promptness and thoroughness.

For the above reasons no attempt will be made in this issue to deal with general information regarding the mineral industries of the Dominion during 1895, but all our energies will be directed toward doing what is possible regarding 1896, and preparing for still better results in the report for 1897.

It is desired to gratefully acknowledge the aid received from various sources. Thanks are due to those who, although too numerous to mention individually, have, by answering our circulars or letters, provided much valuable material for the report. Special mention must be made of the services rendered by my colleague Mr. L. L. Brophy, for his aid in the work of collecting and compiling the statistical material.

Our acknowledgments are also due to the provincial mining departments of Nova Scotia, Quebec, Ontario and British Columbia, and to the Dominion Customs and Inland Revenue departments for aid received.

I am, sir,
Your obedient servant,

ELFRIC DREW INGALL.

Section of Mineral Statistics and Mines,
20th November, 1896.

NOTES.

YEAR AND TON USED.

Except for the figures of imports, which refer to the fiscal year, ending 30th June in the current calendar year, the year used throughout this report is the calendar year. The ton is that of 2000 pounds, unless otherwise stated.

EXPORTS AND IMPORTS.

The figures given throughout the report referring to exports and imports, are compiled from data obtained from the books of the Customs Department, and will occasionally show discrepancies, which, however, there are no means of correcting.

The exports and imports, under the heading of each province, do not necessarily represent the production and consumption of the province, *e. g.*, material produced in Ontario is often shipped from Montreal and entered there for export, so falling under the heading, Quebec.

N.E.S. = Not elsewhere specified.

VALUES ADOPTED.

The values of the metallic minerals produced, as per returns to this department, are calculated on the basis of their metallic contents at the average market price of the metal for the current year. Spot values have been adopted for the figures of production of the non-metallic minerals.

GENERAL NOTES.

As in the past, care is taken to avoid interference with private interests in the manner of publishing results, and all returns of production of individual mines are treated as confidential unless otherwise arranged with those interested. The confidence of the mining community thus gained, has resulted in an increasingly general response to our circulars, although to complete our data personal application is still necessary in a small number of instances, and a yet more prompt response on the part of all applied to, will help still further towards an earlier publication of the material.

In view of criticisms of these statistics which have been made recently, and from time to time in the past, it may be well to take this opportunity to explain the working methods adopted, in order to prevent the misunderstandings which underlie such criticisms and suggestions and to correct the impression thereby conveyed to the public that the reports are unreliable.

The figures given throughout the reports are based as far as possible, upon returns obtained direct from the various operators, and the totals have for some years been checked by comparison with railway shipments, exports, and all other available sources of information. It can be therefore fairly claimed, that they are as accurate as it is possible to make such figures.

After investigation of the subject we have, however, found that in the nature of things, export and railway figures can only be taken as approximately correct in most instances. In the case of the export figures, entries are made as a rule by those having no technical knowledge of mineral substances, and in the case of the railways, but few of the shipments are actually weighed, so that car-load lots, for instance, may differ considerably from the theoretical load of the car.

Mineral production of Canada.

SUMMARY OF THE MINERAL PRODUCTION OF CANADA, IN 1894 AND 1895.

Product.		Calendar Years. 1894. Quantity.	1894. Value.	1895. Quantity.	1895. Value.
Metallic.					
Copper (fine, in ore, etc.)	lbs.	2,737,016	$ 735,017	8,789,162	$ 949,229
Gold	oz.	58,058	1,042,055	92,448	1,910,900
Iron ore	tons.	109,991	226,611	102,797	238,070
Lead (fine, in ore, etc.)	lbs.	5,703,222	185,355	23,075,892	749,966
Mercury	"	....	....	....	2,343
Nickel (fine, in oré, etc.)	"	4,907,430	1,870,958	3,888,525	1,360,984
Platinum	oz.	....	950	....	3,800
Silver (fine, in ore, etc.)	"	847,697	534,049	1,775,683	1,158,633
Total metallic		....	$ 4,594,995	....	$6,373,925
Non-metallic.					
Arsenic (white)	tons.	7	420	....	....
Asbestus	"	7,630	420,825	8,756	368,175
Chromite	"	1,000	20,000	3,177	41,301
Coal	"	3,867,742	8,499,141	3,513,496	7,727,446
Coke	"	58,044	148,551	53,356	143,047
Fireclay	"	539	2,167	1,329	3,492
Grindstones	"	3,757	32,717	3,475	31,932
Gypsum	"	223,631	202,031	226,178	202,608
Limestone for flux	"	35,101	34,347	34,579	32,916
Lithographic stone	"	180	30,000	....	2,000
Manganese ore	"	74	4,180	125	8,464
Mica		....	45,581	....	65,000
Mineral pigments—					
Baryta	tons.	1,081	2,830	....	....
Ochres	"	611	8,690	1,339	14,600
Mineral water	galls.	561,460	100,040	739,382	126,048
Moulding sand	tons.	6,214	12,428	6,765	13,530
Natural gas		....	313,754	....	423,032
Petroleum	brls.	829,104	835,322	728,665	1,090,520
Phosphate (apatite)	tons.	7,290	43,740	1,822	9,565
Precious stones		....	1,500	....	....
Pyrites	tons.	40,527	121,581	34,198	102,594
Quartz		....	....	....	....
Salt	tons.	57,199	170,687	52,376	160,455
Soapstone	"	916	1,640	475	2,138
Whiting	brls.	500	750	....	....
Structural materials and clay products—					
Bricks	M.	....	1,800,000	*a* 308,836	1,670,000
Building stone		....	1,200,000	....	*a* 1,095,000
Cement, natural / do Portland	brls. / "	108,142	144,637	128,294	173,675
Flagstones	sq. ft.	152,700	5,298	80,005	6,687
Granite	tons.	16,392	109,936	19,238	84,838
Lime	bush.	....	*a.* 900,000	*a* 5,225,000	700,000
Marble	tons.	....	....	200	2,000
Pottery		....	162,144	....	151,588
Roofing cement	tons.	815	3,978	....	3,153
Sands and gravels, exports	"	324,656	86,940	277,162	118,359
Sewer pipe		....	250,325	....	257,045
Slate	tons.	....	75,550	....	58,900
Terra cotta	"	....	65,600	....	195,123
Tiles	M.	....	200,000	*a* 19,200	210,000
Total non-metallic		....	$16,057,330	....	$15,295,231
do metallic		....	4,594,995	....	6,373,925
Estimated value of mineral products not returned		....	297,675	....	330,844
Total		....	$20,950,000	....	$22,000,000

(*a*) Partly estimated.

EXPORTS.

EXPORTS

OF PRODUCTS OF THE MINE, WITH DESTINATIONS, DURING THE FISCAL YEAR 1894–1895.

Exports.	Value.	Exports.	Value.
United States	$6,271,397	Brazil	2,730
Great Britain	388,407	Belgium	2,110
Newfoundland	177,388	Hayti	2,078
Germany	28,113	Argentine Republic	1,179
Hawaiian Islands	21,138	United States of Colombia	1,057
British West Indies	20,663	France	760
British Guiana	20,481	Norway and Sweden	534
Spanish West Indies	17,832	Central American Republic	383
Saint Pierre	16,502		
China	6,455		
Holland	4,020	Total	$6,983,227

EXPORTS.

MINERALS AND MINERAL PRODUCTS MINED OR MANUFACTURED IN CANADA DURING 1895.—CALENDAR YEAR.

Products.	Value.	Products.	Value.
Asbestus, first class	$ 169,380	Mineral pigments	$ 3,720
" second class	205,777	Nickel	521,783
" third class	46,533	Oil, crude	1,044
Bricks	8,665	" refined	2,023
Cement	937	Ore, iron	3,907
Chromite	42,236	" manganese	6,351
Clay, manufactures of	887	Phosphate	2,500
Coal	3,318,231	Platinum	47
Coke	60	Plumbago, crude	4,803
Copper	236,965	" manufactures of	30
Felspar	2,545	Pyrites	38,298
Gold	1,133,100	Salt	959
Grindstones	16,723	Sand and gravel	118,359
Gypsum, crude	193,244	Silver	994,354
" ground	22,233	Slate	574
Iron and steel	174,778	Stone, unwrought	51,616
Lead	435,071	" wrought	8,587
Lime	71,697	Other articles	19,444
Mica, crude	17,148		
" cut	31,264	Total	$7,905,986
" ground	113		

IMPORTS. IMPORTS.

MINERALS AND MINERAL PRODUCTS, FOR FISCAL YEAR 1894–1895.

Product.	Value.	Product.	Value.
Alum and aluminous cake..	$ 27,572	Iron and steel—machinery.	$ 2,044,867
Aluminium..	3,248	" manufactures of—hardware, &c.	2,994,571
Antimony	6,131	Lead—bars, bl'ks, old scrap, pig, &c.	155,605
Arsenic	31,932	" manufactures of	38,015
Asbestus and mfrs. of	26,094	Lime	5,743
Asphaltum	41,817	Lithographic stone	10,078
Bismuth	255	Manganese, oxide of	2,781
Borax	42,355	Marble—blocks, slabs, &c.	64,049
Bricks	9,711	" mfrs. of	19,373
" bath	2,015	Mercury	25,703
" and tiles, fire	79,979	Metallic alloys — brass, bronze, german silver, pewter, &c.	349,186
Buhrstones	2,172	Mineral and bituminous substances, N.E.S.	39,837
Building stone	44,282	Mineral and metallic pigments	328,596
Cement	7,001	Mineral water	48,613
" Portland	242,813	Miscellaneous	28,654
Chalk	7,730	Nickel	4,267
Clay, china	23,447	Ores of metals N.E.S.	261
" fire	26,741	Paraffine wax	11,579
" pipe	543	" candles	2,541
" all other, N.E.S.	11,999	Petroleum and products of.	525,372
Coal, anthracite	5,350,627	Platinum	3,937
" bituminous	3,321,387	Precious stones	263,448
" dust, &c.	52,221	Pumice	3,609
" tar and pitch	36,581	Salt	362,592
Coke	149,434	Saltpetre	32,282
Copper, pigs, precipitate, ingots, scrap, &c.	147,090	Sand and gravel	24,779
" mfrs. of	111,295	Slate	19,471
Copperas	3,125	Stone and granite, N.E.S.	51,050
Cryolite	386	Spelter	30,245
Earthenware	547,935	Sulphate of copper	62,777
Emery	22,344	Sulphur	56,965
Felspar, quartz, flint, &c.	7,963	Sulphuric acid	2,481
Fertilizers	42,536	Tiles, sewer pipes, &c.	21,053
Flagstones, dressed	84	Tin—pigs, bars, &c.	215,799
Fuller's earth	1,904	" mfrs. of	757,598
Graphite, crude	2,586	Whiting	25,441
" mfrs. of	35,910	Zinc—pigs, bars, &c.	64,314
Grindstones	22,834	" mfrs. of	5,581
Gypsum, crude	960	Total	$22,659,706
" plaster of Paris, &c.	1,707		
Iron and steel—Pig, scrap, blooms, &c.	688,486		
" ferro-silicon, ferro-manganese, &c.	5,408		
" chrome steel	3,106		
" Rolled—bars, plates, &c.	2,762,847		

ABRASIVE MATERIALS.

ABRASIVE MATERIALS.

Grindstones.

TABLE 1.

ABRASIVE MATERIALS:—PRODUCTION OF GRINDSTONES.

Calendar Year.	Tons.	Value.
1886	4,000	$46,545
1887	5,292	64,008
1888	5,764	51,129
1889	3,404	30,863
1890	4,884	42,340
1891	4,479	42,587
1892	5,283	51,187
1893	4,600	38,379
1894	3,757	32,717
1895	3,475	31,932

TABLE 2.

ABRASIVE MATERIALS:—EXPORTS OF GRINDSTONES.

Calendar Year.	Value.
1884	$28,186
1885	22,606
1886	24,185
1887	28,769
1888	28,176
1889	29,982
1890	18,564
1891	28,433
1892	23,567
1893	21,672
1894	12,579
1895	16,723

TABLE 3.

ABRASIVE MATERIALS:—EXPORTS OF GRINDSTONES.

Provinces.	CALENDAR YEARS.			
	1892.	1893.	1894.	1895.
Quebec	....	$ 625	$ 1	....
Nova Scotia	$ 10,575	11,317	10,048	$ 8,723
New Brunswick	12,992	9,730	2,530	8,000
Totals	$ 23,567	$ 21,672	$ 12,579	$ 16,723

ABRASIVE MATERIALS.

Grindstones.

TABLE 4.

ABRASIVE MATERIALS :—IMPORTS OF GRINDSTONES.

Fiscal Year.	Tons.	Value.
1880	1,044	$11,714
1881	1,359	16,895
1882	2,098	30,654
1883	2,108	31,456
1884	2,074	30,471
1885	1,148	16,065
1886	964	12,803
1887	1,309	14,815
1888	1,721	18,263
1889	2,116	25.564
1890	1,567	20,569
1891	1,381	16,991
1892	1,484	19,761
1893	1,682	20,987
1894	1,918	24,426
*1895. Duty $1.75 per ton.	1,770	22,834

* Not mounted and not less than 12 inches in diameter.

Buhrstones.

TABLE 5.

ABRASIVE MATERIALS :—IMPORTS OF BUHRSTONES.

Fiscal Year.	Value.
1880	$12,049
1881	6,337
1882	15,143
1883	13,242
1884	5,365
1885	4,517
1886	4,062
1887	3,545
1888	4,753
1889	5,465
1890	2,506
1891	2,089
1892	1,464
1893	3,552
1894	3,029
*1895. Duty free.	2,172

*Buhrstones in blocks, rough or unmanufactured, not bound up or prepared for binding into mill-stones.

TABLE 6.

ABRASIVE MATERIALS.

Silex.

ABRASIVE MATERIALS:—IMPORTS OF "SILEX" OR CRYSTALLIZED QUARTZ.

Fiscal Year.	Cwt.	Value.
1880	5,252	$2,290
1881	3,251	1,659
1882	3,283	1,678
1883	3,543	2,058
1884	3,259	1,709
1885	3,527	1,443
1886	2,520	1,313
1887	14,533	5,073
1888	4,808	2,385
1889	5,130	1,211
1890	1,768	2,617
1891	3,674	1,929
1892	1,429	1,244
1893	2,447	1,301
1894	2,451	1,521
1895 ... Duty free	2,882	1,881

TABLE 7.

Pumice stone and emery.

ABRASIVE MATERIALS:—IMPORTS OF PUMICE STONE AND EMERY.

Fiscal Year.	Pumice Stone. *	Emery. †
1885	$ 9,384	$ 5,066
1886	2,777	11,877
1887	3,594	12,023
1888	2,890	15,674
1889	3,232	13,565
1890	3,003	16,922
1891	3,696	16,179
1892	3,282	17,782
1893	3,798	17,762
1894	4,160	14,433
1895 ... Duty free	3,609	14,569

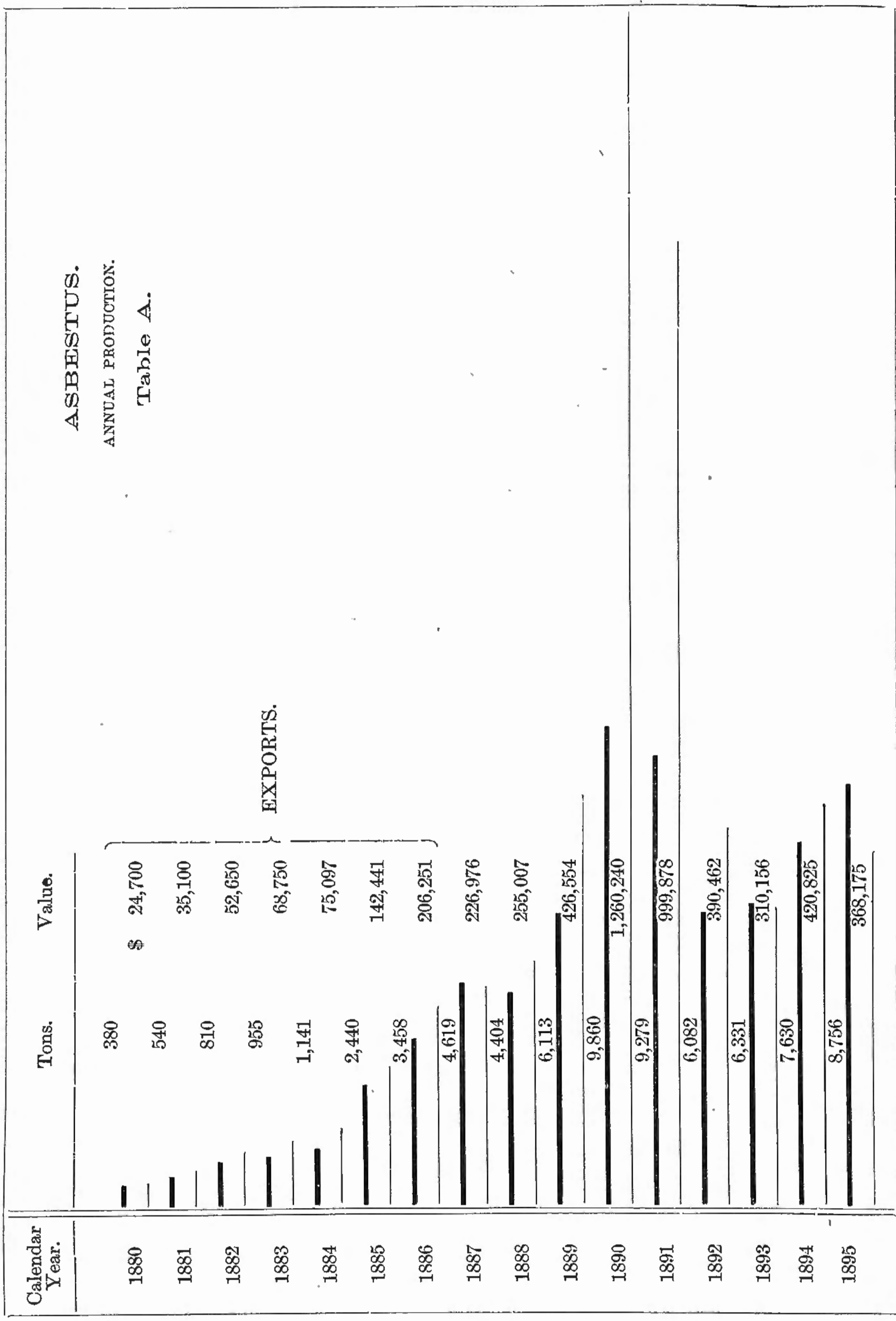
* Pumice and pumice stone, ground or unground.
† Emery, in bulk, crushed or ground.

ASBESTUS.

ASBESTUS.

ANNUAL PRODUCTION.

