SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY DEPARTMENT

OF

CANADA

FOR THE CALENDAR YEAR

1904

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1905

[No. 26—1905.]—*Price, 25 cents.*

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To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G. C. M. G., &c., &c., &c., Governor General of Canada.

MAY IT PLEASE YOUR EXCELLENCY,—

The undersigned has the honour to lay before Your Excellency, in compliance with 3 Vic., Chap. 2, Section 6, the Summary Report of the Operations of the Geological Survey Department for the calendar year ending December 31, 1904.

Respectfully submitted.

FRANK OLIVER,

Minister of the Interior.

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SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY OF CANADA

FOR THE CALENDAR YEAR 1904.

The Honourable FRANK OLIVER, M.P.,
Minister of the Interior.

SIR,—In accordance with the requirements of the Geological Survey Act, I have the honour to lay before you the following Summary Report on the administration of the Department for the calendar year 1904. This report, like those of former years, describes the business of the Department and the scientific work which has been accomplished during the year, both in the field and at headquarters. Report submitted.

The field-work extended to all parts of the country from the Pacific to the Atlantic and from the International Boundary northward into the arctic regions. It will be seen that it was nearly all of a thoroughly practical character, intended to promote the discovery and development of the mineral wealth of the Dominion. In connection with the geological work, a large amount of necessary topographical surveying was done at the same time, which is of much value in elucidating the geography of Canada. Field-work.

The advantages of showing on our new map-sheets, year by year, both the geography and the geology of large areas which had previously been almost blank spaces on the general map of the country, are manifest to everyone. Equally valuable work is being done by the Survey in the older or inhabited parts of Canada by systematic investigation. A single example may be given in illustration of this. Near Pettigrew, in Cumberland county, Nova Scotia, a seam of coal, ten feet thick, has just been struck, in a bore-hole 2,340 feet deep. This bore-hole, sunk through a covering known to be quite unproductive, was put down on the suggestion of Mr. Hugh Fletcher of this Department, who based his advice on the knowledge obtained by a systematic working out of the structural geology of the district. The actual proving of the truth of Mr. Fletcher's inference shows the value of Advantages of the geological surveys.

exact geological work, and it opens at once a prospect of finding numerous workable coal seams throughout a new area fifty miles in length by thirty in breadth. This initial discovery is alone worth incomparably more than the total cost of all Mr. Fletcher's geological work in Nova Scotia during the past thirty years, and yet it is only one among many practical proofs of the great value of his investigations, which are now represented on a considerable number of published maps showing his topographical and geological surveys of a large portion of the province. Mr. Faribault's work on the gold-fields of Nova Scotia has had equally profitable results. Similar benefits have already been derived from the work of the Survey throughout the other provinces and territories.

Home work of the Survey.

The home work of the Survey has also been industriously carried on during the year. It relates to all the processes required for the production of maps from our original surveys, and the printing upon them of the geological colours and signs; to chemical analyses; the assaying of metallic ores; the collection and compilation of information as to mining and smelting; palæontology, zoology, taxidermy, botany and forestry; to quarrying stone, etc.; the manufacture of bricks, tiles, pottery, hydraulic cement, etc.; to the production of slate, corundum, asbestus, petroleum, natural gas, etc.; the distribution of our numerous publications; the supplying of representative, properly-named collections of minerals to educational institutions; to the preparation of reports and other books in reference to all branches of the work of the Department, the editing and printing of these, the business of the accountant's department, a very extensive correspondence on a great variety of technical and other subjects, and the necessary attention to large numbers of visitors seeking information as to geology, mining and other subjects.

Publications.

For some years past, the publications issued by this Department have been so numerous as to require the services of an editor who could devote his entire time to their scrutiny. The United States Geological Survey has long since recognized the necessity of competent editing, and now employs, in addition to a chief editor, two sub-editors and four assistants. The difficulty regarding our own need has been to secure a competent man, but we have now been fortunate in obtaining the services of Mr. Frank Nicolas, a gentleman thoroughly acquainted with this class of work, and one who, from the nature of his mining and literary experiences, is eminently fitted for the post.

Advantages of combined surveys.

In the older civilized countries which are thickly populated, such as Great Britain and France, detailed topographical surveys were absolutely necessary for a variety of purposes, and these, having been made in advance of the geological surveys, were available as a basis for the latter, but in a new and sparsely inhabited country like Canada, the greater part of which is not yet even thoroughly explored, it is impossible to proceed with our field-work without making more or less complete topographical surveys at the same time. Persons who overlook this radical difference in the different countries may write or talk plausibly of a supposed necessity for making separate and independent topographical surveys in the wild parts of Canada, before attempting the geological work. But to do this would double the cost as to both the money and the time required. The advocacy of such a method exhibits a want of knowledge and experience in regard to this matter. Topographical and land surveys on which a preliminary geological map may be based, have been made in the southern parts of the provinces of Quebec and Ontario, and in a narrow strip of territory adjoining the International Boundary line between British Columbia and the State of Washington, but these are exceptional cases in the general problem as it affects the whole Dominion.

Map making.

In our map making we continue to pursue the same system which has been followed for the last four years and which has been found to be the best suited to our conditions. The plotting of the original surveys is done by the field geologists and their assistants, who performed the work and understand it best. The sheets are then accurately compiled, reduced and prepared for the engraver by the regular draughtsmen, under the supervision of the geographer and chief draughtsman of the Department. The engraving and printing are done by contract through the Government stationery office. Any desired number of colours to represent the geological formations is obtained by means of the three-colour system, with a sufficient variety of rulings and cross-rulings.

FIELD-WORK.

In performing the field-work of the year, besides the members of the staff itself, several qualified outside men were employed in the same manner as during the previous seasons, and their reports are given with the others in the present volume. The total number of parties engaged in this work in 1904 was twenty-eight, but in some cases these were divided into two sections which worked separately during most of the season, thus virtually increasing the number actually in operation. The field-work had all been carefully planned, and the whole of it was successfully performed. In the aggregate, it will add greatly to our knowledge, not only of the geology, but also of the geography of the country. The following sketch gives a brief summary of these operations in the respective fields, the order of its arrangement being, as in previous reports, from north-west to south-east.

R. G. McConnell.

Mr. R. G. McConnell, assisted by Mr. F. H. Maclaren, was engaged in the new gold-field of the Kluane district, westward of Whitehorse, in the Yukon territory. It embraces Alsek river, Kluane lake and the north-eastern slope of the St. Elias range. The copper deposits of the Whitehorse district were likewise further examined. Much topographical surveying in other parts of the region was accomplished by Mr. Maclaren.

Joseph Keele.