Table A.



Calendar Year.	Tons.	Value.
1880	380	$ 24,700
1881	540	35,100
1882	810	52,650
1883	955	68,750
1884	1,141	75,097
1885	2,440	142,441
1886	3,458	206,251
1887	4,619	226,976
1888	4,404	255,007
1889	6,113	426,554
1890	9,860	1,260,240
1891	9,279	999,878
1892	6,082	390,462
1893	6,331	310,156
1894	7,630	420,825
1895	8,756	368,175

Figures for 1880–1886: EXPORTS.

Asbestus.

Exports.

TABLE 1.

ASBESTUS:—EXPORTS.

Quality.	1892.		1893.		1894.		1895.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1st class......	1,447	$113,595	975	$ 41,084	5,400	$312,280	2,978	$169,380
2nd "	3,185	228,133	4,592	287,619	1,322	106,374	3,159	205,777
3rd "	748	31,375	350	10,004	1,265	59,183	1,305	46,553
Totals.....	5,380	$373,103	5,917	$338,707	7,987	$477,837	7,442	$421,690

Imports.

TABLE 2.

ASBESTUS:—IMPORTS.

Fiscal Year.	Value.
1885....................	$ 674
1886....................	6,831
1887....................	7,836
1888....................	8,793
1889....................	9,943
1890....................	13,250
1891....................	13,298
1892....................	14,090
1893....................	19,181
1894....................	20,021
*1895........ ..Duty 25 p.c.	26,094

*Asbestus, in any form other than crude, and all manufactures of.

Chromite

CHROMITE.

The only figures available under this heading, are those already given in the general table of production, page 7 s, for the past two years, and the export figures for 1895 in the table of exports following. Previous to that there was no production except of small test lots in 1886 and 1887.

COAL.

COAL.

COAL.

ANNUAL PRODUCTION.

Table A.

Production.

Calendar Year.	Tons.	Value.
		$
1886	2,091,976	4,017,225
1887	2,418,494	4,758,590
1888	2,658,134	5,259,832
1889	2,719,478	5,584,182
1890	3,117,661	6,496,110
1891	3,623,076	8,144,247
1892	3,292,547	7,184,510
1893	3,837,565	8,423,759
1894	3,867,742	8,499,141
1895	3,513,496	7,727,446

COAL

Production.

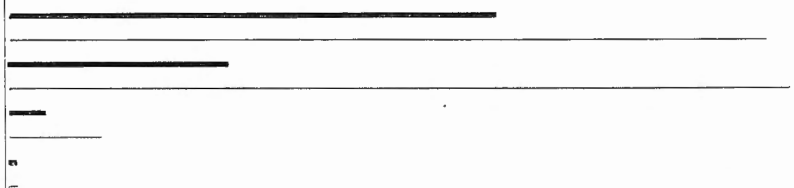
COAL.

CALENDAR YEAR, 1894.

PRODUCTION BY PROVINCES.

Table B.

Province	Tons.	Value.
		$
N. S.	2,526,775	3,948,085
B. C.	1,134,507	4,051,812
N. W. T.	199,981	488,980
N. B.	6,469	10,264



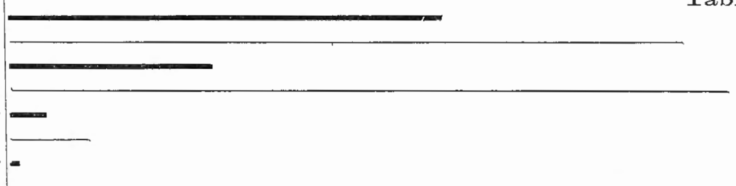
COAL.

CALENDAR YEAR, 1895.

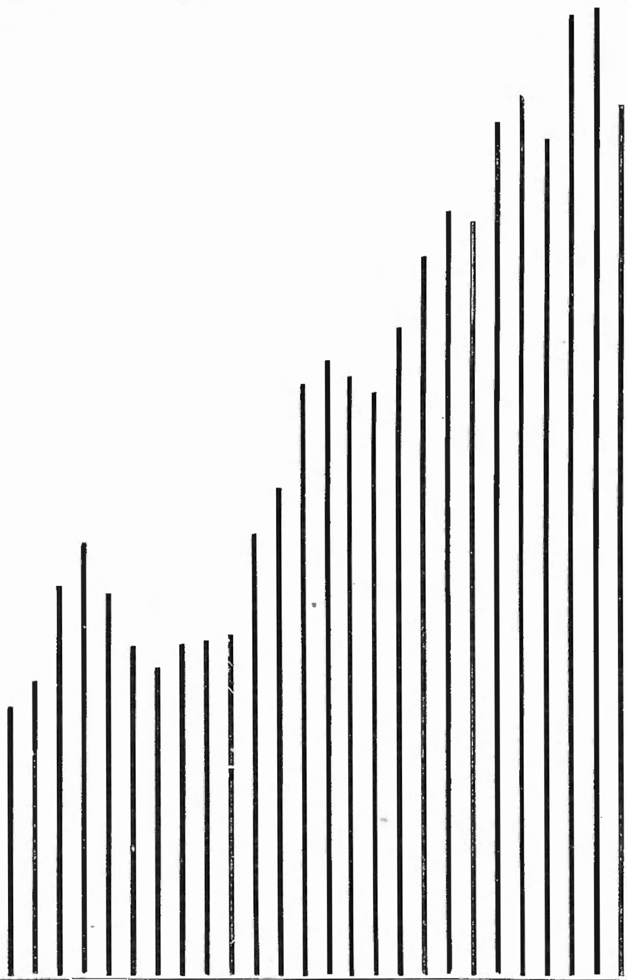
PRODUCTION BY PROVINCES.

Table B.

Province.	Tons.	Value.
		$
N. S.	2,265,930	3,540,516
B. C.	1,052,412	3,758,616
N. W. T.	185,654	414,064
N. B.	9,500	14,250



COAL.
NOVA SCOTIA.
ANNUAL PRODUCTION.
Table C.



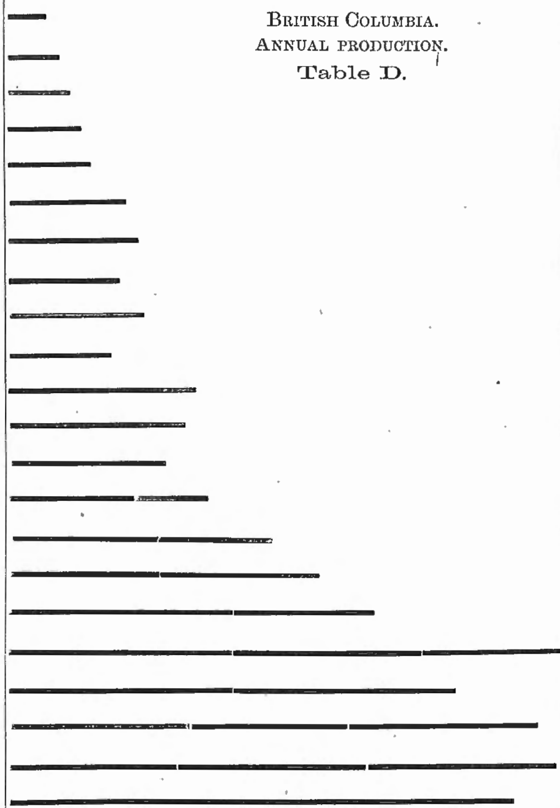
Calendar Year.	Tons.
1870	700,860
1871	754,031
1872	984,664
1873	1,117,643
1874	977,446
1875	848,395
1876	794,803
1877	848,395
1878	863,081
1879	882,863
1880	1,156,635
1881	1,259,182
1882	1,529,708
1883	1,593,259
1884	1,556,010
1885	1,514,470
1886	1.682,924
1887	1,871,338
1888	1,989,263
1889	1,967,032
1890	2,222,081
1891	2,290,935
1892	2,175,914
1893	2,497,281
1894	2,526,775
1895	2,265,930

COAL.

British Columbia.

COAL.
BRITISH COLUMBIA.
ANNUAL PRODUCTION.
Table D.

Calendar Year.	Tons.
1874	81,574
1875	110,145
1876	131,192
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	548,017
1889	649,409
1890	759,517
1891	1,152,588
1892	925,495
1893	1,095,689
1894	1,134,507
1895	1,052,412



The production in the province of New Brunswick and the North-west Territories during past years is shown in the following table:— COAL.

TABLE 1.

COAL:—PRODUCTION IN NEW BRUNSWICK AND NORTH-WEST TERRITORIES.

New Brunswick and North-west Territories.

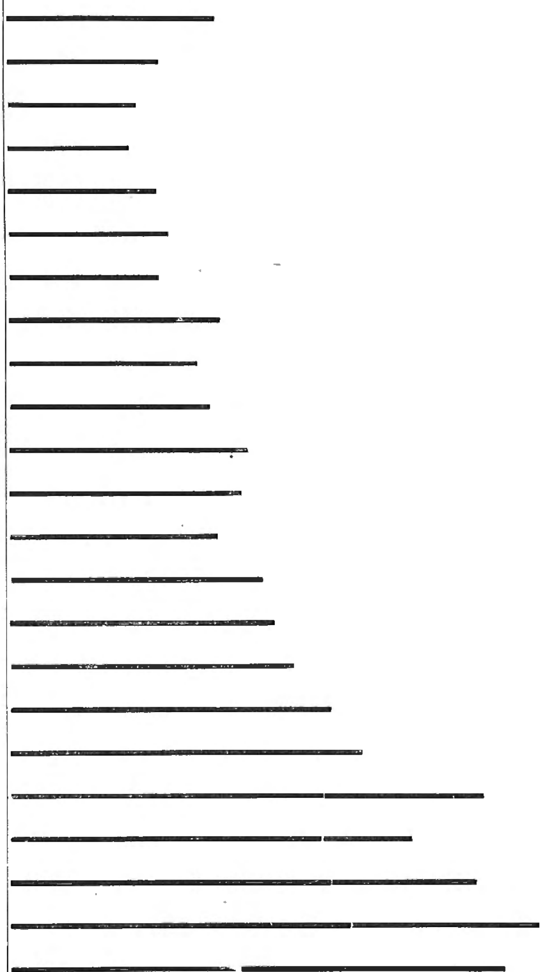
Calendar Year.	New Brunswick.		North-west Territories.	
	Tons.	Value.	Tons.	Value.
1887	10,040	$ 23,607	74,152	$ 157,577
1888	5,730	11,050	115,124	183,354
1889	5,673	11,133	97,364	179,640
1890	7,110	13,850	128,953	198,498
1891	5,422	11,030	174,131	437,243
1892	6,768	9,575	184,370	469,930
1893	6,200	9,837	238,395	598,745
1894	6,469	10,264	199,991	488,980
1895	9,500	14,250	185,654	414,064

Coal.

Exports.

COAL.
Exports.
(Produce of Canada).
Table E.

Calendar Year.	Tons.
1873	420,683
1874	310,988
1875	250,348
1876	248,638
1877	301,317
1878	327,959
1879	306,648
1880	432,188
1881	395,382
1882	412,682
1883	486,811
1884	474,405
1885	427,937
1886	520,703
1887	580,965
1888	588,627
1889	665,315
1890	724,486
1891	971,259
1892	823,733
1893	960,312
1894	1,103,694
1895	1,011,235



COAL.

Exports.

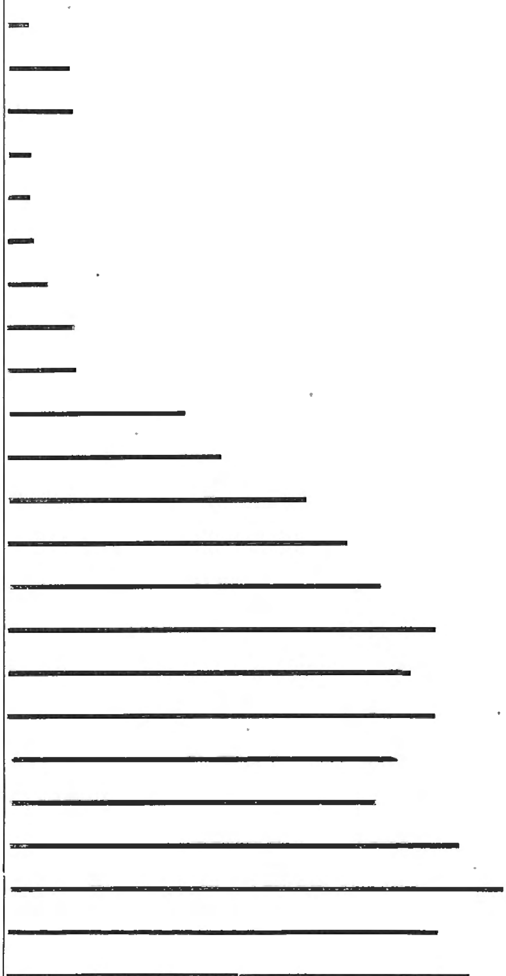
COAL.

EXPORTS.

(NOT THE PRODUCE OF CANADA.)

Table F.

Calendar Year.	Tons.
1873	5,403
1874	12,859
1875	14,026
1876	4,995
1877	4,829
1878	5,468
1879	8,468
1880	14,217
1881	14,245
1882	37,576
1883	44,388
1884	62,665
1885	71,003
1886	78,443
1887	89,098
1888	84,316
1889	89,294
1890	82,534
1891	77,827
1892	93,988
1893	102,827
1894	89,786
1895	96,836



COAL.

Exports.

TABLE 2.

COAL:—EXPORTS. THE PRODUCE OF CANADA.

Provinces.	Calendar Year			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Ontario	104	$ 115	.....	.....
Quebec	7,600	22,995	148	$ 382
Nova Scotia	310,277	633,398	241,091	534,479
New Brunswick	919	2,948	4,445	13,343
Prince Edward Island	1,221	2,850	150	450
North-west Territories	13,134	24,293	37,118	77,015
British Columbia	770,439	2,855,216	728,283	2,692,562
Total	1,103,694	$3,541,815	1,011,235	$3,318,231

TABLE 3.

COAL:—EXPORTS. NOT THE PRODUCE OF CANADA.

Provinces.	Calendar Year.			
	1894.		1895.	
	Tons.	Value.	Tons.	Value.
Ontario	83,599	$ 184,314	93,027	$ 191,783
Quebec	5,338	11,378	2,956	6,139
Nova Scotia	631	1,374	472	1,791
New Brunswick	218	577	380	1,019
Manitoba	....	....	1	13
Total	89,786	$ 197,643	96,836	$ 200,745

TABLE 4.

COAL:—EXPORTS. NOVA SCOTIA AND BRITISH COLUMBIA.

COAL.

Nova Scotia and British Columbia.

Calendar 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	430,3[illegible]0	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
1888	165,863	330,115	405,071	1,605,650
1889	186,608	396,830	470,683	1,918,263
1890	202,387	426,070	508,882	1,977,191
1891	194,867	417,816	767,734	2,958,695
1892	181,547	407,980	599,716	2,317,734
1893	203,198	470,695	708,228	2,693,747
1894	310,277	633,398	770,439	2,855,216
1895	241,091	534,479	728,283	2,692,562

TABLE 5.

COAL:—IMPORTS OF BITUMINOUS COAL.

Imports.

Fiscal Year.	Tons.	Value.
1880	457,049	$1,220,761
1881	587,024	1,741,568
1882	636,374	1,992,081
1883	911,629	2,996,198
1884	1,118,615	3,613,470
1885	1,011,875	3,197,539
1886	930,949	2,591,554
1887	1,149,792	3,126,225
1888	1,231,234	3,451,661
1889	1,248,540	3,255,171
1890	1,409,282	3,528,959
1891	1,598,855	4,060,896
1892	1,615,220	4,099,221
1893	1,603,154	3.967,764
1894	1,359,509	3,315,094
1895 ...Duty 60c. per ton.	1,444,928	3,321,387

COAL.

Imports.

TABLE 6.

COAL:—IMPORTS OF ANTHRACITE COAL.

Fiscal Year.	Tons.	Value.
1880	516,729	$1,509,960
1881	572,092	2,325,937
1882	638,273	2,666,356
1883	754,891	3,344,936
1884	868,000	3,831,283
1885	910,324	3,909,844
1886	995,425	4,028,050
1887	1,100,165	4,423,062
1888	2,138,627	5,291,875
1889	1,291,705	5,199,481
1890	1,201,335	4,595,727
1891	1,399,067	5,224,452
1892	1,479,106	5,640,346
1893	1,500,550	6,355,285
1894	1,530,522	6,354,040
*1895 ... Duty free.	1,404,342	5,350,627

*Coal, anthracite, and anthracite coal dust.

TABLE 7.

COAL:—IMPORTS OF COAL DUST.

Fiscal Year.	Tons.	Value.
1880	3,565	$ 8,877
1881	337	666
1882	471	900
1883	8,154	10,082
1884	12,782	14,600
1885	20,185	20,412
1886	36,230	36,996
1887	31,401	33,178
1888	28,808	34,730
1889	39,980	47,139
1890	53,104	29,818
1891	60,127	36,130
1892	82,091	39,840
1893	109,585	44,474
1894	117,573	49,510
1895 ... Duty 20 p.c.	181,318	52,221

The consumption of coal in Canada for 1895, is illustrated by the following figures:— COAL.

	Tons.
Production	3,513,496
Imports	3,030,588
	6,544,084
Less—Exports	1,108,071
Home consumption	5,436,013

Table 7*a* below illustrates the consumption of coal in Canada as calculated in a similar way for past years Home consumption.

TABLE 7*a*.

CONSUMPTION OF COAL IN CANADA.

Fiscal Year.	Tons.
1886	3,593,266
1887	4,406,916
1888	4,646,513
1889	4,519,787
1890	4,974,362
1891	5,632,039
1892	5,552,243
1893	5,987,717
1894	5,681,866
1895	5,436,013

COAL.

Nova Scotia.

TABLE 8.

NOVA SCOTIA.

COAL:—PRODUCTION, SALES AND COLLIERY CONSUMPTION.

Calendar Year.	Production.	Sales.	Colliery Consumption.
	Tons.	Tons.	Tons.
1895, 1st quarter	343,613	204,532	55,486
1895, 2nd "	559,945	490,123	52,645
1895, 3rd "	774,784	759,732	52,506
1895, 4th "	561,384	553,882	56,238
Totals	2,239,726	2,008,269	216,875
1894	2,501,406	2,290,551	209,528
1893	2,497,281	2,199,444	213,749
1892	2,175,914	1,963,286	196,103
1891	2,290,935	2,071,938	195,981
1890	2,222,081	2,000,444	180,589
1889	1,967,032	1,741,720	177,106
1888	1,989,263	1,765,895	176,336
1887	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

TABLE 8a.

NOVA SCOTIA.

COAL:—PRODUCTION BY COLLIERIES DURING THE CALENDER YEAR, 1895.

Colliery.	Tons.	Colliery.	Tons.
Chignecto	493	International	110,916
Joggins	114,807	Reserve	216,439
Minudie	4,647	Victoria	108,563
Springhill	420,881	Sydney	284,445
Maccan	....	Scotia	1,374
Acadia	227,328	Dominion No. 1	84,217
East River	....	Broad Cove	2,253
Intercolonial	228,628	Mabou	202
Old Bridgeport	120,066	Cape Breton	9,968
Caledonia	148,654	Hub (Dom. Coal Co.)	37,651
Gardener	....	North Sydney	1,790
Glace Bay	55,770		
Gowrie	60,635	Total	2,239,727

TABLE 9.

NOVA SCOTIA.

COAL :—COAL TRADE BY COUNTIES.

COAL.

Nova Scotia.

Calendar Year, 1895.	Cumberland.		Pictou.		Cape Breton.		Other Counties.	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Rais'd	Sold.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1st quarter..	127,489	111,900	78,677	61,056	136,930	31,189	518	388
2nd " ..	135,950	109,456	106,756	94,846	314,561	283,921	2,678	1,899
3rd " ..	130,976	114,365	147,389	137,365	492,038	504,709	4,381	3,293
4th " ..	147,787	134,799	123,134	111,936	285,617	303,870	4,846	3,277
Totals, 1895	542,202	470,520	455,956	405,203	1,229,146	1,123,689	12,423	8,857
" 1894	605,031	537,605	507,684	453,908	1,324,076	1,286,694	13,581	12,344

TABLE 10.

NOVA SCOTIA.

COAL :—DISTRIBUTION OF COAL SOLD.

Market.	Calendar Years.		
	1893.	1894.	1895.
	Tons.	Tons.	Tons.
Nova Scotia, transported by land.........	453,611	418,123	388,625
" " sea..........	316,883	338,121	307,196
Total, Nova Scotia.......... ...	779,494	756,244	695,821
New Brunswick..........................	285,669	261,262	248,198
Prince Edward Island	66,961	70,532	73,706
Quebec	959,139	973,617	818,675
Newfoundland	87,347	114,204	86,919
West Indies	1,689	10,743	9,070
United States	28,108	114,686	75,881
Other countries	37	2,005	Nil.
Total..	2,199,444	2,303,293	2,008,270

TABLE 11.

BRITISH COLUMBIA.

COAL.

Production, sales, &c.

COAL:—PRODUCTION, SALES, &C., FOR CALENDAR YEAR 1895.

Name of Colliery.	Coal raised.	Sold for Home Consumption.	Sold for Exportation.	On hand Jan. 1st, 1895.	On hand Jan. 1st, 1896.	Number of Men employed.
	Tons.	Tons.	Tons.	Tons.	Tons.	
Nanaimo.......	378,782	113,287	262,440	4,039	7,094	1,087
Wellington.....	377,334	57,214	330,263	25,692	15,549	1,024
Union..	296,296	40,450	254,390	13,477	14,933	813
Total........	1,052 412	210,951	847,093	43,208	37,576	2,924

TABLE 11a.

BRITISH COLUMBIA.

COAL:—PRODUCTION, SALES, &C., CALENDAR YEAR, 1894.

Name of Colliery.	Coal raised.	Sold for Home Consumption.	Sold for Exportation.	On hand Jan. 1st, 1894.	On hand Jan. 1st, 1895.	Number of Men employed.
	Tons.	Tons.	Tons.	Tons.	Tons.	
Nanaimo.....	441,980	121,396	323,826	7,281	4,039	1,178
Wellington....	422,191	56,185	341,434	1,120	25,692	986
Union...... ..	270,336	8,089	261,699	12,928	13,476	765
Total.......	1,134,507	185,670	926,959	21,329	43,207	2,929

In order to show the standing of British Columbia coal in the California market, the following returns are set forth, for the year ending December 31st, 1895 :—

British Columbia................	651,295	tons.
Australia........	268,960	"
English and Welsh................	201,180	"
Scotch..........	4,098	"
Eastern, Cumberland and Anthracite.	26,863	"
Seattle, Franklin and Green River..	150,888	"
Carbon Hill and South Prairie.....	256,267	"
Mount Diablo and Coos Bay......	84,954	"
Japan, etc....................	9,015	"
Total for the year 1895.....	1,653,520	"
" " 1894.....	1,527,754	"

COKE.

Coke

TABLE 1.

COKE:—ANNUAL PRODUCTION.

Production.

Calendar Year.	Tons.	Value.
1886	35,396	$101,940
1887	40,428	135,951
1888	45,373	134,181
1889	54,539	155,043
1890	56,450	166,298
1891	57,084	175,592
1892	56,135	160,249
1893	61,078	161,790
1894	58,044	148,551
1895	53,356	143,047

TABLE 1a.

COKE:—IMPORTS OF OVEN COKE.

Imports.

Fiscal Year.	Tons.	Value.
1880	3,837	$ 19,353
1881	5,492	26,123
1882	8,157	36.670
1883	8,943	38,588
1884	11,207	44,518
1885	11,564	41,391
1886	11,858	39,756
1887	15,110	56,222
1888	25,487	102,334
1889	29,557	91,902
1890	36,564	133,344
1891	38,533	177,605
1892	43,499	194,429
1893	41,821	156,277
1894	42,864	176,996
1895 ......Duty free.	43,235	149,434

C PPER.

COPPER.

Production.

TABLE 1.

COPPER:—ANNUAL PRODUCTION.

Calendar Year.	Pounds.	Value.
1886	3,505,000	$354,000
1887	3,260,424	342,345
1888	5,562,864	667,543
1889	6,809,752	885,424
1890	6,013,671	902,050
1891	8,928,921	1,160,760
1892	7,087,275	826,849
1893	8,109,856	875,865
1894	7,737,016	735,017
1895	8,789,162	949,229

Exports.

TABLE 1a.

COPPER:—EXPORTS, OF COPPER IN ORE MATTE, ETC.

Calendar Year.	Nova Scotia.	Ontario.	Quebec.	British Columbia.	Total.
1885			$262,600		$262,600
1886		$ 16,404	232,855		249,259
1887		3,416	134,550		137,966
1888			257,260		257,260
1889			168,457		168,457
1890		2,219	396,278		398,497
1891		64,719	283,385		348,104
1892	$100	79,141	198,391		277,632
1893		212,314	56,846		269,160
1894		25,029	12,005	54,883	91,917
1895		123,997	15,692	97,276	236,965

TABLE 2.

COPPER:—IMPORTS OF PIGS, OLD, SCRAP, ETC.

COPPER.

Imports.

Fiscal Year.	Pounds.	Value.
1880	31,900	$ 2,130
1881	9,800	1,157
1882	20,200	1,984
1883	124,500	20,273
1884	40,200	3,180
1885	28,600	2,016
1886	82,000	6,969
1887	40,100	2,507
1888	32,300	2,322
1889	32,300	3,288
1890	112,200	11,521
1891	107,800	10,452
1892	343,600	14,894
1893	168,300	16,331
1894	101,200	7,397
1895 { Copper, old and scrap .... Duty free.	59,900	5,180
1895 { Copper in pigs .... do	7,100	1,167
1895 { Precipitate of copper, crude .... do	5,062	423
Total, 1895	72,062	$ 6,770

Copper.

Imports.

TABLE 3.

COPPER:—IMPORTS OF MANUFACTURES.

Fiscal Year.	Value.
1880	$123,061
1881	159,163
1882	220,235
1883	247,141
1884	134,534
1885	181,469
1886	219,420
1887	325,365
1888	303,459
1889	402,216
1890	472,668
1891	563,522
1892	422,870
1893	458,715
1894	175,404

Fiscal Year.		Duty.	Pounds.	Value.
1895	Copper, ingots, sheets, plates and sheathing, not planished or coated	Free.	1,299,800	$140,320
	Copper nails, rivets and burrs	30 p. c.		1,414
	" wire	15 "		51,403
	" wire-cloth	20 "		1,213
	" all other manufactures of, N.E.S.	30 "		30,075
	" seamless drawn tubing	Free.		12,539
	" in bars, rods and bolts in lengths not less than 6 feet	"		14,651
	Total, 1895			$251,615

GRAPHITE.

GRAPHITE

TABLE 1.

GRAPHITE:—PRODUCTION.

Production

Calendar Year.	Tons.	Value.
1886	500	$4,000
1887	300	2,400
1888	150	1,200
1889	242	3,160
1890	175	5,200
1891	260	1,560
1892	167	3,763
1893	nil.	nil.
1894*	69	223
1895	220	6,150

* Exports.

TABLE 2.

GRAPHITE:—EXPORTS.

Exports.

Calendar Year.	New Brunswick.		Ontario.		Quebec.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
1886	8,142	$3,586	....	....	....	....
1887	6,294	3,017	....	....	....	....
1888	2,700	1,080	....	....	....	....
1889	660	422	22	$116	....	....
1890	400	160	329	1,369	....	....
1891	464	72	....	....	....	....
1892	1,224	449	15	60	4,590	$3,443
1893	....	....	12	38	....	....
1894	....	....	69	223	....	....
1895	1	8	1,087	4,825	....	....

GRAPHITE.

Imports.

TABLE 3.

GRAPHITE:—IMPORTS OF RAW AND MANUFACTURED PLUMBAGO.

Fiscal Year.		Plumbago.	Manufactures of plumbago.	Black-lead.
1880		$1,677	$2,738	$18,055
1881		2,479	1,202	26,544
1882		1,028	2,181	25,132
1883		3,147	2,141	21,151
1884		2,891	2,152	24,002
1885		3,729	2,805	24,487
1886		5,522	1,408	23,211
1887		4,020	2,830	25,766
1888		3,802	22,604	7,824
1889		3,546	21,789	11,852
1890		3,441	26,605	10,276
1891		7,217	26,201	8,292
1892		2,988	23,085	13,560
1893		3,293	23,051	16,595
1894		2,177	16,686	17,614
	Duty.			
1895 Plumbago, crude	10 p.c.	$2,586		
1895 Black-lead	25 "	......	$13,922	
1895 Plumbago, manufactures of N.E.S.	25 "	......	16,361	
1895 Plumbago crucibles	Free	......	5,627	
Total, 1895	......	$2,586	$35,910	

GYPSUM.

GYPSUM.

Production.

TABLE 1.

GYPSUM:—PRODUCTION.

Calendar Year.	Tons.	Value.
1886	162,000	$178,742
1887	154,008	157,277
1888	175,887	179,393
1889	213,273	205,108
1890	226,509	194,033
1891	203,605	206,251
1892	241,048	241,127
1893	192,568	196,150
1894	223,631	202,031
1895	226,178	202,608

GYPSUM.

Production.

TABLE 2.

GYPSUM:—PRODUCTION BY PROVINCES, CALENDAR YEAR, 1895.

Provinces.	Tons.	Value.
Nova Scotia......	156,809	$133,929
New Brunswick	66,949	63,839
Ontario	2,420	4,840
Total....	226,178	$202,608

Exports.

TABLE 3.

GYPSUM:—EXPORTS OF CRUDE GYPSUM.

Calendar Years	Ontario.		Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1874	......	....	67,830	$ 68,164	....	....	67,830	$ 68,164
1875	......	....	86,065	86,193	5,420	$ 5,420	91,485	91,613
1876	120	$ 180	87,720	87,590	4,925	6,616	92,765	94,386
1877	.....	....	106,950	93,867	5,030	5,030	111,980	98,897
1878	489	675	88,631	76,695	16,335	16,435	105,455	93,805
1879	579	720	95,623	71,353	8,791	8,791	104,993	80,864
1880	875	1,240	125,685	111,833	10,375	10,987	136,935	124,060
1881	657	1,040	110,303	100,284	10,310	15,025	121,270	116,349
1882	1,249	1,946	133,426	121,070	15,597	24,581	150,272	147,597
1883	462	837	145,448	132,834	20,242	35,557	166,152	169,228
1884	688	1,254	107,653	100,446	21,800	32,751	130,141	134,451
1885	525	787	81,887	77,898	15,140	27,730	97,552	106,415
1886	350	538	118,985	114,116	23,498	40,559	142,833	155,213
1887	225	337	112,557	106,910	19,942	39,295	132,724	146,542
1888	670	910	124,818	120,429	20	50	125,508	121,389
1889	483	692	146,204	142,850	31,495	50,862	178,182	194,404
1890	205	256	145,452	139,707	30,034	52,291	175,691	192,254
1891	5	7	143,770	140,438	27,536	41,350	171,311	181,795
1892	.....	....	162,372	157,463	27,488	43,623	189,860	201,086
1893	......	....	132,131	122,556	30,061	36,706	162,192	159,262
1894	...	....	119,569	111,586	40,843	46,538	160,412	158,124
1895	....	....	133,369	125,651	56,117	67,593	189,486	193,244

GYPSUM.

Imports.

TABLE 4.

GYPSUM:—IMPORTS OF CRUDE GYPSUM.

Fiscal Year.	Tons.	Value.
1880	1,854	$3,203
1881	1,731	3,442
1882	2,132	3,761
1883	1,384	3,001
1884	....	3,416
1885	1,353	2,354
1886	1,870	2,429
1887	1,557	2,492
1888	1,236	2,193
1889	1,360	2,472
1890	1,050	1,928
1891	376	640
1892	626	1,182
1893	496	1,014
1894	....	1,660
1895 .... Duty free..	603	960

Imports.

TABLE 5.

GYPSUM:—IMPORTS OF GROUND GYPSUM.

Fiscal Year.	Pounds.	Value.
1880	1,606,578	$ 5,948
1881	1,544,714	4,676
1882	759,460	2,576
1883	1,017,905	2,579
1884	687,432	1,936
1885	461,400	1,177
1886	224,119	675
1887	13,266	73
1888	106,068	558
1889	74,390	372
1890	434,400	2,136
1891	36,500	215
1892	310,250	2,149
1893	140,830	442
1894	23,270	198
1895 .... Duty 15 p.c..	20,700	88

TABLE 6.

GYPSUM. :—IMPORTS OF PLASTER OF PARIS.

GYPSUM.

Imports.

Fiscal Year.	Pounds.	Value.
1880	667,676	$ 2,376
1881	574,006	2,864
1882	751,147	4,184
1883	1,448,650	7,867
1884	782,920	5,226
1885	689,521	4,809
1886	820,273	5,463
1887	594,146	4,342
1888	942,338	6,662
1889	1,173,996	8,513
1890	693,435	6,004
1891	1,035,605	8,412
1892	1,166,200	5,595
1893	552,130	3,143
1894	422,700	2,386
1895 Duty 40c. per 300 lbs.	259,200	1,619

IRON.

IRON.

TABLE 1.

IRON :—PRODUCTION OF ORE, BY PROVINCES, CALENDAR YEAR, 1895.

Production.

Provinces.	Tons.
Nova Scotia	83,792
Quebec	17,783
British Columbia	1,222
Total	102,797

IRON.

Production.

IRON.
ANNUAL PRODUCTION OF ORE.

Table A.

Calendar Year.	Tons.	Value.
1886	69,708	$126,982
1887	76,330	146,197
1888	78,587	152,068
1889	84,181	151,640
1890	76,511	155,380
1891	68,979	142,005
1892	103,248	263,866
1893	125,602	299,368
1894	109,991	226,611
1895	102,797	238,070

TABLE 2.

IRON :—NOVA SCOTIA : ANNUAL PRODUCTION OF ORE.

IRON.

Production.

Calendar Year.	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
1888	42,611
1889	54,161
1890	49,206
1891	53,649
1892	78,258
1893	102,201
1894	89,379
1895	83,792

TABLE 3.

IRON :—EXPORTS OF ORE.

Exports.

Province.	CALENDAR YEARS.							
	1892.		1893.		1894.		1895.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	*10,938	$39,954	1,042	$ 4,083	23	$ 93	....	....
Quebec	203	2,324	....	....	....	13,813	....	....
Nova Scotia	....	....	2	6	....	....	....	....
Manitoba	....	....	30	86	....	....	....	....
British Columbia	1,986	10,802	1,345	3,415	878	7,388	1,571	$ 3,909
Totals	13,127	$52,720	2,419	$ 7,590	....	$21,294	1,571	$ 3,909

* Probably the product of the province of Quebec, shipped via Ontario.

IRON.

Production.

TABLE 4.

IRON :—PIG IRON PRODUCTION : CONSUMPTION OF ORE, FUEL, &c.

Materials made and used.	Calendar Year, 1894.		Calendar Year, 1895.	
	Quantity.	Value.	Quantity.	Value.
Pig iron made............Tons	49,967	$ 646,447	52,454	$ 696,440
Iron ore consumed........ "	108,871	223,861	93,208	218,336
Fuel consu'ed { Charcoal.. Bush.	1,173,970	53,958	789,561	31,582
Fuel consu'ed { Coke ...... Tons	52,373	142,303	48,540	139,475
Fuel consu'ed { Coal..... . "	7,653	14,571	3,089	5,396
Flux consumed........... "	35,101	34,347	31,585	29,922

Exports.

TABLE 5.

IRON :—EXPORTS OF IRON AND STEEL GOODS, THE PRODUCE OF CANADA, CALENDAR YEAR, 1895.

Province.	Scrap Iron.	Iron Stoves.	Iron Castings.	Iron, all other and hardware.	Steel and manufactures of.	Totals.
	$	$	$	$	$	$
Ontario..	845	17,902	4,178	12,583	22,105	57,613
Quebec........	702	20,136	2,094	35,768	9,272	67,972
Nova Scotia	1,263	876	....	14,865	22,422	39,426
New Brunswick...........	5	475	1,300	1,354	....	3,134
Prince Edward Island......	....	255	....	45	....	300
Manitoba	114	37	....	28	674	853
North-west Territories......	....	....	321	......	2,648	2,969
British Columbia..........	....	....	2,051	367	93	2,511
Totals................	$2,929	$39,681	$9,944	$65,010	$57,214	$174,778

IRON.

Imports.

TABLE 6.

IRON :—IMPORTS OF IRON, PIG, SCRAP, ETC.