Mr. Joseph Keele investigated the recent discoveries of gold on the Stewart river and several of its branches, including Duncan creek and vicinity. His labours embraced the examination of alluvial mining along several creeks.

Dr. R. W. Ells.

Dr. R. W. Ells, assisted by Mr. R. A. A. Johnston of this Survey, was occupied in the Nicola valley, British Columbia, working out the geological structure of that region, with special reference to the occurrences of coal and the ores of iron and copper.

Prof. R. W. Brock.

Prof. R. W. Brock, assisted by Mr. W. H. Boyd, as topographer, continued to work out the geology of the Lardeau mining district in British Columbia. He was also engaged for a time in the Rossland mining district. Owing to the prevalence of dense smoke during a considerable part of the summer, much less surveying was accomplished than usual. Mr. Boyd has nearly completed a map showing the work done in this district during the last two years.

Dr. R. A. Daly.

Dr. R. A. Daly was again engaged on the geology of the ten-mile belt along the Canadian side of the International Boundary line in British Columbia.

Prof. John Macoun.

Prof. John Macoun worked in the National Park, both as botanist and zoologist. His investigations were carried on on both sides of the Rocky mountains, and occupied his time during the whole summer and autumn. They will enable him to give a full report on the botany and zoology of the park, a report that should render it much more interesting as a summer resort.

Mr. Lawrence Lambe, assisted by Mr. J. S. DeLury, was engaged in making a collection of the fossil remains of the large extinct vertebrate animals to be found in the Tertiary formations of the Cypress hills, and which, from their great geological interest, are now attracting much attention. Mr. Lambe brought home an extensive collection, embracing some fine specimens of the remains of extinct mammals. Lawrenee Lambe.

Mr. D. B. Dowling, assisted by Messrs. George S. Malloch and F. Bell, continued the examinations which he began last year in the coal-fields of the Rocky Mountain region adjacent to the line of the Canadian Pacific railway, where he has made important discoveries and has worked out the geological structure of the region. This is of the greatest importance in connection with the discovery, following-up and working of the coal seams. D. B. Dowling

Mr. Charles Camsell, assisted by Messrs. Gordon Greenshields and W. H. Dawes, made geological (and also the necessary topographical) surveys in Eastern Manitoba and those parts of the country between Lake Winnipeg and the Severn river, and along the upper branches of that stream, which had not been already examined by other members of the staff. Mr. Camsell delimited the eastern extension of the large Huronian area around Red lake which had been discovered and partly explored by myself in 1883 and further surveyed by Mr. Dowling in 1893. He also discovered some additional small areas of Huronian rocks. In returning he connected his surveys with the explorations which had been made to Cat lake in 1886 by my own assistants of that year, Messrs. John McMillan and Alfred Polson Murray, and also with the survey of this lake by Dr. Alfred W. G. Wilson and Mr. Frank Johnston, also of the Geological Survey staff, in 1902. Charles Camsell.

Mr. William McInnes followed up his interesting explorations begun the previous year, in the extensive and heretofore almost unknown region of the Winisk river and surrounding country, lying to the south of Hudson bay proper. He surveyed the western branches of this large stream and examined the country lying between its head-waters and Lake St. Joseph on the Albany. Mr. McInnes, in the course of his geological exploration, endeavoured to find indications of economic minerals of various kinds. His work adds materially to our knowledge of the distribution of the rock-formations of the Hudson Bay region. Besides many valuable observations on the various resources of this region, he made an exhaustive collection of its land and fresh water mollusca, which afford a good natural indication of the climate of any William McInnes.

district, and Mr. McInnes' collection is of a favourable character in this respect.

In his report for 1903, Mr. McInnes mentioned that a black birch grows along the upper part of the Winisk river. This he supposed to be identical with the black birch of more southern latitudes, *Betula lenta*. Last year he brought home specimens of its leaves, fruit, &c. and Professor Macoun found it to be a new species. This adds one more to the large number of trees native to Canada. A black birch found by the writer south of Rupert river in 1896 and mentioned in his report of that year may be identical with this species.

A. P. Low.

Mr. A. P. Low, of the Geological Survey, was given command of the Canadian Government Expedition to our northern waters, which started in the summer of 1903. The appropriation for the expenses of this expedition was made through the Department of Marine and Fisheries, but a portion of the work was for the Customs and Geological Departments. The sealing steamship *Neptune*, which had been employed for the Hudson Bay expedition in 1884, was again chartered from Messrs. Job Bros. of St. Johns, Newfoundland. She was brought to Halifax, and, during July and part of August, was there fitted out by Commander Low; she sailed for the north on August 22, 1903, with a total company of forty-three. She made a good run to Nachvak inlet on the Labrador coast, about a hundred miles south of Cape Chidley, at the entrance to Hudson strait, and thence to Port Burwell, just inside of this cape. She then proceeded north to Cumberland gulf, on the east coast of Baffin Island. Returning to Hudson strait, calls were made at Charles island and Cape Wolstenholme. Commander Low then coasted along the eastern side of the so-called Bell island, as far as Seahorse point, and made some geological examinations near the junction of the Archæan with the Silurian rocks of this shore. The *Neptune* was placed in winter quarters in Fullerton inlet at the north-west angle of Hudson bay, alongside an American whaling vessel, the *Era*, which had already taken up her berth in the inlet. The *Neptune*, roofed in, and then banked all round with a wall of snow, was rendered dry and comfortable, and a pleasant winter was passed. During April and May, Mr. Caldwell was sent to sketch the coast and report upon the rocks from Fullerton inlet to and around the great Wager bay. Meantime Mr. King made an instrumental survey of the shores in the vicinity of the *Neptune's* anchorage, and sounded the entrance of the inlet through the ice, 433 holes being made for this purpose. Commander Low went southward and sketched the shore as far as Chesterfield inlet, going inland about forty miles from Winchester inlet. Later in the spring, he crossed, with two whale-boats, to Southampton island and examined its western coast for forty miles northward, collecting fossils and geological specimens, as well as making notes as to the geology of this great island.

Leaving three members of the Dominion police force at Fullerton inlet, the *Neptune* quitted her winter quarters on the 19th of July, and met, by appointment, the steamer *Erik*, which had been sent to Port Burwell with a supply of coal. This vessel arrived at the rendezvous only one hour ahead of the *Neptune*. Mr. Caldwell was left at Port Burwell to make a survey of the eastern shore of Ungava bay, and the *Neptune* proceeded northward, through Baffin bay, as far as Cape Sabine and Beechey island. Commander Low entered Lancaster sound and found it perfectly clear of ice. Had his instructions permitted, he could probably have made the North-west passage. On the return journey, the *Neptune* put into Port Burwell at noon on October 1, meeting the Dominion Government steamer *Arctic*, from Quebec, which arrived an hour and a half later. Halifax was made on the 10th of October and Mr. Low arrived in Ottawa on the 17th, after an absence of fifteen months, including the time spent in fitting out the *Neptune*. During her absence from Halifax, the *Neptune* covered about 10,000 nautical miles. Besides the instrumental surveys of Mr. King and Mr. Caldwell and Commander Low's own explorations from Fullerton to Chesterfield inlet and on Southampton island, track surveys of most of the coasts between Beechey island and Baffi Isnland were made by the first named gentleman. The total length of the various surveys accomplished by the expedition amounted to 2,041 nautical miles.

In addition to a variety of official duties performed by Commander Low, many astronomical observations were made to fix, accurately, points for geographical purposes; much new geological and other information was obtained; numerous rock-specimens and fossils were collected; many fine photographs were taken, illustrating in a striking manner the different localities visited; information was obtained as to the zoology, botany, fisheries and Eskimos and as to a variety of other subjects of interest. The zoological collection includes six specimens of the musk-ox of different ages and both sexes. These are now being mounted by Ward of Rochester and are intended to form a group to be placed in the new Victoria Museum.

Mr. W. J. Wilson, with Mr. J. J. Collins as assistant, left as early as possible in the season and worked all summer in the country lying northward of Long lake, north of the central part of Lake Superior W. J. Wilson.

including the head--waters of some large branches of the Albany river. He also made a survey of the Pagwachuan river, which falls into the Kenogami, the principal tributary of the Albany. Mr. Wilson, like all the other field-geologists, paid particular attention to the occurrence of economic minerals in his district, and he extended an area of Huronian rocks in which gold, copper and iron ores may eventually be found.

Owen O'Sullivan.

Mr. Owen O'Sullivan, assisted by Mr. William Spreadborough, performed a very arduous, instrumental survey of the whole of the southern and western coasts of James bay, as far north as Cape Henrietta Maria. These coasts, occupying the central part of the map of Canada, are very prominent features in the geography of the Dominion, and yet they had heretofore been quite inaccurately delineated. It was with a view to supplying a conspicuous geographical want, and at the same time to make the requisite observations in regard to geological conditions, that this work was undertaken. Many new facts as to the botany and ornithology of northern Canada were brought to light on these coasts. It was in order to take advantage of this opportunity to investigate such matters that Mr. Spreadborough, the well-known practical botanist and ornithologist, was sent with Mr. O'Sullivan. Besides noting many interesting zoological facts, Mr. Spreadborough found upwards of forty flowering plants that had not previously been known to occur on the shores of Hudson bay. Owing to the extraordinarily flat and muddy character of the tide-swept shores on the south and west sides of James bay, Mr. O'Sullivan's task was a very difficult and unpleasant one, and he is entitled to much credit for having carried it out so expeditiously and successfully.

E. D. Ingall and Theo. Denis.

Mr. E. D. Ingall and M. Theo. Denis continued their work of the past two seasons on the detailed geology of the typical Huronian area to the northward of the Bruce Mines and eastward of Echo lake and Great Lake George. This work is now so far completed as to admit of the publication of the accompanying map showing most of this area. Besides the geological interest connected with this investigation, it is expected to be of service in the future search for copper deposits. During the thirty years from 1845 to 1875 the Bruce, Wellington, Huron and Copper Bay mines were the largest producers in old Canada. In the above period these mines yielded copper to the value of $3,300,000. The details, as to quantities, prices, etc., from year to year, were investigated by myself and published in the Descriptive Catalogue of Canadian Minerals exhibited at the World's Centennial Exhibition at Philadelphia in 1876.

Dr. A. E. Barlow, assisted by Dr. G. A. Young, and Messrs. W. Herridge and Morley Wilson, was instructed to continue work in the Temagami lake region. Dr. A. E. Barlow.

Prof. W. A. Parks, assisted by Mr. H. L. Kerr, was engaged in investigating a part of the country on the western side of Lake Timiskaming, and thence northward to some of the branches of the Blanche river, in connection with the recent discoveries of silver and cobalt in that district. He mapped out the various rock-formations of the region and indicated the zone in which the above metals occur. Prof. W. G. Miller, provincial geologist of Ontario, did similar work in the district adjoining Professor Parks' area on the south, a plan of co-opération having been arranged at the outset. Prof. W. A. Parks.

Mr. A. F. Hunter was employed in the district from Orangeville northward to Thornbury, Ontario, in tracing the interesting high-level shore-lines along the flanks of the Blue mountain escarpment south of Georgian bay. A. F. Hunter.

Mr. C. W. Willimott collected large supplies of minerals for distribution to educational institutions throughout the Dominion, and at the same time he obtained many fine specimens for the new Museum. His work was principally in the province of Quebec, but he also collected at some localities in Ontario. C. W. Willimott.

Professor Ernest Haycock was employed in working out the detailed geology of the upper Laurentian series in the south-western part of the county of Ottawa. This area embraces a variety of ancient crystalline rocks which Professor Haycock has endeavoured to arrange in nine groups, consisting of different kinds of gneiss, crystalline limestone, quartzite, altered greenstone, etc. It is proposed to continue Professor Haycock's labours in this field next summer, and, afterwards, to publish a map of the district on a scale of one mile to the inch, to show the geological structure and the distribution of the different belts, as was done by Sir William Logan on his map of a typical area of similar Upper Laurentian rocks in the county of Argenteuil. Prof. Ernest Haycock.

Mr. Frank Johnston did similar work in an area lying immediately north-east of the last, and also in the county of Ottawa. Some geological work had been done in this county in previous years by members of the staff; among these being Mr. E. D. Ingall, Mr. James White, Dr. R. W. Ells and the late Mr. H. G. Vennor. Frank Johnston.

Dr. Robert Chalmers investigated the surface-geology of the Gaspé peninsula and of the country along the south side of the Lower St. Dr. Robert Chalmers.

Lawrence from Gaspé south-westward towards the city of Quebec. Thence he worked northward to Lake St. John and spent some time in the valley of the Saguenay, where many interesting facts were ascertained.

Dr. J. A. Dresser.

Dr. J. A. Dresser coutinued the work of previous years in defining the copper-bearing belts in various parts of the Eastern Townships, including Drummond and Arthabaska. The object in view is to enable prospectors to confine their labours to the productive zones only. Dr. Dresser's work in this connection during the past three years has shown that the copper is confined almost entirely to the igneous rocks of the series, which are often much altered. A discovery of alluvial gold having been reported on lot 1 concession VII of the township of Stoke, in the province of Quebec, Dr. Dresser was requested to investigate the matter. He reported the 'find' to consist of mica in fine scales disseminated through gravel along the bed of a small stream. The gravel seemed to be of glacial origin, assorted by the stream.