Fiscal Year.	Pig Iron.		Charcoal Pig Iron.		Old and Scrap Iron.		Wrought Scrap and Scrap Steel.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1880	23,159	(a) 371,956	....	....	928	14,042	....	....
1881	43,630	(a) 715,997	....	....	584	8,807	....	....
1882	56,594	811,221	6,837	211,791	1,327	20,406	....	....
1883	75,295	1,085,755	2,198	58,994	709	7,776	....	....
1884	49,291	653,708	2,893	66,602	3,136	44,223	....	....
1885	42,279	545,426	1,119	27,333	3,552	46,275	....	....
1886	42,463	528,483	3,185	60,086	10,151	158,100	....	....
1887	46,295	554,388	3,919	77,420	17,612	220,167	(b) 79	1,086
	Pig Iron, &c. (c)							
	Tons.	Value.						
		$						
1888	48,973	648,012	....	....	....	....	23,293	297,496
1889	72,115	864,752	....	....	....	....	26,794	335,090
1890	87,613	1,148,078	....	....	....	....	47,846	678,574
1891	81,317	1,085,929	....	....	....	....	43,967	652,842
1892	68,918	886,485	....	....	....	....	32,627	433,695
	Pig Iron.		Charcoal Pig Iron.		Cast Scrap Iron.			
	Tons.	Value.	Tons.	Value.	Tons.	Value.		
		$		$		$		
1893	56,849	682,209	5,944	84,358	729	9,317	45,459	574,809
1894	42,376	483,787	2.906	34,968	78	771	30,850	369,682
1895	(d) 31,637	341,259	2,780	31,171	643	4,347	(e)23,390	244,388

(a) Comprises pig iron of all kinds.

(b) From 13th May only.

(c) These figures appear in Customs reports under heading "Iron in pigs, iron kentledge and cast scrap iron."

(d) Includes iron kentledge.

(e) Scrap-iron and scrap-steel, old, and fit only to be re-manufactured, being part of or recovered from any vessel wrecked in waters subject to the jurisdiction of Canada. Duty—Free.

Wrought scrap-iron and scrap-steel, being waste or refuse fit only to be re-manufactured, the same having been in actual use, not to include cuttings or chippings which can be used as iron or steel without re-manufacture, and steel bloom ends and crop ends of steel rails. Duty—$3 per ton to 1st January, 1895, after that $4 per ton.

Iron or steel, being pieces, punchings or clippings of boiler plate or other plates, sheets or bars of iron or steel, whether the same have had the ragged or cropped ends or edges sheared off or not, and crops from iron or steel rails having both ends sawn or sheared off, the same not having been in actual use and being fit for re-rolling or re-manufacturing only. Duty—$4 per ton.

IRON.

Imports.

TABLE 7.

IRON :—IMPORTS OF FERRO-MANGANESE, ETC.

Fiscal Year.	Duty.	Tons.	Value.
*1887		123	$ 1,435
*1888		1,883	29,812
*1889		5,868	72,108
*1890		696	18,895
*1891		2,707	40,711
*1892		1,311	23,930
*1893		529	15,858
*1894		284	9,885
1895 { Ferro-silicon, spiegeleisen and ferro-manganese	5 p. c.	164	$5,408
1895 { Steel-chrome	15 p. c.	29	3,106
Total 1895		193	$8,514

*These amounts include :—ferro-manganese, ferro-silicon, spiegel, steel bloom ends, and crop ends of steel rails, for the manufacture of iron or steel.

TABLE 8.

IRON :—IMPORTS : IRON IN SLABS, BLOOMS, LOOPS AND PUDDLED BARS, ETC.*

Fiscal Year.	Cwt.	Value.
1880	195,572	$244,601
1881	111 666	111,374
1882	203,888	222,056
1883	258,639	269,818
1884	252,310	264,045
1885	312.329	287,734
1886	273,316	248,461
1887	522,853	421,598
1888	110,279	93,377
1889	80,383	67,181
1890	15,041	45,923
1891	41,567	38,931
1892	64,397	56,186
1893	65,269	58,533
1894	50,891	45,018
1895. Duty $5 per ton	78,639	67,321

*Iron in slabs, blooms, billets, loops, puddle bars, or other forms less finished than iron in bars, and more advanced than pig iron, except castings.

The following tables Nos. 9*a* and 9*b* are meant to replace, for the year under review, a table used in previous reports of the Section which merely gave the total of the imports of iron and steel goods. The items now furnished are taken from the Trade and Navigation returns, but are so arranged as to illustrate the material from which the compilations in this particular were made in past years. The classification here attempted is, however, only intended to show roughly the distinction between articles partially manufactured or the result of first processes, and those of a more highly finished character. IRON.

TABLE 9*a*.

IRON:—IMPORTS OF IRON AND STEEL GOODS. Imports.

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Swedish rolled iron rods, under ½ inch in diameter and not less than 1¾c. per lb. value	Cwt.	15 p. c.	2,260	$ 4,887
Swedish rolled iron nail rods under half an inch in diameter, for manufacture of horse-shoe nails	"	15 "	12,564	21,348
Switches, frogs, crossings and intersections for railways	"	30 "	741	3,230
Steel rails weighing not less than 45 lbs. per lineal yard, for use in railway tracks	"	Free.	972,578	838,144
Iron or steel railway bars or rails of any form, punched or not punched, N.E.S., for railways which term for the purposes of this item shall include all kinds of railways, street railways and tramways, even although the same are used for private purposes only, and even although they are not used or intended to be used in connection with the business of common carrying of goods or passengers	Tons.	30 p. c.	4,660	94,858
Railway fish-plates and tie-plates	"	$10 per ton	2,174	50,412
Rolled iron or steel angles, channels, and other sections, weighing less than 35 lbs. per lineal yard, N.E.S.	Cwt.	35 p. c. but not less than $10 per ton.	29,084	33,857
Rolled iron or steel angles, channels, and special sections, weighing less than 35 lbs. per lineal yard	"	12½ p. c.	137,312	156,458
Rolled iron or steel beams, joists, girders, column sections, trough sections, and other building or bridge structural sections, weighing not less than 25 lbs. per lineal yard and rolled iron or steel bridge plate not less than ⅜ of an inch thick or less than 15 inches wide, and flat eye bar blanks not punched or drilled	"	12½ "	52,328	59,312
Carried forward				$1,262,506

TABLE 9a—*Continued.*

IRON.

Imports.

IRON :—IMPORTS OF IRON AND STEEL GOODS—*Continued.*

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Brought forward				$1,262,506
Iron or steel beams, sheets, plates, angles and knees for iron, steel or composite ships or vessels	Cwt.	Free	22,994	22,462
Locomotive and car-wheel tires of steel in the rough	"	"	8,971	24,947
Bar iron, rolled or hammered, comprising rounds, squares, shapes of rolled iron not more than four inches in diameter, and flats not thinner than No. 16 gauge, whether in coils, bundles, rods or bars, N.E.S.	"	$10 per ton	100,696	170,331
Iron or steel plates or sheets, sheared or unsheared, and skelp iron or steel, sheared or rolled in grooves, and iron or steel of all widths thicker than No. 17 gauge, N.E.S.	"	$10 per ton	33,689	56,121
Iron bridges and structural iron work.	Lbs.	30 p. c. but not less than 1 c. per lb.	377,655	13,440
Hoop iron, not exceeding three eighths of an inch in width and being No. 25 gauge or thinner, used for the manufacture of tubular rivets	Cwt.	Free	22,105	23,811
Iron or steel hoops, bands and strips, 8 inches and less in width, No. 18 gauge and thicker	"	$10 per ton	18,936	26,233
Iron or steel sheets, or other iron or steel of all widths, sheet iron, common or black, smoothed polished, coated or galvanized and Canada plates, No. 17 gauge and thinner and hoop, band or strip, iron or steel, N.E.S	"	5 p. c.	355,972	707,974
Plough plates, mould boards, land sides and other plates for agricultural implements, when cut to shape from rolled plates of steel but not moulded, punched, polished or otherwise manufactured, and being of a greater value than 4 cts. a lb.	"	5 "	5,371	19,492
Steel, valued at 2½ cts. per lb. and upwards, for manufacture of skates.	"	Free	1,894	6,144
Steel for saws and straw cutters, cut to shape but not further manufactured	"	"	8,106	72,530
Steel for the manufacture of hammers, augers and auger bits, when imported by the manufacturers of such articles, for use in their factories only	"	"	1,949	3,983
Steel of Nos. 24 and 17 gauge, in sheets 63 inches long and from 18 inches to 32 inches wide, for the manufacture of tubular bow sockets, when imported by the manufacturers of such articles, for use in their own factories only	"	"	329	764
Carried forward				$2,410,738

TABLE 9a—*Concluded.*

IRON:—IMPORTS OF IRON AND STEEL GOODS—*Concluded.*

IRON.

Imports.

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Brought forward......				$2,410,738
Crucible sheet steel, 11 to 16 gauge, 2½ to 18 inches wide, imported by manufacturers of mower and reaper knives for manufacture of such knives in their own factories	Cwt.	Free.............	4,619	13,840
Steel, rolled rods of, under ½-inch in diameter, or under ½-inch square, imported by knob or lock manufacturers or cutlers for use exclusively in such manufactures in their own factories..	"	"	229	752
Steel of No. 20 gauge, and thinner, but not thinner than No. 30 gauge, to be used in the manufacture of corset steels, clock springs, and shoe shanks; and flat wire of steel of No. 16 gauge or thinner to be used in the manufacture of crinoline or corset wire and dress stays, when imported by the manufacturers of such articles for use in their factories..........	"	"	3,309	16,753
Steel of No. 12 gauge and thinner, but not thinner than No. 30 gauge, imported by manufacturers of buckle clasps and ice-creepers.....	"	"	260	1,207
Steel for the manufacture of files, when imported by file manufacturers for use in their factories......	"	"	2,774	9,252
Steel ingots, cogged ingots, blooms and slabs, or other forms less finished than steel bars, N.E.S....	"	$5 per ton	20,736	18,645
Steel, bars rolled or hammered comprising rounds and squares, shapes of rolled steel not more than 4 inches in diameter, and flats not thinner than No. 16 gauge, whether in coils, bundles, rods or bars, N.E.S....	"	$10 "	118,997	223,021
Steel plate, universal mill or rolled edge, less than thirty inches wide, and plates or sheets of iron or steel thirty inches wide and over, and one-quarter of an inch and over in thickness..........	"	12½ p.c..........	186,457	99,845
Malleable iron castings and iron or steel castings, N.E.S........	"	25 "	22,942	71,264
Iron sand or globules and dry putty for polishing glass or granite......	"	Free............	393	1,300
Rolls of chilled iron or steel.........	"	35 p.c........	1,215	4,852
Total............				$2,871,469

TABLE 9b.

IRON.

IRON :—IMPORTS OF IRON AND STEEL GOODS.

Imports.

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Wire, covered with cotton, linen, silk or other material	Lbs.	30 p. c.	621,309	$50,652
Wire, galvanized-iron, No. 6, 9, 12 and 14 gauge, when imported by makers of wire fencing, for use in their factories only	Cwt.	20 "	56,032	88,147
Steel wire, Bessemer soft drawn spring, of Nos. 10, 12 and 13 gauge, respectively, and homo steel spring wire of Nos. 11 and 12 gauge, respectively, when imported by manufacturers of wire mattresses, to be used in their own factories in the manufacture of such articles	"	Free	2,676	8,192
Wire of all kinds, N.E.S.	"	25 p. c	112,801	110,759
Wire rope, of iron or steel, N.O.P	"	25 "	4,300	32,228
Wire, crucible cast-steel	Lbs.	Free	316,017	22,592
Wire of iron or steel, No. 13 and 14 gauge, flattened and corrugated, used in connection with the wire grip and champion nailing machines for the manufacture of boots and shoes and leather belting	"	"	115,504	3,832
Wire rigging for ships and vessels	Cwt.	"	2,751	13,777
Wire fencing, barbed, of iron or steel	Lbs.	$\frac{3}{4}$c. per lb.	826,299	17,273
Wire fencing, buckthorn, and strip of iron or steel	"	$\frac{1}{2}$c. "	46,569	1,558
Bar and round rods, galvanized	"	$27\frac{1}{2}$ p. c.	163	466
Chains, iron or steel, $\frac{5}{16}$ of an inch in diam. and over	Cwt.	5 p. c.	19,149	51,432
Chains, N.E.S	"	$27\frac{1}{2}$ p. c.	20,055	6,659
Forgings of iron and steel, of whatever shape or size, or in whatever stage of manufacture, N.E.S.	Lbs.	35 p. c. but not less than $15 per ton.	510,672	21,713
Nails, spikes and sheathing nails, composition	"	15 p. c.	54,245	6,020
Nails and spikes, wrought and pressed, galvanized or not, horseshoe nails, and all wrought-iron or steel and other nails, N.E.S., and horse, mule and ox-shoes	"	30 "	444,432	16,264
Nails and spikes, cut, including railway spikes	"	$\frac{3}{4}$c. per lb.	428,885	8,814
Nails, wire	"	1c. "	375,253	8,072
Tacks, shoe, $\frac{1}{2}$ oz. to 4 oz. to the thousand	M.	1c. per M.	6,611	210
Cut tacks, brads or sprigs, not exceeding 16 oz. to the thousand	"	$1\frac{1}{2}$c. "	62,666	2,918
Cut tacks, exceeding 16 oz. to the thousand	Lbs.	$1\frac{1}{2}$c. per lb.	15,866	904
Wrought iron or steel nuts and washers, iron or steel rivets, bolts with or without threads, nuts and bolt blanks, T and strap hinges and hinge blanks, N.E.S.	"	1c. per lb. and 20 p.c.	866,751	31,307
Carried forward				$503,789

TABLE 9b—*Continued.*

IRON :—IMPORTS OF IRON AND STEEL GOODS—*Continued.*

IRON.

Imports.

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Brought forward				$503,789
Wrought-iron or steel nuts and washers, iron or steel rivets, bolts with or without threads, nut and bolt blanks, less than three-eighths of an inch in diameter	Lbs.	1c. per lb. and 25 p. c., but not less than 35 per cent.	116,621	8,211
Screws, iron and steel, commonly called "wood screws":—				
2 inches and over in length	"	3c. per lb. but not less than 35 p. c.	5,585	682
1 inch and less than 2 inches	"	6c. per lb. but not less than 35 p. c.	16,758	1,729
Less than 1 inch	"	8c. per lb. but not less than 35 p. c.	3,039	543
Tubing—				
Boiler tubes of wrought iron or steel, including corrugated tubes or flues for marine boilers	Feet.	7½ p. c.	1,491,966	86,257
Lap-welded iron or steel tubing, threaded and coupled or not, one and one-quarter to two inches inclusive in diameter, for use exclusively in artesian wells, petroleum pipe lines, and petroleum refineries	"	20 "	379,569	20,053
Tubes, not welded, not more than 1½ inches in diameter, of rolled steel	"	15 "	217,641	23,820
Tubing, wrought-iron or steel, threaded and coupled or not, over 2 inches in diameter	"	15 "	1,777,822	184,816
Other wrought-iron or steel tubes or pipes	Lbs.	$\frac{5}{10}$c. per lb. & 30 p.c.	7,403,518	156,508
Rolled iron tubes not welded, under 1½-inch in diameter, angle iron 9 and 10 gauge, not over 1½-inch wide, iron tubing lacquered or brass covered, not over 1½ inch diameter, all of which are to be cut to lengths for the manufacture of bed-steads, and to be used for no other purpose, when imported for the manufacturers of iron bed-steads to be used for these purposes only, in their own factories	Cwt.	Free	831	1,478
Cast iron pipes of every description	"	$10 per ton but not less than 35 p. c.	53,241	60,409
Fittings of wrought iron or steel pipe	Lbs.	35 p. c.	1,263,875	51,384
Tools and implements—				
Axes of all kinds, N.E.S	Doz.	35 "	2,079	11,593
Saws	$	32½ "		74,309
Carpenters', coopers', cabinetmakers', and all other mechanics' tools, N.E.S	"	35 "		216,573
Files and rasps	"	35 "		62,823
Carried forward				$1,464,977

TABLE 9b—*Continued.*

IRON.

IRON :—IMPORTS OF IRON AND STEEL GOODS.—*Continued.*

Imports.

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Brought forward				$1,464,977
Picks, mattocks, grub hoes, hatchets and eyes or poles for same	$	35 p. c.		5,268
Tools of all descriptions, N.E.S.	"	35 "		30,943
Track tools, wedges, crow-bars and sledges	"	30 "		8,527
Knife blades, or knife blanks, in the rough for use by electroplaters	"	10 "		2,105
Manufactured articles or wares not specially enumerated or provided for, composed wholly or in part of iron or steel, and whether partly or wholly manufactured	"	27½ "		563,342
Pen knives, jack knives, and pocket knives of all kinds	"	25 "		61,640
Table cutlery, N.E.S	"	32½ "		55,309
All other cutlery, N.E.S	"	25 "		91,075
Muskets, rifles, and other fire arms	"	20 "		113,643
Needles, sewing machine, and all other, N.O.P	"	30 "		30,632
Needles, knitting	"	30 "		6,439
Surgical and dental instruments	"	15 "		38,684
Forks, table, cast iron, not handled, ground or otherwise manufactured.	No.	10 "	83,400	542
Hardware, viz. : Builders', cabinet-makers', upholsterers', harness makers' and saddlers' including curry combs, carriage hardware, &c.	$	32½ "		297,360
Hardware, N.E.S.	"	32½ "		4,036
Scales, balances and weighing beams.	"	30 "		21,888
Skates, of all kinds	Pairs.	10c. per pair and 30 p. c.	18,317	7,997
Stoves	$	27½ p. c.		37,000
Butts and hinges, N.E.S	"	32½ "		12,161
Cast iron vessels, plates, stoves plates and irons, sad irons, hatters' irons, tailors' irons	"	27½ "		22,089
Locks of all kinds	"	32½ "		56,405
Safes, and doors for safes and vaults.	"	30 "		4,296
Ware—stamped tinware, japanned ware, galvanized-iron ware, including signs made from these materials	"	25 "		21,541
Ware, enamelled iron or steel ware, including signs and letters enamelled on any metal and granite or agate ware	"	35 "		128,050
Machines and machinery, &c. :—				
Windmills	No.	30 "	332	19,008
Fanning mills	"	35 "	6	80
Portable machines :				
Horse-powers	"	30 "	65	8,206
Portable steam-engines	"	30 "	89	17,299
Portable saw-mills and planing mills	"	30 "	199	7,530
Threshers and separators	"	30 "	80	12,781
Parts of above articles	$	30 "		29,620
Sewing-machines, or parts of	No.	30 "	4,907	111,991
Machines, type-writing	"	27½ "	977	44,535
Carried forward				$3,336,999

TABLE 9b—*Concluded.*

IRON :—IMPORTS OF IRON AND STEEL GOODS—*Concluded.*

IRON.

Imports.