Prof. L. W. Bailey.

Prof. L. W. Bailey devoted about one month to defining the boundaries of the rock-formations and ascertaining more accurately their geological horizons in the counties of York and Carleton, New Brunswick. He next inspected the more recent workings of certain economic minerals in that province and he has prepared the accompany ing report on these subjects.

Dr. R. W. Ells.

Dr. R. W. Ells, assisted by Mr. R. A. A. Johnston, devoted the early part of the season to investigating the geology of the greater part of Charlotte county, New Brunswick. The north-eastern portion of the county has still to be finished, and it is proposed to send Mr. Johnston, next summer, to complete this and to continue the work as far as the St. John river. When this has been done, a map will be published on a sufficiently large scale to show the details of the geology of the whole county and this additional area.

Dr. Henry S. Poole.

Dr. Henry S. Poole completed the work necessary to construct a geological map of the district around Lake Ainslie, in Cape Breton, which will be published with his report on Barytes in Canada. In this report the veins of this mineral at Lake Ainslie are particularly described.

Hugh Fletcher.

Mr. Hugh Fletcher, with two assistant geologists, was engaged in in general systematic geological work in Kings, Annapolis and Cumberland counties, Nova Scotia, including practical researches in the coal-fields and iron ore districts of these counties. The actual discovery of a thick seam of coal, by boring where Mr. Fletcher had indicated, after his geological investigation, within a large area not before known to be productive, has been referred to in a previous page. This is a good example of the immense value of a well conducted geological survey.

Mr. E. R. Faribault, with two assistant geologists, worked in the more westerly of the gold districts of Nova Scotia. Instrumental surveys were made of these districts similar to those which were completed in previous years, in other gold districts of the province. Mr. Faribault has laid down all the surveyed gold districts separately on a large scale. He is preparing a general sheet comprising a number of these districts, to accompany a Bulletin by himself on the occurrence of gold in Nova Scotia generally, in which many interesting points of economic importance will be brought out. E. R. Faribault.

Mr. L. N. Richard, assisted by Mr. J. J. McGee, was occupied during part of the summer in running lines of accurate survey in Nova Scotia, between the Bay of Fundy and the Atlantic, south of Halifax. This work is described in Mr. Senecal's report. L. N. Richard.

My own field-work, as a member of the International Committee of Geologists on the crystalline rocks of the Lake Superior region, is referred to in connection with the report of the Committee.

The report of the Mines Section and the preliminary tabulated statement of the output of the various mineral products of the Dominion, given further on in this volume, show some interesting features. Among the large number of questions received either personally by members of the staff, or through correspondence, in regard to economic minerals, the following, embodying more than fifty kinds, were those more particularly inquired for during the year :— Mines Section.

Albertite,	Marls,
Anthracite,	Mica,
Apatite,	Mineral waters,
Asbestus,	Molybdenite,
Barytes,	Monazite,
Bauxite,	Nickel,
Blende,	Ochres,
Chromic iron,	Ozokerite,
Clays,	Petroleum,
Coal,	Pitchblende,
Cobalt,	Platinum,
Copper ores,	Radium,
Corundum,	Rotten-stone,

Feldspars,
Fire-clay,
Galena,
Gas,
Gold,
Gypsum,
Hematite,
Infusorial earth,
Iron ores in general,
Iron pyrites,
Lignite,
Limestones,
Magnesite,
Magnetite,
Marbles,
Rutile,
Slates,
Soapstone,
Sodalite,
Talc,
Titanite,
Titanium,
Tripolite,
Tungsten,
Uranium,
Vanadinite,
Witherite,
Wolfram,
Zinc ores.

Information was especially sought in regard to clays, limestones and marls suitable for the manufacture of hydraulic cement, and also as to petroleum, natural gas, peat and molybdenite.

Peat.

Owing to the constantly increasing price of fuel and the absence of coal in Ontario and Quebec, the most populous provinces of the Dominion, much interest is being taken in peat. The excellent bulletin on this subject by Dr. Robert Chalmers of this Survey, published in the early part of the year, has been much asked for. The Honourable Senator McMullen, during last session of parliament, called for a Return, giving all information which might be available in regard to fuels (other than wood) in the provinces of Quebec, Ontario and Manitoba. The matter is of so much importance that that Return, which was then furnished by this Department, is here reproduced. In the course of my inquiries as to peat, I had some correspondence with Dr. G. H. Kinahan, formerly Director of the Geological Survey of Ireland, to whom I am indebted for valuable information on this subject.

COAL OR OTHER MINERAL FUEL SUPPLY IN THE PROVINCES OF QUEBEC, ONTARIO AND MANITOBA.

The following return was made by the Geological Survey to an Address by the Honourable Senator McMullen 'for all reports bearing upon the question of coal or other fuel supply in the provinces of Quebec, Ontario and Manitoba.' (No reference was made to wood, which still constitutes the chief fuel of these provinces, except in the cities and towns, as it was understood that the Return should apply to mineral fuel only.)

List of publications and references in the reports of the Geological Survey of Canada, etc.

List of publications referring to fuel.

PROVINCE OF QUEBEC.

Peat.

Combustible and carbonaceous materials (Eastern Canada), Geology of Canada, 1863, p. 771.

Peat and its applications, Report of Progress, 1866, p. 285.

Peat in the Province of Quebec, The Mineral Resources of the Province of Quebec, Report Geol. Survey, vol. IV, p. 85K.

Statistics of Peat Manufacture in the Province of Quebec, Report of Progress, 1871-72, p. 148,

Peat at Huntingdon, Report Geol. Survey, vol. VIII, p. 74A.

Peat at Charlevoix county, Report Geol. Survey, vol. V,. p. 52A.

Peat at Rivière du Loup, Report of Progress, 1866-69, p. 141.

Peat in Eastern Townships, Report Geol, Survey, vol. VII, p. 91J.

Peat in Grenville township, Report Geol. Survey, vol. XII, p. 137J.

NOTE.—Dr. Chalmers, of the Geological Survey, has written a Bulletin on Canadian peat, giving a full account of the state of the industry, occurrences of peat bogs, &c., published by the Geological Survey.

Natural Gas.

Borings for gas at Louiseville, St. Grégoire, &c. Annual Report, vol. IV, p. 74S.

Gas at St. Hyacinthe, Report Geol. Survey, vol. VI, p. 6A.

Borings at St. Grégoire, Report Geol. Survey, vol. XI, p. 62J.

Borings in vicinity of Three Rivers, Report of Progress, 1882-84, p. 13.

Gas occurrences in Champlain county, Report Geol. Survey, vol. XI, p. 122S.

Petroleum.