Fiscal Year, 1895.		Duty.	Quantity.	Value.
Brought forward				$3,336,999
Portable machines, other, N.E.S.	No.	30 p. c.	27	9,435
All other machinery composed wholly or in part of iron or steel, N.E.S.	$	27½ "		990,252
Agricultural implements, N. E. S., viz.:				
Binding attachments	No.	20 "	16	566
Cultivators	"	20 "	1,796	12,283
Drills, grain seed	"	20 "	1,235	15,825
Forks, pronged	"	35 "	13,277	3,697
Harrows	"	20 "	1,819	15,418
Harvesters, self-binding and without binders	"	20 "	1,045	82,094
Hoes	"	35 "	2,335	617
Horse rakes	"	20 "	295	4,450
Knives, hay	"	35 "	37	11
Lawn mowers	"	35 "	183	1,027
Mowing-machines	"	20 "	1,451	48,113
Ploughs, sulky and walking	"	20 "	1,661	29,814
Rakes, N.E.S.	"	35 "	10,136	2,411
Reapers	"	20 "	19	952
Scythes	Doz.	35 "	4,938	23,296
Spades and shovels and spade and shovel blanks, and iron or steel cut to shape for the same	"	50c. per doz. and 25 p. c.	6,136	23,396
Parts of agricultural implements		20 p. c.		5,229
Steel bowls, for cream separators	$	Free		29,333
All other agricultural tools or implements, N.E.S	$	35 p. c.		22,023
Axles, springs and parts thereof, axle bars and axle blanks of iron or steel, N.E.S.	Lbs.	1c. per lb. and 20 p. c.	244,898	12,128
Axles, springs and parts thereof, axle bars and axle blanks of iron or steel, for railway or tram-way vehicles	Cwt.	$20 per ton but not less than 35 p. c.	6,803	17,140
Engines, locomotives for railways	No.	35 p. c.	20	146,211
Fire	"	35 "	8	5,503
Other, and boilers, N.E.S	$	27½ "		30,133
Fire extinguishers	"	35 "		3,107
Pumps, N.E.S	"	30 "		66,426
Pumps, steam	No.	30 "	149	23,178
Mining and smelting machinery, which is at the time of its importation of a class or kind not manufactured in Canada.	$	Free		169,749
		Total		$5,130,816

IRON.

Imports.

TABLE 10.

IMPORTS OF PIG IRON, IRON AND STEEL GOODS, &c., CALENDAR YEAR, 1895.
RECAPITULATION OF TABLES, 6, 7, 8, 9a AND 9b.

—	Tons.	Value.
		$
Pig iron and iron kentledge	31,637	341,259
" charcoal	2,780	31,171
Scrap iron, cast	643	4,347
" steel, wrought	23,390	244,388
Ferro-manganese, &c	193	8,514
Iron in slabs, blooms, puddled bars, &c	78,639	67,321
Iron and steel goods, manufactured	....	2,871,469
" highly manufactured *	....	5,130,816
Total	....	$8,699,285

* Machinery, &c., classed under iron and steel goods, in Customs report.

LEAD.

Production.

LEAD.

TABLE 1.

LEAD :—PRODUCTION.

Calendar Year.	Pounds.	Value.
1890	113,000	$ 5,805
1891	588,665	25,607
1892	1,768,420	72,505
1893	2,135,023	78,966
1894	5,703,222	185,355
1895	23,075,892	749,966

LEAD. Imports.

TABLE 2.

LEAD :—IMPORTS OF LEAD.

Fiscal Year.	Old, Scrap and Pig.		Bars, Blocks, Sheets.		Total.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
1880	....	....	....	....	30,298	$124,117
1881	16,236	$ 56,919	18,222	$70,744	34,458	127,663
1882	36,655	120,870	10,540	35,728	47,195	156,598
1883	48,780	148,759	8,591	28,785	57,371	177,544
1884	39,409	103,413	9,704	28,458	49,113	131,871
1885	36,106	87,038	9,362	24,396	45,468	111,434
1886	39,945	110,947	9,793	28,948	49,738	139,895
1887	61,160	173,477	14,153	41,746	75,313	215,223
1888	68,678	196,845	14,957	45,900	83,635	242,745
1889	74,223	213,132	14,173	43,482	88,396	256,614
1890	101,197	283,096	19,083	59,484	120,280	342,580
1891	86,382	243,033	15,646	48,220	102,028	291,253
1892	97,375	254,384	11,299	32,368	108,674	286,752
1893	94,485	215,521	12,403	32,286	106,888	247,807
1894	70,223	149,440	8,486	20,451	78,709	169,891
1895	*67,261	139,290	†6,739	16,315	74,000	155,605

* Duty 40c. per 100 lbs. † Duty 60c. per 100 lbs.

TABLE 3.

LEAD :—IMPORTS OF LEAD MANUFACTURES.

Fiscal Year.		Value.
1880		$15,400
1881		22,629
1882		17,282
1883		25,556
1884		31,361
1885		36,340
1886		33,078
1887		19,140
1888		18,816
1889		16,315
1890		25,600
1891		23,893
1892		22,636
1893		33,783
1894		29,361
	Duty.	
1895. Lead, Tea	Free	$ 1,574
1895. " Pipe	$\frac{4}{10}$c. per lb. and 25 p. c.	1,284
1895. " Shot	" " " "	1,832
1895. " Manufactures, N.E.S.	30 p. c	33,325
	Total	$38,015

MANGANESE.

MANGANESE.

Production.

TABLE 1.

MANGANESE :—PRODUCTION.

Calendar Year.	Tons.	Value.
1886	1,789	$41,499
1887	1,245	43,658
1888	1,801	47,944
1889	1,455	32,737
1890	1,328	32,550
1891	255	6,694
1892	115	10,250
1893	213	14,578
1894	74	4,180
1895	125	8,464

Exports.

TABLE 2.

MANGANESE :—EXPORTS OF MANGANESE ORE.

CALENDAR YEARS.	NOVA SCOTIA.		NEW BRUNSWICK.		TOTAL.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1873	....	....	1,031	$20,192	1,031	$20,192
1874	6	$ 12	776	16,961	782	16,973
1875	....	200	194	5,314	203	5,514
1876	21	723	391	7,316	412	8,039
1877	106	3,699	785	12,210	891	15,909
1878	106	4,889	520	5,971	626	10,860
1879	154	7,420	1,732	20,016	1,886	27,436
1880	79	3,090	2,100	31,707	2,179	34,797
1881	200	18,022	1,504	22,532	1,704	40,554
1882	123	11,520	771	14,227	894	25,747
1883	313	8,635	1,013	16,708	1,326	25,343
1884	134	1,054	469	9,035	603	20,089
1885	77	5,054	1,607	29,595	1,684	34,649
1886	(*a*) 441	854	1,377	27,484	(*a*)1,818	58,338
1887	578	14,240	837	20,562	1,415	34,802
1888	87	5,759	1,094	16,073	1,181	21,832
1889	59	3,024	1,377	26,326	1,436	29,350
1890	177	2,583	1,729	34,248	1,906	36,831
1891	22	563	233	6,131	255	6,694
1892	84	6,180	59	2,025	143	8,205
1893	123	12,409	10	112	133	12,521
1894	11	720	45	2,400	56	3,120
1895	108	6,348	$\frac{3}{10}$	3	$108\frac{3}{10}$	6,351

(*a*) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

TABLE 3.

MANGANESE:—IMPORTS: OXIDE OF MANGANESE.

MANGANESE.

Imports.

Fiscal Year.	Pounds.	Value.
1884	3,989	$ 258
1885	36,778	1,794
1886	44,967	1,753
1887	59,655	2,933
1888	65,014	3,022
1889	52,241	2,182
1890	67,452	3,192
1891	92,087	3,743
1892	76,097	3,530
1893	94,116	3,696
1894	101,863	4,522
1895. Duty free.	64,151	2,781

MICA.

MICA.

TABLE 1.

MICA:—PRODUCTION.

Production.

Calendar Year.	Value.
1886	$ 29,008
1887	29,816
1888	30,207
1889	28,718
1890	68,074
1891	71,510
1892	104,745
1893	75,719
1894	45,581
1895	65,000

TABLE 2.

MICA:—EXPORTS.

Exports.

Calendar Year.	Value.
1887	$ 3,480
1888	23,563
1889	30,597
1890	22,468
1891	37,590
1892	86,562
1893	70,081
1894	38,971
1895	48,525

MINERAL PIGMENTS.

MINERAL PIGMENTS.

TABLE 1.

Production of ochres.

MINERAL PIGMENTS:—PRODUCTION OF OCHRES.

Calendar Year.	Tons.	Value.
1887	385	$ 2,233
1888	397	7,900
1889	794	15,280
1890	275	5,125
1891	900	17,750
1892	390	5,800
1893	1,070	17,710
1894	611	8,690
1895	1,339	14,600

TABLE 2.

Imports of ochres.

MINERAL PIGMENTS:—IMPORTS OF OCHRES, &c.

Fiscal Year.	Duty.	Pounds.	Value.
1880		571,454	$ 6,544
1881		677,115	8,972
1882		731,526	8,202
1883		898,376	10,375
1884		533,416	6,398
1885		1,119,177	12,782
1886		1,100,243	12,267
1887		1,460,128	17,067
1888		1,725,460	17,664
1889		1,342,783	12,994
1890		1,394,811	14,066
1891		1,528,696	20,550
1892		1,708,645	22,908
1893		1,968,645	23,134
1894		1,358,326	18,951
1895 Ochres and ochrey earths and raw siennas	20 p. c.	183,900	$ 2,077
1895 Oxides, dry fillers, fire-proofs, umbers and burnt siennas, N.E.S.	25 "	609,358	9,971
Total, 1895		793,258	$12,048

TABLE 3.

MINERAL PIGMENTS:—IMPORTS OF BARYTA.

MINERAL PIGMENTS.

Baryta.

Fiscal Year.	Cwt.	Value.
1880	2,230	$1,525
1881	3,740	1,011
1882	497	303
1883	....	185
1884	....	229
1885	7	14
1886	....	62
1887	379	676
1888	236	214
1889	1,332	987
1890	1,322	978

TABLE 4.

MINERAL PIGMENTS:—MISCELLANEOUS IMPORTS, CALENDAR YEAR, 1895.

Miscellaneous imports.

		Duty.	Quantity.	Value.
Paints, ground or mixed in, or with, either japan, varnish, lacquers, liquid dryers, collodion, oil finish or oil varnish	Lbs.	25 p. c.	37,733	$ 3,189
Paints and colours, and rough stuff and fillers, N.E.S.	"	25 "	96,964	5,712
Paris green, dry	"	10 "	155,009	14,731
Paints and colours ground in spirits, and all spirit varnishes and lacquers	Galls.	$1 per gall.	523	1,791
Putty	Lbs.	15 p. c.	197,077	2,918
Colours, metallic, viz.: Oxides of cobalt, tin and copper, N.E.S.	"	Free	....	1,242
				$ 29,583

MINERAL PIGMENTS.

Litharge.

TABLE 5.

MINERAL PIGMENTS :—IMPORTS OF LITHARGE.

Fiscal Year.	Cwt.	Value.
1880.............	3,041	$14,334
1881........	6,126	22,129
1882........	4,900	16,651
1883.............	1,532	6,173
1884.............	5,235	18,132
1885......	4,990	16,156
1886.............	4,928	16,003
1887............	6,397	21,865
1888............	7,010	23,808
1889.......	8,089	31,082
1890.............	9,453	31,401
1891.............	7,979	27,613
1892.............	10,384	34,343
1893.............	7,685	24,401
1894.............	38,547	28,685
1895...Duty free.	11,955	32,953

MINERAL WATERS.

MINERAL WATERS.

Production.

TABLE 1.

MINERAL WATERS :—PRODUCTION.

Calendar Year.	Gallons.	Value.
1888.................	124,850	$ 11,456
1889.................	424,600	37,360
1890.	561,165	66,031
1891............... .	427,485	54,268
1892.................	640,380	75,348
1893.................	725,096	108,347
1894.................	767,460	110,040
1895.................	739,382	126,048

TABLE 2.

MINERAL WATERS :—IMPORTS.

MINERAL WATERS.

Imports.

Fiscal Year.		Value.
1880		$15,721
1881		17,913
1882		27,909
1883		28,130
1884		27,879
1885		32,674
1886		22,142
1887		33,314
1888		38,046
1889		30,343
1890		40,802
1891		41,797
1892		55,763
1893		57,953
1894		49,546
	Duty.	
1895. { Mineral waters, natural not in bottle	Free	$ 1,237
1895. { Mineral and aerated waters, N.E.S.	20 p. c.	47,376
		$48,613

MISCELLANEOUS.

MISCELLANEOUS.

TABLE 1.

MISCELLANEOUS :—PRODUCTION OF ANTIMONY.

Antimony.

Calendar Year.	Tons.	Value.
1887	584	$10,860
1888	345	3,696
1889	55	1,100
1890	26½	625
1891	10	60
1892	Nil.	Nil.
1893	"	"
1894	"	"
1895	"	"

MISCEL-LANEOUS.

Antimony.

TABLE 2.

MISCELLANEOUS :—EXPORTS OF ANTIMONY ORES.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1880	40	$ 1,948	1886	665	$31,490
1881	34	3,308	1887	229	9,720
1882	323	11,673	1888	352½	6,894
1883	165	4,200	1889	30	695
1884	483	17,875	1890	38	1,000
1885	758	36,250	1891*	3½	60

* No exports since 1891.

TABLE 3

MISCELLANEOUS :—IMPORTS OF ANTIMONY.

Fiscal Year.	Pounds.	Value.
1880	42,247	$ 5,903
1881	....	7,060
1882	183,597	15,044
1883	105,346	10,355
1884	445,600	15,564
1885	82,012	8,182
1886	89,787	6,951
1887	87,827	7,122
1888	120,125	12,242
1889	119,034	11,206
1890	117,066	17,439
1891	114,084	17,483
1892	180,308	17,680
1893	181,823	14,771
1894	139,571	12,249
*1895 .... Duty free	79,707	6,131

* Antimony, not ground, pulverized or otherwise manufactured, and antimony salts.

MISCELLANEOUS. Arsenic.

TABLE 4.

MISCELLANEOUS:—PRODUCTION OF ARSENIC.

Calendar Year.	Tons.	Value.
1885	440	$17,600
1886	120	5,460
1887	30	1,200
1888	30	1,200
1889	Nil.	Nil.
1890	25	1,500
1891	20	1,000
1892	Nil.	Nil.
1893	"	"
1894	7	420
1895	Nil.	Nil.

TABLE 5.

MISCELLANEOUS:—IMPORTS OF ARSENIC.

Fiscal Year.	Pounds.	Value.
1880	18,197	$ 576
1881	31,417	1,070
1882	138,920	3,962
1883	51,953	1,812
1884	19,337	773
1885	49,080	1,566
1886	30,181	961
1887	32,436	1,116
1888	27,510	1,016
1889	69,269	2,434
1890	138,509	4,474
1891	115,248	4,027
1892	302,958	9,365
1893	447,079	12,907
1894	292,505	10,018
1895 ....Duty free..	1,115,697	31,932

Felspar.

TABLE 6.

MISCELLANEOUS:—PRODUCTION OF FELSPAR.

Calendar Year.	Tons.	Value.
1890	700	$3,500
1891	685	3,425
1892	175	525
1893	575	4,525
1894	nil.	nil.
1895	"	"

MISCELLANEOUS.

Fireclay.

TABLE 7.

MISCELLANEOUS:—PRODUCTION OF FIRECLAY.

Calendar Year.	Tons.	Value.
1889	400	$4,800
1890	nil.	nil.
1891	250	750
1892	1,991	4,467
1893	540	700
1894	539	2,167
1895	1,329	3,492

Mercury.

TABLE 8.

MISCELLANEOUS:—IMPORTS OF MERCURY.

Fiscal Year.	Pounds.	Value.
1882	2,443	$ 965
1883	7,410	2,991
1884	5,848	2,441
1885	14,490	4,781
1886	13,316	7,142
1887	18,409	10,618
1888	27,951	14,943
1889	22,931	11,844
1890	15,912	7,677
1891	29,775	20,223
1892	30,936	15,038
1893	50,711	22,998
1894	36,914	14,483
1895....... Duty free.	63,732	25,703

Moulding sand.

TABLE 9.

MISCELLANEOUS:—PRODUCTION OF MOULDING SAND.

Calendar Year.	Tons.	Value.
1887	160	$ 800
1888	169	845
1889	170	850
1890	320	1,410
1891	230	1,000
1892	345	1,380
1893	4,370	9,086
1894	6,214	12,428
1895	6,765	13,530

MISCELLANEOUS.

Platinum.

TABLE 10.

MISCELLANEOUS:—PRODUCTION OF PLATINUM.

Calendar Year.	Value.
1887	$ 5,600
1888	6,000
1889	3,500
1890	4,500
1891	10,000
1892	3,500
1893	1,800
1894	950
1895	3,800

TABLE 11.

MISCELLANEOUS:—IMPORTS OF PLATINUM.

Fiscal Year.	Value.
1883	$ 113
1884	576
1885	792
1886	1,154
1887	1,422
1888	13,475
1889	3,167
1890	5,215
1891	4,055
1892	1,952
1893	14,082
1894	7,151
*1895 ....Duty free.	3,937

* Platinum sheets and wire, and retorts, pans, condensers, tubing and pipe made of platinum, imported by manufacturers of sulphuric acid.

Soapstone.

TABLE 12.

MISCELLANEOUS:—PRODUCTION OF SOAPSTONE.

Calendar Year.	Tons.	Value.
1886	50	$ 400
1887	100	800
1888	140	280
1889	195	1,170
1890	917	1,239
1891	Nil	Nil
1892	1,374	6,240
1893	717	1,920
1894	916	1,640
1895	475	2,138

MISCELLANEOUS.

Tin.

TABLE 13.

MISCELLANEOUS:—IMPORTS OF TIN AND TINWARE.

Fiscal Year.		Duty.	Value.
1880			$ 281,880
1881			413,924
1882			790,285
1883			1,274,150
1884			1,018,493
1885			1,060,883
1886			1,117,368
1887			1,187,312
1888			1,164,273
1889			1,243,794
1890			1,289,756
1891			1,206,918
1892			1,594,205
1893			1,242,994
1894			1,310,389
1895	Tin crystals	Free	$ 1,320
	Tin in blocks, pigs and bars	do	214,397
	Tin plates and sheets	do	681,739
	Tin foil	do	31,489
	Tin strip waste	do	82
	Tin plate in sheets, decorated	25 p.c	788
	Tinware and all manufactures of tin, N.E.S	25 p.c	43,582
			$ 973,397

Whiting.

TABLE 14.

MISCELLANEOUS:—IMPORTS OF WHITING.

Fiscal Year.	Cwt.	Value.
1880	84,115	$26,092
1881	47,480	16,637
1882	36,270	16,318
1883	76,012	29,334
1884	76,268	28,230
1885	67,441	23,492
1886	65,124	25,533
1887	47,246	15,191
1888	76,619	20,508
1889	84,658	22,735
1890	96,243	27,471
1891	84,679	27,504
1892	102,985	26,867
1893	88,835	25,563
1894	103,633	26,649
*1895	102,751	25,441

*Whiting or whitening, gilders' whiting and Paris white.—Duty free.

MISCELLANEOUS.

Chalk.

TABLE 15.

MISCELLANEOUS:—IMPORTS OF CHALK.

Fiscal Year.	Value.
1880	$2,117
1881	2,768
1882	2,88[illegible]
1883	5,067
1884	2,589
1885	8,003
1886	6,583
1887	5,635
1888	5,865
1889	5,336
1890	7,221
1891	8,193
1892	9,558
1893	9,966
1894	11,308
*1895	7,730

*Chalk, prepared.—Duty 20 p.c.

Zinc.

TABLE 16.

MISCELLANEOUS:—IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

Fiscal Year.	Cwt.	Value.
1880	13,805	$67,881
1881	20,920	94,015
1882	15,021	76,631
1883	22,765	94,799
1884	18,945	77,373
1885	20,954	70,598
1886	23,146	85,599
1887	26,142	98,557
1888	16,407	65,827
1889	19,782	83,935
1890	18,236	92,530
1891	17,984	105,023
1892	21,881	127,302
1893	26,446	124,360
1894	20,774	90,680
1895......Duty free..	15,061	63,373

MISCEL-
LANEOUS

Zinc.

TABLE 17.

MISCELLANEOUS :—IMPORTS OF SPELTER.

Fiscal Year.	Cwt.	Value.
1880	1,073	$ 5,310
1881	2,904	12,276
1882	1,654	7,779
1883	1,274	5,196
1884	2,239	10,417
1885	3,325	10,875
1886	5,432	18,238
1887	6,908	25,007
1888	7,772	29,762
1889	8,750	37,403
1890	14,570	71,122
1891	6,249	31,459
1892	13,909	62,550
1893	10,721	49,822
1894	8,423	35,615
*1895	9,249	30,245

* Spelter in blocks and pigs.—Duty free.

TABLE 18.

MISCELLANEOUS :—IMPORTS OF ZINC, MANUFACTURES OF

Fiscal Year.	Value.
1880	$ 8,327
1881	20,178
1882	15,526
1883	22,599
1884	11,952
1885	9,459
1886	7,345
1887	6,561
1888	7,402
1889	7,233
1890	6,472
1891	7,178
1892	7,563
1893	7,464
1894	6,193
1895....Duty, 25 p.c.	5,581

NICKEL.

NICKEL.

TABLE 1.

NICKEL :—PRODUCTION.

Production.

Calendar Year.	Pounds of Nickel in Matte.	Price per lb.	Value.
1890..................	1,435,742	65c.	$ 933,232
1891..................	4,626,627	60c.	2,755,976
1892.........	2,413,717	58c.	1,399,956
1893	3,982,982	52c.	2,071,151
1894....	4,907,430	38⅛c.	1,870,958
1895...........	3,888,525	35c.	1,360,984

TABLE 2.

NICKEL :—EXPORTS.*

Exports.

Calendar Year.	Value.
1890..................................	$ 89,568
1891..................................	667,280
1892..................................	293,149
1893..................................	629,692
1894..................................	559,356
1895..................................	521,783

* Practically all the nickel-bearing ore and matte produced in Canada is exported, the apparent discrepancy between Tables Nos. 1 and 2 being due to the different basis of valuation adopted in the two instances. Table 1 represents the total final values of the nickel produced in Canada, for the years represented. In Table 2 the worth of the product shipped is entered at its spot value to the operators, and depends upon the particular stage to which they happen to carry the process of extraction at the time *e.g.*, whether the shipments made are raw ore, low grade matte or high grade matte, etc.

TABLE 3.

NICKEL :—IMPORTS.

Imports.

Fiscal Year.	Value.
1890	$ 75
1891..................................	62
1892..................................	50
1893..................................	15
1894..................................	3,528
1895..................................	4,267

Petroleum.

PETROLEUM.

Table 1.

Production.

Petroleum:—Production of Canadian Oil Refineries.

Products.	Calendar Years.					
	1893.		1894.		1895.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$
Illuminating oils. galls.	11,100,810	1,073,738	11,289,741	1,003,973	10,711,378	1,217,426
Benzine and naphtha .... "	721,192	54,760	645,031	54,515	642,484	63,026
Paraffine oils..... "	1,243,924	116,233	1,282,749	118,053	1,016,039	140,245
Gas and fuel oils.. "	7,559,489	217,740	7,323,374	197,193	6,095,355	218,692
Lubricating oils and tar........ "	1,876,633	92,616	1,801,174	74,309	1,698,559	75,578
Paraffine wax .... lbs.	1,659,167	120,697	1,950,172	119,091	1,840,021	82,970
Axle grease ..... "	....	....	....	....	....	8,300
Totals........	....	1,675,784	....	1,567,134	....	1,806,237

Table 2.

Consumption.

Petroleum:—Consumption of Crude Oil and Chemicals.

Articles.	Calendar Years.			
	1892.	1893.	1894.	1895.
Crude petroleum........galls.	27,218,812	27,994,805	27,884,080	24,954,855
Sulphuric acid......... lbs.	4,803,301	4,676,353	4,974,610	4,919,271
Soda. .... "	369,857	420,047	430,810	390,781
Litharge.... .... "	434,982	470,666	472,139	390,573
Sulphur.... .... "	73,278	74,012	96,144	78,597

TABLE 3.

PETROLEUM:—CANADIAN OILS AND NAPHTHA INSPECTED AND CORRESPONDING QUANTITIES OF CRUDE OIL.

PETROLEUM.

Inspection of oils.

Calendar Year.	Refined Oils. Inspected.	Crude Equivalent Calculated.	Ratio of Crude to Refined.
	Galls.	Galls.	
1881	6,406,783	12,813,566	100 : 50
1882	5,910,787	13,134,993	100 : 45
1883	6,970,550	15,490,111	100 : 45
1884	7,656,011	19,140,027	100 : 40
1885	7,661,617	19,154,042	100 : 40
1886	8,149,472	21,445,979	100 : 38
1887	8,243,962	21,694,637	100 : 38
1888	9,545,895	25,120,776	100 : 38
1889	9,462,834	24,902,195	100 : 38
1890	10,121,210	26,634,763	100 : 38
1891	10,270,107	27,026,597	100 : 38
1892	10,370,707	27,291,334	100 : 38
1893	10,618,804	27,944,221	100 : 38
1894	11,027,082	29,018,637	100 : 38
1895	10,674,232	25,414,838	100 : 42

PETROLEUM.

Inspection of oils.

TABLE 4.

PETROLEUM:—TOTAL AMOUNT OF OIL INSPECTED, IMPORTED AND CANADIAN.

Calendar Year.	Imported.	Canadian.	Total.
	Galls.	Galls.	Galls.
1881	476,784	6,406,783	6,883,567
1882	1,351,412	5,910,747	7,262,159
1883	1,190,828	6,970,550	8,161,378
1884	1,142,575	7,656,011	8,798,586
1885	1,278,115	7,661,617	8,939,732
1886	1,327,616	8,149,472	9,477,088
1887	1,665,604	8,243,962	9,909,566
1888	1,821,342	9,545,895	11,367,237
1889	1,767,812	9,462,834	11,230,646
1890	2,020,742	10,121,210	12,141,952
1891	2,022,002	10,270,107	12,292,109
1892	2,601,946	10,370,707	12,972,653
1893	4,520,392	10,618,804	15,139,196
1894	5,705,787	11,027,082	16,732,869
1895	5,677,381	10,674,232	16,351,613

Exports.

TABLE 5.

PETROLEUM:—EXPORTS OF CRUDE AND REFINED PETROLEUM.

Calendar Year.	Crude Oil.		Refined Oil.		Total.	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
1881	....	....	....	....	501	$ 99
1882	....	....	....	....	1,119	286
1883	....	....	....	....	13,283	710
1884	....	....	....	....	1,098,090	30,168
1885	....	....	....	....	337,967	10,562
1886	....	....	....	....	241,716	9,855
1887	....	....	....	....	473,559	13,831
1888	....	....	....	....	196,602	74,542
1889	....	....	....	....	235,855	10,777
1890	....	....	....	....	420,492	18,154
1891	446,770	$18,471	585	$104	447,355	18,575
1892	310,387	12,945	1,146	100	311,533	13,045
1893	107,719	3,696	2,196	394	109,915	4,090
1894	53,985	2,773	5,297	513	59,282	3,286
1895	22,831	1,044	10,237	2,023	33,068	3,067

TABLE 6.

PETROLEUM :—IMPORTS OF PETROLEUM AND PRODUCTS OF.

PETROLEUM.

Imports.

Fiscal Year.		Gallons.	Value.
1880		687,641	$131,359
1881		1,437,475	262,168
1882		3,007,702	398,031
1883		3,086,316	358,546
1884		3,160,282	380,082
1885		3,767,441	415,195
1886		3,819,146	421,836
1887		4,290,003	467,003
1888		4,523,056	408,025
1889		4,650,274	484,462
1890		5,075,650	515,852
1891		5,071,386	498,330
1892		5,649,145	475,732
1893		6,002,141	446,389
1894		6,597,108	439,988
1895 — Oils: Mineral—	Duty.		
Coal and kerosene, distilled, purified or refined, naphtha and petroleum, N.E.S.	6c. per gall.	6,454,666	414,427
Products of petroleum	6 "	381,658	22,245
Crude petroleum, fuel and gas oils (other than naphtha benzine or gasoline) when imported by manufacturers (other than oil refiners) for use in their own factories, for fuel purposes or for the manufacture of gas	3 "	86	4
Illuminating oils composed wholly or in part of the products of petroleum, coal, shale or lignite, costing more than thirty cents per gallon	25 p. c	16,015	5,730
Lubricating oils composed wholly or in part of petroleum costing less than 25 cents per gallon	6c. per gall.	725,249	82,966
		7,577,674	$525,372

PETROLEUM.

Imports.

TABLE 7.

PETROLEUM:—IMPORTS OF CRUDE AND MANUFACTURED OILS, OTHER THAN ILLUMINATING.

Fiscal Year.	Gallons.
1881	960,691
1882	1,656,290
1883	1,895,488
1884	2,017,707
1885	2,489,326
1886	2,491,530
1887	2,624,399
1888	2,701,714
1889	2,882,462
1890	3,054,908
1891	3,049,384
1892	3,047,199
1893	1,481,749
1894	1,860,829
1895	1,106,907

TABLE 8.

PETROLEUM:—IMPORTS OF PARAFFINE WAX.

Fiscal Year.	Pounds.	Value.
1883	43,716	$ 5,166
1884	39,010	6,079
1885	59,967	8,123
1886	62,035	7,953
1887	61,132	6,796
1888	53,862	4,930
1889	63,229	5,250
1890	239,229	15,844
1891	753,854	50,275
1892	733,873	48,776
1893	452,916	38,935
1894	208,099	15,704
*1895	163,817	11,579

* Duty—2c. per lb.

PETROLEUM.

Imports.

TABLE 9.

PETROLEUM :—IMPORTS OF PARAFFINE WAX CANDLES.

Fiscal Year.	Pounds.	Value.
1880	10,445	$2,269
1881	7,494	1,683
1882	5,818	1,428
1883	7,149	1,734
1884	8,755	2,229
1885	9,247	2,449
1886	12,242	2,587
1887	21,364	3,611
1888	22,054	2,829
1889	8,038	1,337
1890	7,233	1,186
1891	10,598	2,116
1892	9,259	1,952
1893	8,351	1,735
1894	10,818	1,685
*1895	19,448	2,541

* Duty—4c. per lb.

Prices.

TABLE 10.

PETROLEUM :—AVERAGE CLOSING PRICES FOR CRUDE OIL ON PETROLEA OIL EXCHANGE.

Month.	CALENDAR YEARS.				
	1891.	1892.	1893.	1894.	1895.
	$	$	$	$	$
January	1.30	1.29¼	1.18¼	1.01¼	1.16
February	1.28½	1.29	1.18¾	1.01	1.19⅞
March	1.31¾	1.27¾	1.19	1.01	1.27
April	1.37	1.26	1.19	.99½	1.55¾
May	1.37½	1.25¾	1.07	.92	1.67¼
June	1.37	1.27½	1.07	.92¾	1.52
July	1.33½	1.26½	1.06	.94	1.54¼
August	1.34¾	1.26	1.05	.96	1.54
September	1.35	1.26¼	1.04½	.98	1.55½
October	1.35	1.26¾	1.04	1.06	1.59⅞
November	1.33¼	1.25	1.04	1.12¼	1.64½
December	1.31½	1.18½	1.02	1.13½	1.72⅜
The Year	1.33¾	1.26¼	1.09½	1.00¾	1.49⅔

PHOSPHATE.

PHOSPHATE (APATITE).

Production.

TABLE 1.

PHOSPHATE :—PRODUCTION.

Calendar Year.	Tons.	Value.
1886	20,495	$304,338
1887	23,690	319,815
1888	22,485	242,285
1889	30,988	316,662
1890	31,753	361,045
1891	23,588	241,603
1892	11,932	157,424
1893	8,198	70,942
1894	6,861	41,166
1895	1,822	9,565

Exports.

TABLE 2.

PHOSPHATE :—EXPORTS.

Calendar Year.	Ontario.		Quebec.	
	Tons.	Value.	Tons.	Value.
1878	824	$12,278	9,919	$195,831
1879	1,842	20,565	6,604	101,470
1880	1,387	14,422	11,673	175,664
1881	2,471	36,117	9,497	182,339
1882	568	6,338	16,585	302,019
1883	50	500	19,666	427,168
1884	763	8,890	20,946	415,350
1885	434	5,962	28,535	490,331
1886	644	5,816	19,796	337,191
1887	705	8,277	22,447	424,940
1888	2,643	30,247	16,133	268,362
1889	3,547	38,833	26,440	355,935
1890	1,866	21,329	26,591	478,040
1891	1,551	16,646	15,720	368,015
1892	1,501	12,544	9,981	141,221
1893	1,990	11,550	5,748	56,402
1894	1,980	10,560	3,470	29,610
1895	....	....	250	2,500

PHOSPHATE.

Exports.

PHOSPHATE.
ANNUAL EXPORTS.
Table A.

Calendar Year.	Tons.	Value.
		$
1878	10,743	208,109
1879	8,446	122,035
1880	13,060	190,086
1881	11,968	218,456
1882	17,153	338,357
1883	19,716	427,668
1884	21,709	424,240
1885	28,969	496,293
1886	20,440	343,007
1887	23,152	433,217
1888	18,776	298,609
1889	29,987	394,768
1890	28,457	499,369
1891	17,271	384,661
1892	11,482	153,764
1893	7,738	67,952
1894	5,450	40,170
1895	250	2,500

PRECIOUS METALS.

Gold.

Production.

PRECIOUS METALS.

TABLE 1.

GOLD:—PRODUCTION BY PROVINCES.

CALENDAR YEAR, 1895.

Provinces.		Ounces.*	Value.
Nova Scotia................................	b.	19,679	$ 406,764.93
Quebec..	a.	62	1,281.54
Ontario..	b.	3,015	62,320.05
N. W. Territories (including Yukon District)	a.	7,257	150,002.19
British Columbia..............................	c.	62,435	1,290,531.45
Total..............................		92,448	$1,910,900.16

* Gold calculated at $20.67 per ounce.
a. Placer gold.
b. Gold produced in treating free milling ores.
c. As follows : Placer gold.................................. $501,684
Gold from free milling ores.................. 134,847
Gold in shipments of ores, matte, &c......... 654,000
$1,290,531

GOLD.
British Columbia.
Annual Production.
Table A.

Calendar Year.	Value.
	$
1858	705,000
1859	1,615,072
1860	2,228,543
1861	2,661,118
1862	2,656,903
1863	3,913,563
1864	3,735,850
1865	3,491,205
1866	2,662,106
1867	2,480,868
1868	2,372,972
1869	1,774,978
1870	1,336,956
1871	1,799,440
1872	1,610,972
1873	1,305,749
1874	1,844,618
1875	2,474,904
1876	1,786,648
1877	1,608,182
1878	2,275,204
1879	1,290,058
1880	1,013,827
1881	1,046,737
1882	954,085
1883	794,252
1884	736,165
1885	713,738
1886	903,651
1887	693,709
1888	616,731
1889	588,923
1890	494,436
1891	429,811
1892	399,525
1893	379,535
1894	456,066
1895	1,290,531

PRECIOUS METALS.

Gold.

British Columbia.

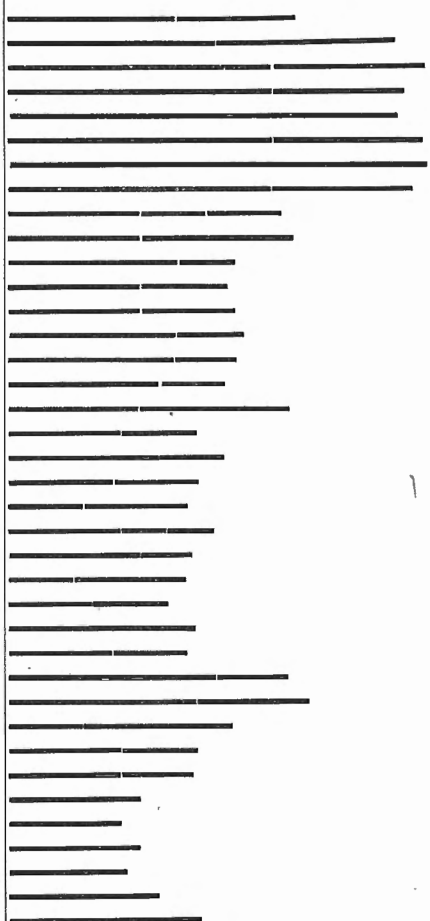
GOLD.
BRITISH COLUMBIA.
EARNINGS PER MAN.
Table B.

Calendar Year.	Value.
	$
1858	235
1859	403
1860	506
1861	634
1862	648
1863	889
1864	849
1865	813
1866	893
1867	814
1868	992
1869	749
1870	569
1871	734
1872	671
1873	567
1874	643
1875	1,222
1876	783
1877	820
1878	677
1879	607
1880	518
1881	551
1882	548
1883	404
1884	396
1885	246
1886	287
1887	296
1888	307
1889	330
1890	423
1891	358
1892	298
1893	304
1894	283
1895	313

Precious metals.
Gold.
British Columbia.

GOLD.
British Columbia.
Number of Men employed.
Table C.

Calendar Year.	Number.
1858	3,000
1859	4,000
1860	4,400
1861	4,200
1862	4,100
1863	4,400
1864	4,400
1865	4,294
1866	2,982
1867	3,044
1868	2,390
1869	2,369
1870	2,348
1871	2,450
1872	2,400
1873	2,300
1874	2,868
1875	2,024
1876	2,282
1877	1,960
1878	1,883
1879	2,124
1880	1,955
1881	1,898
1882	1,738
1883	1,965
1884	1,858
1885	2,902
1886	3,147
1887	2,342
1888	2,007
1889	1,929
1890	1,342
1891	1,199
1892	1,340
1893	1,247
1894	1,610
1895	2,030



PRECIOUS METALS.