The Gaspé oil fields.	Geol. of Canada, 1863, p. 789.
"	Report of Progress, 1866, p. 260.
"	" 1880-82, p. 14DD.
"	Geol. Survey, vol. IV, p. 83K.
"	" vol. V. p. 120.
"	" vol. VI, p; 120S.
"	Summary Report for 1902, p. 338

Bituminous Shales.

Bituminous shales on Rivière à la Rose, Montmorency, Geology of Canada, 1863, p. 521.

Occurrences of Anthraxolite on Island of Orleans, Geology of Canada, 1863, p. 525.

ONTARIO.

Lignite.

Lignite on Missinaibi river, Report of Progress, 1875-76, p. 326.

Lignite on Missinaibi river, Report of Progress, 1877-78, p 4C.

Lignite on Kenogami river, Report of Progress, 1871-72, p. 112.

Lignite on Abitibi river, Summary, 1902, p. 233.

Lignite on Missinaibi river, Ontario Bureau of Mines, 1894, p. 125.

Lignite in Northern Ontario, Ontario Bureau of Mines, 1901-03.

Anthraxolite, Ontario Bureau of Mines, 1896, p. 159.

Anthraxolite, Ontario Bureau of Mines, 1900, p. 51.

Peat.

Peat in Eastern Canada, Geol. of Canada, 1863, p. 771.

Peat bogs south of Ottawa, Report Geol. Survey, vol. XII, p. 137A.

Peat in Ontario, Summary Report Geol. Survey, 1902, p. 275.

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Petroleum in Western Ontario, Geology of Canada, 1863, p. 785.

Petroleum in Ontario, Report of Progress, 1866, p. 240.

Petroleum at Wequemakong bay, Report of Progress, 1866, p. 179.

Petroleum and Natural Gas in Ontario, Report of Geol. Survey, vol. V, part Q.

Petrolia and other Ontario oil pools, with sketch map, Report Geol. Survey, vol. XI, p. 135S.

Statistics and state of Petroleum Industry, Annual Reports of Mines Section from 1886 to 1903.

Oil in Raleigh township, etc., Summary Report Geol. Survey, 1902, p. 269.

Petroleum in Ontario, Paper by Dr. Bell, Trans. Royal Society of Canada, vol. V, p. 101.

Natural Gas.

Report of Natural Gas and Pretroleum in Ontario, Report Geol. Survey, vol. V, part Q.

Natural Gas in Essex, Report Geol. Survey, vol. VI, p. 77A.

Natural Gas in Lambton, Report Geol. Survey, vol. IV, p. 46A.

Natural Gas in Ontario, Report Geol. Survey, vol. XI, p. 117S, with sketch maps.

Statistics of Natural Gas and state of Industry, Annual Reports of Mines Section from 1886 to date.

Oil Shales.

Bituminous shales in Bosanquet, Lambton, Geology of Canada, 1863, p. 785.

Bituminous limestones at Kincardine and on Manitoulin island, Geology of Canada, 1863, p. 790.

Bituminous shale at Collingwood, Geology of Canada, 1863, pp. 622 and 784.

MANITOBA.

Lignite.

Exposure of lignite on Swan lake, Report of Progress, 1874-75, p. 34.

Eastern limit of Souris Coal Fields, Report of Progress, 1879-80, p. 16A.

Eastern Assiniboia and Southern Manitoba, Summary Report Geol. Survey for 1902, p. 181.

PUBLICATIONS (EXCLUSIVE OF MAPS) WHICH HAVE BEEN ISSUED BY THE GEOLOGICAL SURVEY IN 1904.

In former years the need of publications by the Survey of the nature of "bulletins", by means of which the printing of papers or articles by members of the staff could be secured without undue delay, was seriously felt. A Geological Survey Bulletin issued as soon as ready in pamphlet form or even as an octavo volume would supply a medium through which officers of the Survey could readily give to the public the results of work in greater detail than is desirable for the pages of the "Summary Report," and yet more tentative in its nature than what would be necessary for a report, memoir or monograph giving the final opinions of its author. It was felt that an official bulletin would further have the advantage of placing, under one cover, papers or reports by officers of the Survey that are at present published in various scientific journals of this country, the United States and Europe, and that are therefore scattered and less easily obtainable by the Canadian public.

Publications in 1904.

Volumes XIV and XV of the Annual Reports are nearly in type, and the printing of Volume XVI has been commenced. Mr. McConnell's full report on '*The Gold of the Yukon*' was placed in the printer's hands last November. It has often been found difficult to get all the individual reports at the same time, as they are written by so many different persons. A certain number of the composite reports have been placed for reference in the libraries of universities and other public institutions; but for most purposes, only one of the parts which go to make up the volume is required at a time, and a great element of its value depends upon its prompt receipt. It is therefore proposed, hereafter, to print and issue the whole edition of each individual report as soon as it is ready and to cease binding them together in the present form after Volume XVI has been completed.

New index.

It is also proposed, after the completion of this series of Annual Reports I to XVI, to compile a complete index of these volumes. Such an index has long been needed, both by our own staff and the scientists of every country with which we exchange publications, and it has been somewhat of a reproach to this survey that we have issued no index since 1885. That index answered—and still answers—its purpose admirably so far as regards the Progress Reports, but we have had nothing of the kind, since the discontinuance of these reports, except the very elementary index at the end of each volume, an index both inconvenient and quite inadequate.

In order to meet the demand for up-to-date information on the economic minerals of Canada, I commenced in 1903 the publication of a series of Bulletins, and in that year four were issued, namely, on Platinum, Zinc, Asbestus, and Shell Marl. During 1904 the following ten have been published:—Manganese, Molybdenum and Tungsten, Coal, Common Salt, Infusorial Earth, Mica, Graphite, Apatite, Peat, and Copper in Quebec and the Maritime Provinces, making fourteen in all at the present date.

Economic geology was made a special feature in all the field operations of the year, and therefore nearly all the reports of the officers in charge of this work may be regarded as having reference to this subject. The work of the chemists and the metallurgist of the Survey and of the staff of the Mines Section was wholly of an economic character. Five of the individual reports which go to make up the large volume called the Annual Report for the year are entirely of this nature and might have been issued as Bulletins. These are (1) Dr. Barlow's report on the Nickel and Copper Deposits of Sudbury District, (2) Dr. Poole's Report on the Pictou Coal-field, (3) Dr. Adams' Report on the Deep Wells of the Island of Montreal, (4) Mr. Dowling's Report on the Coal-field of the Souris River, and (5) The Annual Report of the Section of Mines of the Department.

Five more Bulletins on economic minerals have been prepared by officers of the Survey, and will be published as soon as possible. They are on the following subjects :—Barytes, Clays suitable for the manufacture of bricks, tiles, pottery, etc., Building Stones, Corundum and Mineral Pigments.