Gold.

British Columbia.

TABLE 2.

GOLD:—BRITISH COLUMBIA, YIELD, &c., BY DISTRICTS, CALENDAR YEAR, 1895.

District.	Division.	Men employed.		Yield of Gold by Divisions.	Total Yield by Districts.
		Whites.	Chinese.		
				$	$
Cariboo..........	Barkerville	178	148	81,000	
	Lightning Creek....	49	95	40,700	
	Quesnel Mouth......	43	117	18,200	
	Keithley Creek......	153	162	142,500	282,400
		423	522		
Cassiar...........	Laketown	7	29	12,450	
	Liard River.........	....	....	475	
	McDame Creek.....	5	21	9,650	22,575
		12	50		
Kootenay East...	....	155	28		17,575
Kootenay West..	Nelson.............	....	....	25,500	
	Revelstoke..........	75	3	10,020	
	Trout Lake.........	20	....	500	36,020
		95	3		
Lillooet..........	....	20	50		40,663
Yale...	Osoyoos...........	88	49	147,261	
	Similkameen........	154	67	41,650	
	Yale...............	80	250	48,400	237,311
		322	366		
	Total, white.......	1,027			
	" Chinese.....	....	1,019		
	" employed....	2,046			636,544

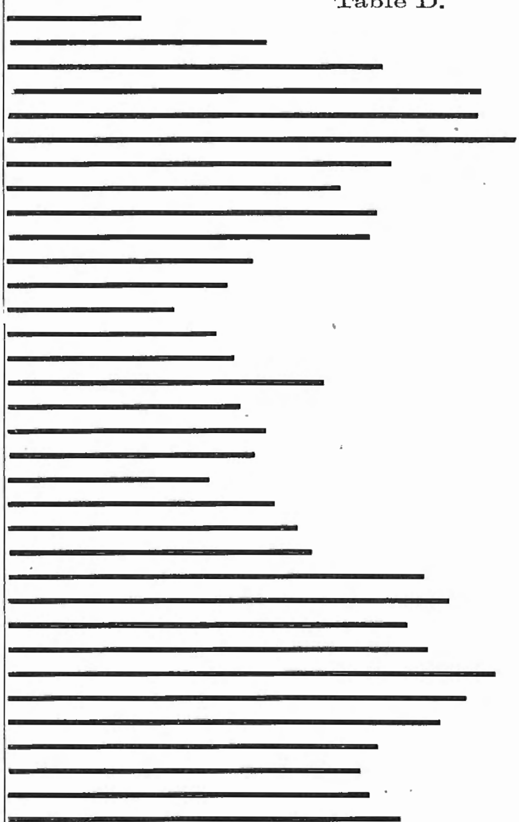
PRECIOUS METALS.

Gold.

Nova Scotia.

GOLD.
NOVA SCOTIA.
ANNUAL PRODUCTION.
Table D.

Calendar Year.	Value.
	$
1862	141,871
1863	272,448
1864	390,349
1865	496,357
1866	491,491
1867	532,563
1868	400,555
1869	348,427
1870	387,392
1871	374,972
1872	255,349
1873	231,122
1874	178,244
1875	218,629
1876	233,585
1877	329,205
1878	245,253
1879	268,328
1880	257,823
1881	209,755
1882	275,090
1883	301,207
1884	313,554
1885	432,971
1886	455,564
1887	413,631
1888	436,939
1889	510,022
1890	474,990
1891	451,511
1892	389,965
1893	367,556
1894	377,169
1895	406,770



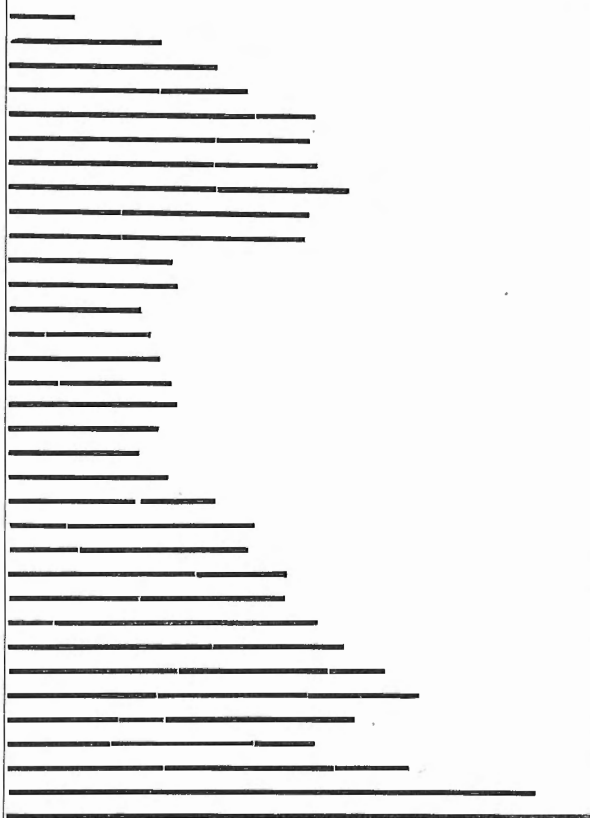
PRECIOUS METALS.

Gold.

Nova Scotia.

GOLD.
NOVA SCOTIA.
TONS OF QUARTZ CRUSHED.
Table E.

Calendar Year.	Tons.
1862	6,473
1863	17,000
1864	21,431
1865	24,421
1866	32,157
1867	31,384
1868	32,259
1869	35,144
1870	30,824
1871	30,787
1872	17,089
1873	17,708
1874	13,844
1875	14,810
1876	15,490
1877	17,369
1878	17,989
1879	15,936
1880	13,997
1881	16,556
1882	21,081
1883	25,954
1884	25,186
1885	28,890
1886	29,010
1887	32,280
1888	36,178
1889	39,160
1890	42,749
1891	36,351
1892	32,552
1893	42,354
1894	55,357
1895	60,600



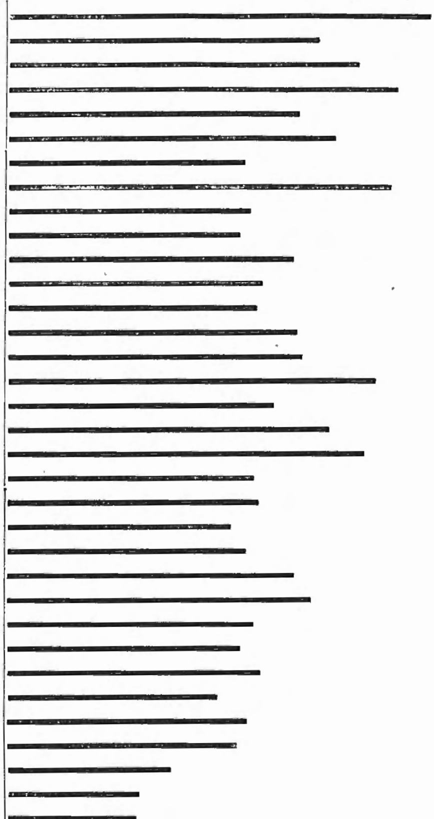
PRECIOUS METALS.

Gold.

Nova Scotia.

GOLD.
NOVA SCOTIA.
AVERAGE YIELD PER TON OF ORE CRUSHED.
Table F.

Calendar Year.	Value.
	$
1862	21·91
1863	16·02
1864	18·11
1865	20·32
1866	15·28
1867	16·96
1868	12·41
1869	19·91
1870	12·56
1871	12·17
1872	14·81
1873	13·05
1874	12·87
1875	14·89
1876*	15·08
1877	19·01
1878	13·63
1879	16·83
1880	18·42
1881	12·66
1882	13·04
1883	11·60
1884	12·44
1885	14·98
1886	15·70
1887	12·81
1888	12·08
1889	13·02
1890	11·11
1891	12·42
1892	11·98
1893	8·68
1894	6·81
1895	6·71



PRECIOUS METALS.

Gold.

Nova Scotia.

TABLE 3.

GOLD:—NOVA SCOTIA. PRODUCTION OF THE DIFFERENT DISTRICTS, FROM 1862 TO 1895, INCLUSIVE.

Districts.	Tons of Ore Crushed.	Total Yield.				Average yield per ton of 2,000 lbs.
		Oz.	Dwt.	Grs.	Value at $19.50 per oz.	
Caribou and Moose R.	79,322	34,058	12	23	$664,144	$ 8·37
Montague	20,037	35,749	3	10	697,108	34·79
Oldham	44,265	48,438	12	2	944,553	21·31
Renfrew	48,130	33,704	0	2	657,228	13·65
Sherbrooke	171,779	122,872	19	2	2,396,023	13·94
Stormont	67,843	37,943	11	0	739,899	10·90
Tangier and Mooseland	33,789	20,012	8	15	390,243	11·54
Uniacke	46,308	30,674	5	15	598,149	12·91
Waverly	116,909	59,531	9	14	1,160,863	9·92
Salmon River	44,079	13,190	14	0	257,219	5·83
Brookfield	10,645	8,141	8	4	158,757	14·91
Whiteburn	7,216	10,120	14	20	197,355	27·34
Lake Catcha	11,892	10,859	13	3	211,763	17·82
Rawdon	12,175	9,632	13	21	187,838	15·42
Killag	482	413	8	21	8,062	16·72
Wine Harbour	42,562	29,085	1	13	567,158	13·32
Darr's Hill	39,909	18,715	19	19	364,962	9·14
Fifteen-Mile Stream	21,775	11,999	11	5	233,991	10·74
Malaga	22,277	14,449	9	21	281,765	12·64
Unproclaimed	56,424	42,854	17	21	835,671	14·81
Totals	897,818	592,448	15	15	$11,552,751	$12·86

TABLE 4.

GOLD:—NOVA SCOTIA. DISTRICT DETAILS—CALENDAR YEAR 1895.

Districts.	Mines.	Mills.	Tons of Ore Crushed.	Total Yield of Gold.			Total Yield of Gold per ton.		
				Oz.	Dwt.	Grs.	Oz.	Dwt.	Grs.
Caribou & Moose River	6	5	13,781	3,646	14	11	0	5	6
Montague	3	3	254	118	5	0	0	9	7
Oldham	2	2	331	199	6	15	0	12	1
Renfrew	2	2	847	956	12	0	1	2	14
Sherbrooke	4	4	4,350	2,205	13	0	0	10	3
Stormont	8	8	14,646	3,619	11	15	0	4	22
Tangier and Mooseland	2	2	1,770	116	11	5	0	1	7
Uniacke	7	7	4,233	2,928	17	6	0	13	20
Waverly	1	1	5,540	1,115	4	0	0	4	0
Brookfield	2	2	4,542	2,995	10	1	0	13	4
Lake Catcha	3	2	1,021	579	13	0	0	11	8
Rawdon	4	4	418	375	12	0	0	17	23
Wine Harbour	2	2	693	362	0	12	0	10	10
Fifteen-Mile Stream	2	1	5,239	2,956	2	0	0	11	6
Malaga	2	2	2,526	657	0	3	0	5	4
Unproclaimed and other	6	5	409	404	5	5	0	19	18
Totals and averages	56	52	60,600	23,236	18	1	0	7	8

PRECIOUS METALS.

Gold.

Quebec.

GOLD.

QUEBEC.

ANNUAL PRODUCTION.

Table G.

Calendar Year.	Value.
	$
1877	12,057
1878	17,937
1879	23,972
1880	33,174
1881	56,661
1882	17,093
1883	17,787
1884	8,720
1885	2,120
1886	3,981
1887	1,604
1888	3,563
1889	1,207
1890	1,350
1891	1,800
1892	12,987
1893	15,696
1894	29,196
1895	1,281

PRECIOUS METALS.

Silver.

Annual production.

SILVER.

TABLE 1.

SILVER:—ANNUAL PRODUCTION.

CALENDAR YEAR.	ONTARIO.		QUEBEC.		BRITISH COLUMBIA.		TOTAL.	
	Oz.	Value.	Oz.	Value.	Oz.	Value.	Oz.	Value.
1887..	190,495	$190,495	146,898	$146,898	11,937	$11,937	349,330	$349,330
1888..	208,064	208,064	149,388	149,388	37,925	37,925	395,377	395,377
1889..	181,609	162,309	148,517	133,666	53,192	47,873	383,318	343,848
1890..	158,715	166,652	171,545	180,122	70,427	73,948	400,687	420,722
1891..	225,633	221,120	185,584	181,872	3,306	3,241	414,523	406,233
1892..	41,581	36,072	191,910	166,482	77,160	66,935	310,651	269,489
1893..	....	8,689	....	126,439	....	195,000	....	330,128
1894..	....	....	101,318	63,830	746,379	470,219	847,697	534,049
1895 .	....	....	81,753	53,343	1,693,930	1,105,289	1,775,683	1,158,633

Exports.

TABLE 2.

SILVER:—EXPORTS OF SILVER ORE.

Provinces.	CALENDAR YEARS.						
	1889.	1890.	1891.	1892.	1893.	1894.	1895.
	$	$	$	$	$	$	$
Ontario	203,871	203,142	222,071	35,992	7,878	....	100
Quebec *	2,500	900	....	....	....	....	....
Nova Scotia......	50	....	....	....	....	....	....
Manitoba	5	....	....	80	820	....	....
British Columbia..	5,737	100	3,241	20,616	204,997	359,731	994,254
Totals	212,163	204,142	225,312	56,688	213,695	359,731	994,354

*The production of silver given under the heading Quebec, in Table 1, represents the amount of that metal in the pyritous copper ores produced and exported from that province. Being but in small proportion it is ignored and does not appear under the heading Silver in the export returns.

PYRITES.

PYRITES.

TABLE 1.

PYRITES :—PRODUCTION.

Production.

Calendar Year.	Tons.	Value.
1887	38,043	$171,194
1888	63,479	285,656
1889	72,225	307,292
1890	49,227	123,067
1891	67,731	203,193
1892	59,770	179,310
1893	58,542	175,626
1894	40,527	121,581
1895	34,198	102,594

TABLE 2.

PYRITES :—IMPORTS. BRIMSTONE OR CRUDE SULPHUR.

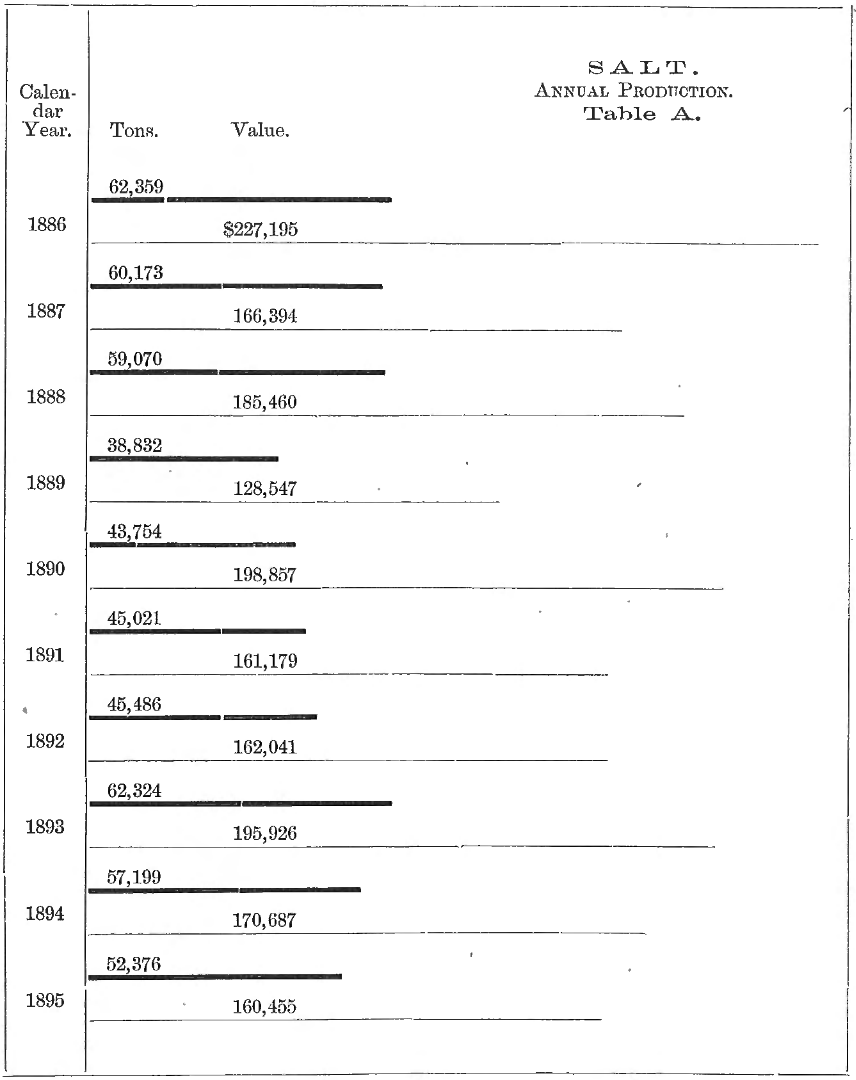
Imports.

Fiscal Year.	Pounds.	Value.
1880	1,775,489	$27,401
1881	2,118,720	33,956
1882	2,375,821	40,329
1883	2,336,085	36,737
1884	2,195,735	37,463
1885	2,248,986	35,043
1886	2,922,043	43,651
1887	3,103,644	38,750
1888	2,048,812	25,318
1889	2,427,510	34,006
1890	4,440,799	44,276
1891	3,601,748	46,351
1892	4,769,759	67,095
1893	6,381,203	77,216
1894	5,845,463	61,558
*1895	4,900,225	56,965

* Brimstone, crude, or in roll or flour, and sulphur in roll or flour. Duty free.

SALT.
Production.

SALT.



SALT.

TABLE 1.

SALT :—EXPORTS.

Exports.

Calendar Year.	Bushels.	Value.
1880	467,641	$46,211
1881	343,208	44,627
1882	181,758	18,350
1883	199,733	19,492
1884	167,029	15,291
1885	246,794	18,756
1886	224,943	16,886
1887	154,045	11,526
1888	15,251	3,987
1889	8,557	2,390
1890	6,605	1,667
1891	5,290	1,277
1892	2,000	504
1893	4,940	1,267
1894	4,639	1,120
1895	4,865	959

TABLE 2.

SALT :—IMPORTS. SALT PAYING DUTY.

Imports.

Fiscal Year.		Pounds.	Value.
1880		726,640	$ 3,916
1881		2,588,465	6,355
1882		3,679,415	12,318
1883		12,136,968	36,223
1884		12,770,950	38,949
1885		10,397,761	31,726
1886		12,266,021	39,181
1887		10,413,258	35,670
1888		10,509,799	32,136
1889		11,190,088	38,968
1890		15,135,109	57,549
1891		15,140,827	59,311
1892		18,648,191	65,963
1893		21,377,339	79,838
1894		15,867,825	53,336
	Duty.		
1895 Salt, coarse, N.E.S	5c. per 100 lbs.	1,355,487	2,820
1895 Salt, fine, in bulk	5c. "	1,163,067	2,293
1895 Salt, N.E.S., in bags, barrels or other packages	7½c. "	5,979,850	24,768
Total		8,498,404	$29,881

SALT,

Imports.

TABLE 3.

SALT:—IMPORTS. SALT NOT PAYING DUTY.

Fiscal Year.	Duty.	Pounds.	Value.
1880		212,714,747	$400,167
1881		231,640,610	488,278
1882		166,183,962	311,489
1883		246,747,113	386,144
1884		225,390,121	321,243
1885		171,571,209	255,719
1886		180,205,949	255,359
1887		203,042,332	285,455
1888		184,166,986	220,975
1889		180,847,800	253,009
1890		158,490,075	252,291
1891		195,491,410	321,239
1892		201,831,217	314,995
1893		191,595,530	281,462
1894		196,668,730	328,300
1895 Salt, imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries	Free	201,691,248	$332,711

STRUCTURAL MATERIALS.

Building stone.

STRUCTURAL MATERIALS.

TABLE 1.

STRUCTURAL MATERIALS:—PRODUCTION OF BUILDING STONE.

Calendar Year.	Value.
1886	$ 642,509
1887	552,267
1888	641,712
1889	913,691
1890	964,783
1891	708,736
1892	609,827
1893	1,100,000
1894	1,200,000
1895	1,095,000

TABLE 2.

STRUCTURAL MATERIALS:—EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

STRUCTURAL MATERIALS.

Stone and marble.

Province.	Wrought.		Unwrought.	
	Calendar Years.			
	1894.	1895.	1894.	1895.
Ontario	$17,497	$5,165	$16,250	$37,166
Quebec	1,761	3,196	1,883	1,925
Nova Scotia	3,185	126	7,525	9,534
New Brunswick	133	100	5,686	2,925
British Columbia	....	....	2,786	66
Totals	$22,576	$8,587	$34,130	$51,616

TABLE 3.

STRUCTURAL MATERIALS:—IMPORTS OF BUILDING STONE.

Building stone,

Fiscal Year.		Duty.	Value.
1880			$ 35,970
1881			58,149
1882			33,623
1883			35,061
1884			51,088
1885			30,491
1886			41,675
1887			54,368
1888			86,373
1889			100,314
1890			132,155
1891			170,890
1892			95,550
1893			56,510
1894			52,908
1895	Flagstones, granite and rough freestone, sandstone and all building stone, except marble from the quarry, not hammered or chiselled	20 p. c.	$37,732
	Granite and freestones, dressed; all other building stone dressed, except marble	30 "	6,550
			$44,282

STRUCTURAL MATERIALS.

Stone or granite.

TABLE 4.

STRUCTURAL MATERIALS :—IMPORTS OF MANUFACTURES OF STONE OR GRANITE, N.E.S.

Fiscal Year.	Value.
1880	$29,408
1881	36,877
1882	37,267
1883	45,636
1884	45,290
1885	39,867
1886	41,984
1887	41,829
1888	47,487
1889	61,341
1890	84,396
1891	61,051
1892	39,479
1893	49,323
1894	49,510
1895 Duty—30 p. c.	51,050

Marble.

TABLE 5.

STRUCTURAL MATERIALS :—PRODUCTION OF MARBLE.

Calendar Year.	Tons.	Value.
1886	501	$9,900
1887	242	6,224
1888	191	3,100
1889	83	980
1890	780	10,776
1891	240	1,752
1892	340	3,600
1893	590	5,100
1894	Nil.	Nil.
1895	200	2,000

STRUCTURAL MATERIALS.

TABLE 6.

STRUCTURAL MATERIALS:—IMPORTS OF MARBLE.

Marble.

Fiscal Year.		Value.
1880		$ 63,015
1881		85,977
1882		109,505
1883		128,520
1884		108,771
1885		102,835
1886		117,752
1887		104,250
1888		94,681
1889		118,421
1890		99,353
1891		107,661
1892		106,268
1893		96,177
1894		94,657
	Duty.	
1895 Marble and manufactures of:—		
Blocks or slabs, sawn on not more than two sides	10 p. c.	$23,915
" " more than two sides	20 "	39,248
Finished	30 "	5,996
Manufactures of, N. E. S.	30 "	13,377
Rough blocks	Free	886
Total marble and manufactures of		$83,422

TABLE 7.

STRUCTURAL MATERIALS:—PRODUCTION OF GRANITE.

Granite.

Calendar Year.	Tons.	Value.
1886	6,062	$63,309
1887	21,217	142,506
1888	21,352	147,305
1889	10,197	79,624
1890	13,307	65,985
1891	13,637	70,056
1892	24,302	89,326
1893	22,521	94,393
1894	16,392	109,936
1895	19,238	84,838

STRUCTURAL MATERIALS.

Slate.

TABLE 8.

STRUCTURAL MATERIALS :—PRODUCTION OF SLATE.

Calendar Year.	Tons.	Value.
1886	5,345	$64,675
1887	7,357	89,000
1888	5,314	90,689
1889	6,935	119,160
1890	6,368	100,250
1891	*	....
1892	5,180	69,070
1893	7,112	90,825
1894	....	75,550
1895	....	58,900

* Only one return received, marked "confidential."

TABLE 9.

STRUCTURAL MATERIALS :—EXPORTS OF SLATE.

Calendar Year.	Tons.	Value.
1884	539	$6,845
1885	346	5,274
1886	34	495
1887	27	373
1888	22	475
1889	26	3,303
1890	12	153
1891	15	195
1892	87	2,038
1893	178	3,168
1894	187	3,610
1895	36	574

STRUCTURAL MATERIALS.

TABLE 10.

STRUCTURAL MATERIALS :—IMPORTS OF SLATE.

Slate.

Fiscal Year.		Duty.	Value.
1880			$21,431
1881			22,184
1882			24,543
1883			24,968
1884			28,816
1885			28,169
1886			27,852
1887			27,845
1888			23,151
1889			41,370
1890			22,871
1891			46,104
1892			50,441
1893			51,179
1894			29,267
1895	Slate and manufactures of—		
	Mantels	30 p. c	$1,868
	Roofing slate, black or blue	30 p. c., not over 75c. per square.	3,825
	" red, green or other colour	30 p. c., not over 90c. per square.	1,901
	School writing slates	30 p. c.	5,041
	Slate pencils	25 "	2,557
	Slate of all kinds and manufactures of, N.E.S.	30 "	4,279
	Total slate		$19,471

TABLE 11.

STRUCTURAL MATERIALS :—PRODUCTION OF FLAGSTONES.

Flagstones.

Calendar Year.	Quantity Sq. ft.	Value.
1887	116,000	$11,600
1888	64,800	6,580
1889	14,000	1,400
1890	17,865	1,643
1891	27,300	2,721
1892	13,700	1,869
1893	40,500	3,487
1894	152,700	5,298
1895	80,005	6,687

STRUCTURAL MATERIALS.

Flagstones.

TABLE 12.

STRUCTURAL MATERIALS :—IMPORTS OF FLAGSTONES.

Fiscal Year.	Tons.	Value.
1881	23	$ 241
1882	90	848
1883	10	99
1884	137	1,158
1885	205	1,756
1886	1,602	9,443
1887	1,316	10,966
1888	2,642	21,077
1889	1,669	15,451
1890	5,665	48,995
1891	3,770	36,348
1892	1,571	15,048
1893	884	8,500
1894	218	2,429
*1895	15	84

* Flagstones, dressed. Duty—30 p. c.

Cement.

TABLE 13.

STRUCTURAL MATERIALS :—PRODUCTION OF CEMENT.

Calendar Year.	Bbls.	Value.
1887	69,843	$ 81,909
1888	50,668	35,593
1889	90,474	69,790
1890	102,216	92,405
1891	93,473	108,561
1892	107,408	147,663
1893	158,597	194,015
1894	108,142	144,637
1895	128,294	173,675

TABLE 14.

STRUCTURAL MATERIALS :—EXPORTS OF CEMENT.

Province.	CALENDAR YEARS.			
	1892.	1893.	1894.	1895.
Ontario	$399	$ 718	$339	$662
Quebec	539	386	42	30
Nova Scotia	....	68	101	245
Totals	$938	$1,172	$482	$937

STRUCTURAL MATERIALS.

TABLE 15.

STRUCTURAL MATERIALS:—IMPORTS OF CEMENT IN BULK OR BAGS.

Cement.

Fiscal Year.	Bushels.	Value.
1880	65	$ 28
1881	579	298
1882	386	86
1883	1,759	548
1884	4,626	1,236
1885	4,598	1,315
1886	6,808	1,851
1887	5,421	1,419
1888	23,919	5,787
1889	32,818	10,668
1890	21,055	5,443
1891	11,281	2,890
1892	14,351	3,394
1893	12,534	2,909
1894	9,027	2,618
*1895	....	2,112

* N.E.S. Duty—20 p.c.

TABLE 16.

STRUCTURAL MATERIALS:—IMPORTS OF HYDRAULIC CEMENT.

Hydraulic cement.

Fiscal Year.	Duty.	Barrels.	Value.
1880		10,034	$ 10,306
1881		7,812	7,821
1882		11,945	13,410
1883		11,659	13,755
1884		8,606	9,514
1885		5,613	5,396
1886		6,164	6,028
1887		6,160	8,784
1888		5,636	7,522
1889		5,835	7,467
1890		5,440	9,048
1891		3,515	6,152
1892		2,214	2,782
1893		4,896	8,060
1894		1,054	985
1895 Cement, hydraulic or waterlime	40 c. per bbl.	5,333	$ 7,001

STRUCTURAL MATERIALS.

Portland cement.

TABLE 17.

STRUCTURAL MATERIALS:—IMPORTS OF PORTLAND CEMENT.

Fiscal Year.		Barrels.	Value.
1880			$ 55,774
1881			45,646
1882			66,579
1883			102,537
1884			102,857
1885			111,521
1886			120,398
1887		102,750	148,054
1888		122,402	177,158
1889		122,273	179,406
1890		192,322	313,572
1891		183,728	304,648
1892		187,233	281,553
1893		229,492	316,179
1894		224,150	280,841
	Duty.		
1895 Portland or Roman	40 c. per bbl.	196,281	$ 242,813

Roofing cement.

TABLE 18.

STRUCTURAL MATERIALS:—PRODUCTION OF ROOFING CEMENT.

Calendar Year.	Tons.	Value.
1890	1,171	$ 6,502
1891	1,020	4,810
1892	800	12,000
1893	951	5,441
1894	815	3,978
1895		3,153

STRUCTURAL MATERIALS

Lime.

TABLE 19.

STRUCTURAL MATERIALS :—PRODUCTION OF LIME.

Calendar Year.	Value.
1886	$283,755
1887	394,859
1888	339,951
1889	362,848
1890	412,308
1891	251,215
1892	411,270
1893	900,000
1894	900,000
1895	700,000

TABLE 20.

STRUCTURAL MATERIALS :—EXPORTS OF LIME.

Province.	Calendar Years.	
	1894.	1895.
Ontario	$ 13,208	$ 25,257
Quebec	30,294	23,047
Nova Scotia	3,482	1,468
New Brunswick	33,830	21,891
Prince Edward Island	3	....
Manitoba	....	30
British Columbia	2,853	4
	$83,670	$ 71,697

STRUCTURAL MATERIALS.

Lime.

TABLE 21.

STRUCTURAL MATERIALS:—IMPORTS OF LIME.

Fiscal Year.	Barrels.	Value.
1880	6,100	$ 6,013
1881	5,796	4,177
1882	5,064	5,365
1883	7,623	9,224
1884	10,804	11,200
1885	12,072	11,503
1886	11,021	9,347
1887	10,835	8,524
1888	10,142	7,537
1889	13,079	9,363
1890	8,149	5,360
1891	6,259	4,273
1892	6,132	4,241
1893	6,879	4,917
1894	6,766	4,907
1895 ....Duty—20 p. c.	12,008	5,743

Building bricks.

TABLE 22.

STRUCTURAL MATERIALS:—PRODUCTION OF BUILDING BRICKS.

Calendar Year.	Value.
1886	$ 873,600
1887	986,689
1888	1,036,746
1889	1,273,884
1890	1,266,982
1891	1,061,536
1892	1,251,934
1893	1,800,000
1894	1,800,000
1895	1,670,000

STRUCTURAL MATERIALS.

Bricks.

TABLE 23.

STRUCTURAL MATERIALS :—EXPORTS OF BRICKS.

Province.	Calendar Years.									
	1891.		1892.		1893.		1894.		1895.	
	M	Value	M	Value	M	Value	M	Value	M	Value
Ontario..........	229	$1,039	1,347	$8,784	552	$2,462	280	$1,257	1,053	$4,420
Quebec..........	.....	......	353	1,566	2,189	17,969	68	917	82	1,092
Nova Scotia	14	94	252	1,662	2,561	16,449	489	3,252	199	834
New Brunswick...	.....	......	10	170	767	7,185	258	1,979	321	2,319
P. E. Island......	3	30	1	10	.....	......	.....	......	.....	......
British Columbia..	.....	......	.....	......	4	45	.....	......	....	......
Totals......	246	1,163	1,963	12,192	6,073	44,110	1,095	7,405	1,655	8,665

TABLE 24.

STRUCTURAL MATERIALS :—IMPORTS OF BUILDING BRICKS.

Fiscal Year.	Value.
1880......................	$ 2,067
1881......................	4,281
1882......................	24,572
1883......................	14,234
1884......................	20,258
1885......................	14,632
1886......................	5,929
1887......................	2,440
1888......................	20,720
1889......................	24,585
1890......................	12,500
1891......................	9,744
1892......................	5,075
1893......................	14,108
1894......................	18,320
1895.. .... Duty—20 p. c..	4,705

STRUCTURAL MATERIALS.

Terra cotta.

TABLE 25.

STRUCTURAL MATERIALS:—PRODUCTION OF TERRA COTTA.

Calendar Year.	Value.
1888	$ 49,800
1889	Not available.
1890	90,000
1891	113,103
1892	97,239
1893	55,704
1894	65,600
1895	195,123

Sewer pipes.

TABLE 26.

STRUCTURAL MATERIALS:—PRODUCTION OF SEWER PIPES, &c.

Calendar Year.	Value.
1888	$266,320
1889	Not available.
1890	348,000
1891	227,300
1892	367,660
1893	350,000
1894	250,325
1895	257,045

TABLE 27.

STRUCTURAL MATERIALS:—IMPORTS OF DRAIN TILES AND SEWER PIPES.

STRUCTURAL MATERIALS.

Drain tiles and sewer pipes.

Fiscal Year.		Duty.	Value.
1880			$ 33,796
1881			37,368
1882			70,065
1883			70,699
1884			71,755
1885			69,589
1886			57,953
1887			71,203
1888			101,257
1889			83,215
1890			77,434
1891			87,195
1892			59,537
1893			39,001
1894			24,625
1895	Drain tile, not glazed	20 p. c.	$ 695
	Drain pipes, sewer pipes, chimney linings or vents and inverted blocks, glazed or unglazed	35 "	20,358
			$21,053

TABLE 28.

STRUCTURAL MATERIALS:—PRODUCTION OF POTTERY.

Pottery.

Calendar Year.	Value.
1888	$ 27,750
1889	Not available.
1890	195,242
1891	258,844
1892	265,811
1893	213,186
1894	162,144
1895	151,588

STRUCTURAL MATERIALS.

Earthenware.

TABLE 29.

STRUCTURAL MATERIALS :—IMPORTS OF EARTHENWARE.

Fiscal Year.		Value.
1880		$322,333
1881		439,029
1882		646,734
1883		657,886
1884		544,586
1885		511,853
1886		599,269
1887		750,691
1888		697,082
1889		697,949
1890		695,206
1891		634,907
1892		748,810
1893		709,737
1894		695,514
	Duty.	
1895 Earthenware and china ;—		
1895 Brown or coloured earthen and stoneware, and Rockingham ware	30 p. c.	$ 14,620
1895 Decorated, printed or sponged, and all earthenware, N.E.S	30 "	163,836
1895 Demijohns or jugs, churns and crocks	3c. per gall. (holding capacity)	3,073
1895 Porous and hollow earthenware for fire proofing purposes	30 p. c.	72
1895 White granite or ironstone ware, C. C. or cream coloured ware	30 "	193,697
1895 China and procelain ware	30 "	146,555
1895 Earthenware tiles	35 "	19,987
1895 Manufactures of earthenware, N.E.S.	30 "	6,095
Total earthenware		$547,935

TABLE 30.

STRUCTURAL MATERIALS:—EXPORTS OF SAND AND GRAVEL.

STRUCTURAL MATERIALS.

Sand and gravel.

Province.	Calendar Years.					
	1893.		1894.		1895.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario	328,707	$121,237	323,679	$84,223	276,685	$117,182
Quebec	....	....	....	....	....	....
Nova Scotia	10	9	401	1,605	225	675
New Brunswick	383	525	572	1,104	242	480
Manitoba	....	....	....	....	....	....
British Columbia	16	24	4	8	10	22
Total	329,116	$121,795	324,656	$86,940	277,162	$118,359

TABLE 31.

STRUCTURAL MATERIALS:—EXPORTS OF SAND AND GRAVEL.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1877	11,998	$ 2,151	1887	180,860	$ 30,307
1878	50,140	8,381	1888	260,929	38,398
1879	46,999	9,438	1889	283,044	52,647
1880	53,951	11,177	1890	342,158	65,518
1881	58,693	15,129	1891	243,724	59,501
1882	60,158	16,218	1892	297,878	85,329
1883	55,346	14,065	1893	329,116	121,795
1884	73,741	19,978	1894	324,656	86,940
1885	110,661	22,878	1895	277,162	118,359
1886	124,865	24,226			

INDEX—VOL. VIII.

(NEW SERIES.)

ABBREVIATIONS.

Al.	District of Alberta.	N.E.T.	North-east Territory.
B.C.	Province of British Columbia.	N.W.T.	North-west Territory.
N.B.	Province of New Brunswick.	O.	Province of Ontario.
N.S.	Province of Nova Scotia.	Q.	Province of Quebec.

INDEX TO SUMMARY REPORT, 1895, (PART A, VOL. VIII.)

(All references to Part A must be taken from this Special Index and not from the General Index, which is incorrect for Part A.)