We are collecting the data and preparing Bulletins on twelve other economic minerals, and it is hoped that most of these will be ready for publication before long. Counting the separate Bulletins, the Summary Reports in the present volume and the Annual Reports on economic minerals published by this Department in 1904, the total number is found to be larger than for any single year during the previous existence of the Survey.

The other Reports, Special Publications, &c. issued during the year are the following :—

Catalogue of Canadian Birds, Part III, pp. 733 by Professor John Macoun.

Contributions to Canadian Palæontology, Vol. III, (quarto) Part II, on Vertebrata of the Mid-Cretaceous of the North-west Territory pp. 81, and 21 plates, by Henry F. Osborn and Lawrence M. Lambe.

Contributions to Canadian Palæontology, Vol. III (quarto) Part III on Deyptosaurus Incrassatus (Cope). From the Edmonton series of the North-west Territory, pp. 27, (illustrated by eight plates,) by Lawrence M. Lambe.

Summary Report of the Geological Survey of Canada for the calendar year 1903, pp. 218, (with 8 maps, 2 sections and several other illustrations.) *Sessional document.*

Part AA, Vol. XV, with 8 maps, 2 sections and other illustrations by the Geological corps.

Report on the exploration of the Ekwan river, Sutton Mill lakes and part of the West Coast of James bay, Part F, Vol. XIV, pp. 60 by Mr. D. B. Dowling.

Report on The Pictou Coal Field, Nova Scotia, Part M., Vol. XIV, pp. 38 (with map) by Dr. H. S. Poole.

Report on the Artesian and other Deep Wells on the Island of Montreal, Part O. Vol. XIV, pp. 74, (with maps and illustrations,) by Dr. F. D. Adams and Mr. O. E. Leroy.

Report on the Origin, Composition and Geological Relations of the Nickel and Copper Deposits of Sudbury, Ont., pp. 237, (29 illustrations and 5 maps,) by Dr. A. E. Barlow.

Report on the Coal-field of the Souris river, Eastern Assinaboia, Part F., Vol. XV, pp. 45, (with illustrations) by Mr. D. B. Dowling.

Annual Report of the Mines Section for 1902, part S., Vol. XV, pp. 280, by Mr. E. D. Ingall and Mr. J. McLeish.

The Annual Report of the Mines Section for 1903, Part S, Vol. XVI, is in press, and is expected to be issued about the end of May.

COMMITTEES ON GEOLOGICAL NOMENCLATURE AND THE CORRELATION OF ROCK FORMATIONS.

Geological Nomenclature.

In the Summary Report of this department for 1902, page 17, it was explained that in May 1901, the writer was appointed by the Royal Society of Canada as convener of a committee of Canadian geologists, whom he was to select, to take into consideration the Nomenclature of Geological Formations in Canada. The progress subsequently made by this committee was also referred to in that report. The committee still exists and may do good work in connection with the nomenclature of the geological formations in Canada. But the settlement of various questions affecting the geology of both Canada and the United States demands more immediate attention.

Committees appointed.

For many years past there have been much discussion and controversy between geologists of Canada and those of the United States, and indeed among the geologists of each country itself, as to a variety of questions touching the relative ages, positions, etc., of the various groups and divisions of the rocks, especially the crystalline rocks, of the two countries. The want of agreement was particularly manifest in regard to the crystalline rocks of the Lake Superior region. It seemed to me that much of this disagreement arose from radical misunderstandings and that it was possible to overcome these, and to divert the energy spent by numerous geologists on endless controversy, to the more profitable employment of promoting the progress of original research. With this object in view, I corresponded, in 1902, with

Dr. Charles D. Walcott, Director of the United States Geological Survey and President Van Hise of the State University of Wisconsin and a member of that Survey (in charge of the geology of the crystalline rocks) on the subject, and this led to the appointment of an International Committee to take into consideration all questions affecting geological nomenclature and succession in which the geologists of both countries are interested. This permanent or parent committee consists of Dr. C. W. Hayes (who is in charge of the purely geological work of the United States Geological Survey) and President Van Hise, representing the United States; Dr. Frank D. Adams, Professor of Geology in McGill University, and myself, representing Canada. This committee first met at Washington on January 2, 1903. It then appointed several special or sub-committees to investigate the rocks of various districts near the Boundary line. One of them was the Lake Superior Committee which consisted of the following: for the United States, Dr. C. R. Van Hise and Professor C. K. Leith, of the United States Geological Survey and Dr. A. C. Lane, State Geologist of Michigan; and for Canada, Dr. Robert Bell of the Dominion Geological Survey, Dr. F. D. Adams of McGill University, and Professor W. G. Miller, Provincial Geologist of Ontario.

As was explained in my Summary Report for 1902, page 20, it was agreed at the above meeting in Washington, that the first practical steps towards a mutual understanding would be actual joint inspection by the respective special committees, of the rocks which might be in question, so that they might be discussed on the ground, and a decision reached in each case.

Work by Lake Superior Committee.

The Lake Superior Committee was to commence field-work in the spring of the same year (1903), but shortly after the above meeting had been held, it was found that some of the United States geologists, would not be able to take part, and this work was reluctantly postponed until 1904, when we began operations in the Marquette district in Michigan on the 3rd of August, all the members being present. Our investigations in United States territory were in the states of Michigan, Wisconsin and Minnesota; while in Canada they were made in various localities in the country on the northern sides of Lakes Superior and Huron. Before separating at the conclusion of our field labours, we drew up a draft report at Thessalon, which embodied our conclusions. A typewritten copy of this report was, soon after, sent to each member for consideration.

In December, another meeting of the Committee was held in Philadelphia, at which all the members but one were present. After further careful consideration and discussion at this meeting, our report has been printed. It is hoped that it will commend itself to all geologists as the best solution that can at present be offered of the difficulties which have been experienced in regard to the geology of the crystalline rocks of the Lake Superior region.

This report may be regarded as a new starting point in Lake Superior geology, and in view of the great importance of having at last arrived at reasonable conclusions, the many years of previous study involved, and the desirability of promoting harmony in this connection, a synopsis of the report is here given for convenience of reference.

Synopsis of the Report of the Special Committee for the Lake Superior Region

To C. Willard Hayes, Robert Bell, Frank D. Adams, and Charles R. Van Hise, general committee on the relations of the Canadian and the United States Geological Surveys.

INTRODUCTORY NOTE BY C. R. VAN HISE.

The report below of the special committee on the nomenclature and correlation of the geological formations of the United States and Canada is the first joint report of the geologists of the two countries. Before the death of Dr. G. M. Dawson, formerly Director of the Canadian Geological Survey, I had correspondence with him in reference to joint field-work in the Lake Superior region. It was agreed between us that such field-work should be undertaken, but his untimely death occurred before anything was done.

Note by C. R. Van Hise.

After Dr. Dawson's death, I continued correspondence upon the subject with Dr. Robert Bell, Acting Director of the Canadian Geological Survey. As a result of this correspondence, December 22, 1902, Dr. Bell wrote to Dr. C. D. Walcott, Director of the United States Geological Survey, suggesting a conference in reference to the mutual interest of the two Surveys. This letter led to the appointment of a committee—consisting of C. W. Hayes and C. R. Van Hise, for the United States Geological Survey, and Robert Bell and Frank D. Adams, for the Canadian Geological Survey—to consider all questions as to the successions of formations, and as to nomenclature, which concerned the two Surveys.

The committee, with C. W. Hayes as chairman, met for the first time at Washington, January 2, 1903. At this meeting several special committees were appointed to consider different districts along the International Boundary. For the Lake Superior region, the following committee was appointed: for the United States, C. R. Van Hise and C. K. Leith, of the United States Geological Survey, and A. C. Lane, state geologist of Michigan; and for Canada, Robert Bell and Frank D. Adams, of the Canadian Geological Survey, and W. G. Miller, provincial geologist of Ontario.

August 3, 1904, this special committee met in the Marquette district of Michigan, and during the six weeks following visited successively the Gogebic, Mesabi, Vermilion, Rainy Lake, Lake of the Woods, Animikie and original Huronian districts. After finishing the field-work, a report in preliminary form was drawn up.

In December, 1904, another meeting of the special committee was held at Philadelphia, further to consider the report, all members of the committee being present except C. R. Van Hise. At this meeting, the report of the subcommittee was completed.

Synopsis of Report.

The special committee on the Lake Superior region, during the months of August and September, 1904, visited various districts in the Lake Superior country, their purpose being to ascertain, if possible, whether they could agree upon the succession and relations of the formations in the various districts, and could further agree upon a nomenclature appropriate to express the facts. The districts visited were the Marquette, the Penokee-Gogebic, the Mesabi, the Vermilion, the Rainy Lake, the Lake of the Woods, the Thunder Bay, and the original Huronian of the north shore of Lake Huron. In addition to the regular members of the special committee, other geologists were with the party for portions of the trip. Dr. C. W. Hayes, geologist in charge of geology, United States Geological Survey, and a member of the general committee, was with the party for the Marquette, Penokee-Gogebic, Mesabi, Vermilion, and Rainy Lake districts. Professor A. E. Seaman was with the party for the Marquette Penokee-Gogebic, Rainy lake, Lake of the Woods, and Thunder Bay districts. Mr. J. U. Sebenius was with the party for the Mesabi district; Mr. W. N. Merriam, for the Mesabi and Vermilion districts; Mr. W. N. Smith, for the Thunder Bay district; Mr. E. D. Ingall and Mr. T. Denis, for the Lake Huron district. The knowledge of these men was of great assistance to the committee. Synopsis of report.

In the Marquette district the committee found the upper series there exposed to be as follows: (1) Michigamme slate and schist, and (2)

Ishpeming formation. Locally within the Michigamme slate, and apparently near its base, is an iron-bearing horizon. The Clarksburg volcanics, a local phase of the Michigamme formation, were seen at Champion. The basal member of the Ishpeming formation is the Goodrich quartzite or Upper Marquette series. The next series is the Middle Marquette series, consisting of (1) the Negaunee formation, (2) the Siamo slate, and (3) Ajibik quartzite. Below this is the Lower Marquette series, consisting of (1) the Wewe slate, (2) the Kona dolomite, and (3) the Mesnard quartzite. At the base of the Lower Marquette series is an unconformity, marked by conglomerates bearing fragments of all the kinds of rocks seen in the underlying series. Two classes of fragments are especially abundant. These are (1) tuff, greenstone schist, and many kinds of greenstones which belong to the so-called green-schist series of the district, and (2) various kinds of granite and gneissoid granite. The Penokee-Gogebic series consists of (1) the Tyler slate, (2) the Ironwood formation, and (3) the Palms slate.

East of the Presqu'isle river the lower sedimentary succession of the Penokee-Gogebic district was visited, here consisting of (1) cherty limestone and (2) quartzite.

In the Mesabi district the succession of the Mesabi series is as follows : (1) Virginia slate, (2) the Biwabik iron formation, and (3) the Pokegama quartzite. At the base of this series at Biwabik is a conglomerate which rests upon a series of slates and graywacke, the latter in nearly vertical attitude. The unconformity between the two is most pronounced.

In the Vermilion district the Upper series, where seen, consists of (1) Knife slates and (2) Ogishke conglomerate. The Ogishke conglomerate contains very numerous fragments of all the underlying formations noted—porphyrites, green schists, iron formation, granite etc —and we have no doubt that there is a great structural break at the base of the Ogishke. The series below this unconformity, the Vermilion series, consists of (1) the Ely greenstone and (2) the Soudan formation. The Ely greenstone is the dominant formation. It is mainly composed of green schists and greenstones, many of which show ellipsoidal structure. The other important formation of the Vermilion series is the Soudan iron formation. The structural relations of the Ely greenstone and the Soudan formation are most intricate. No opinion is here expressed as to their order.

In the Rainy Lake district the Couchiching schists form the highest formation at the east end of Shoal lake and at a number of other localities.

They are a series of micaceous schists graduating downward into green hornblendic and chloritic schists, which pass into a conglomerate known as the Shoal Lake conglomerate. This conglomerate lies upon an area of green schists and granites known as the Bad Vermilion granites. It holds numerous large well-rolled fragments of the underlying rocks, and forms the base of a sedimentary series. It is certain that in this line of section the Couchiching is stratigraphically higher than the chloritic schists and conglomerates mapped as Keewatin. On the south side of Rat Root bay there is also a great conglomerate belt, the dominant fragments of which consist of green schist and greenstone, but which also contains much granite.

In the Lake of the Woods area one main section was made from Falcon Island to Kenora, with various traverses to the east and west of the line of section. We were unable to find any belts of undoubted sedimentary slate of considerable magnitude. At one or two localities, subordinate belts of slate, which appeared to be ordinary sediment, and one belt of black slate which is certainly sedimentáry, are found. In short, the materials which we could recognize as water-deposited sediments are small in volume. Many of the slaty phases of rocks seemed to be no more than the metamorphosed ellipsoidal greenstones and tuffs, but some of them may be altered felsite. However, we do not assert that the larger area may not be sedimentary in the sense of having been deposited under water. Aside from the belts mapped as slate, there are great areas mapped as agglomerates, but which seem to the committee to be largely tuff deposits, which also include extensive areas of ellipsoidal greenstones.

The committee could discover no structural breaks between the above formations of the Lake of the Woods. The various classes of materials—slates, agglomerates, and ellipsoidal greenstones—all seem to belong together. In short, these rocks in the Lake of the Woods seem to constitute one series which is very largely igneous or volcanic in origin, but does, as above mentioned, contain some sediments.

The ellipsoidal greenstone-agglomerate-slate series is cut in a most intricate way by granite and granitoid gneiss, which constitute much of Falcon island at the southern part of the Lake of the Woods and a great area north of the Lake of the Woods. These relations between the granite and Keewatin were seen on the north-west part of Falcon island and on a small island adjacent. They were also seen north of Keenora. At the latter place the rocks adjacent to the granite are banded hornblende and micaceous schists, very similar to the banded rocks of Lighthouse point, at Marquette. At Hebe falls, the granite and Keewatin series are seen to be in actual contact, the Keewatin being apparently intruded by the granites.

In the Thunder Bay district the committee visited especially the areas about Loon lake and Port Arthur. In the Loon lake area the succession is as follows: The top series is the Keweenawan, here consisting of sandstone above and conglomerate below, with interbedded basic igneous flows or sills. Below the Keweenawan is the Animikie. The contact between the Keweenawan and the Animikie was seen at two places. At both localities the conglomerate at the base of the Keweenawan bears detritus from the underlying series. The Animikie succession, which the committee saw near Loon lake, includes two phases of the iron-bearing formation with an interstratified belt of slate.

Near Port Arthur the higher slate member of the Animikie was visited by a portion of the party, and on previous occasions had been visited by the other members. This is the formation which is agreed by all to rest upon the Animikie iron formation.

At one place near Loon lake a test pit has been sunk to the bottom of the Animikie, and here, at the base of the formation, is a conglomerate, bearing fragments of the next underlying series—a graywacke slate.

In the original Huronian area—i. e., the area described by Logan and Murray as extending from near Sault Ste. Marie along the north shore of Lake Huron to Thessalon and northward—the committee examined a number of crucial localities. At the first of these, about five miles east of Sault Ste. Marie, near Root river, it studied the relations of Logan's lower slate-conglomerate.

The party next visited the abandoned limestone quarry north of Garden River station and examined the slate-conglomerate belt north of the limestone. The committee concludes that the rock on each side of the limestone is the upper slate conglomerate, the structure probably being anticlinal, possibly with faulting. This conclusion suggests that the same relation obtains at the Root river locality.

On the limestone point on the east side of Echo lake the following ascending succession was found, with monoclinal dip to the south-east: (1) white or gray quartzite, grading through graywacke into (2) a thin belt of conglomerate not exceeding twenty feet in thickness and containing numerous granite fragments. Above the conglomerate is (3) limestone in considerable thickness, and over this (4) the upper slate conglomerate.

On the west side of Echo lake, on the prominent bluff next north of the formation is nearly horizontal, but dips slightly into the hill. The total thickness of the limestone here seen was probably not more than fifty feet, and of the conglomerate below, not more than thirty feet. The lower five hundred feet or more of the bluff is the white quartzite.

Observations from Root river to Echo lake convince the committee that there is a considerable structural break in the Huronian. The upper series includes the following formations of Logan, viz.: white quartzite, chert, and limestone, yellow chert and limestone, white quartzite, red jasper conglomerate, red quartzite, and upper slate conglomerate. The lower series includes the lower limestone of Logan and the lower slate conglomerate, white quartzite, and gray quartzite.

Four miles east of Thessalon, on several islands off the coast, is a great conglomerate, mapped by Logan and Murray as gray quartzite. This conglomerate was found to rest unconformably upon the granite, the actual contact being observed upon one island opposite the north-west quarter of section twelve of the township of Thessalon. The fragments in the conglomerate are well-rounded and are largely granite, but there are also numerous pebbles and boulders of greenstone and green schist. On several islands adjacent to the conglomerate the massive granite includes many fragments of greenstone and green schist, showing the granite to be intrusive into a greenstone formation. Thus, in the complex against which the conglomerate rests we have a source both for the granite and greenstone pebbles and boulders. The relations here are believed by certain members of the party to show that the quartzite and conglomerate rest unconformably upon the greenstone, but other members felt that this conclusion is not certain.

The rocks called green chloritic schist by Logan, consisting of ellipsoidal greenstones, amygdaloids, agglomerates, and massive greenstones may be called the Thessalon series and should be excluded from the Huronian. If this series be excluded, the Huronian of Lake Huron consists of two series, an Upper Huronian and a Lower Huronian. The Upper Huronian extends from the top of the series, downward to, and including, the upper slate conglomerate; and the Lower Huronian extends from the main limestone formation to the gray quartzite, including its basal conglomerates.

General Conclusions.

There are certain general points which seem to be reasonably clear, and about which there is no difference of opinion. These are as follows :—

There is an important structural break at the base of the Keweenawan. The term "Keweenawan" should include substantially all of the areas which have been thus mapped, or mapped as Nipigon, by the Canadian and United States Surveys, and the State Surveys of Michigan, Minnesota and Wisconsin.

Below the Keweenawan is the Huronian system, which should include the following series :—In the Marquette district, the Huronian should include the Upper and Lower Marquette series, as defined in the monograph of the United States Geological Survey, or the Upper, Middle, and Lower Marquette series, as given in the previous paragraphs. In the Penokee-Gogebic district, the Huronian should include the series which has been called the Penokee-Gogebic series proper, and the limestone and quartzite which have local development, and which we visited east of Presqu'isle river. In the Mesabi district, the Huronian should include the Mesabi series proper, and the slate-graywacke-conglomerate series unconformably below the Mesabi series. In the Vermilion district, the Huronian should include the Knife slates and the Ogishke conglomerates. In the Rainy Lake district, the Huronian should include that part of the Couchiching of the south part of Rainy lake which is limited below by basal conglomerate, as shown at Shoal lake. In the Thunder Bay district, the Huronian should include the Animikie and the graywacke series of the Loon Lake area. In the original Huronian area, the Huronian should include the area mapped by Logan and Murray as Huronian, except that the Thessalon greenstones should probably be excluded.

Unconformably below the Huronian is the Keewatin. The Keewatin includes the rocks so defined for the Lake of the Woods area and their equivalents. The committee believes the Kitchi and Mona schists of the Marquette district, the green schist (Mareniscan) of the Penokee-Gogebic district, the greenstone series of the Mesabi district, the Ely greenstones and Soudan formation of the Vermilion district, the part of the area mapped as Keewatin by Lawson in the Rainy Lake district not belonging structurally with the Couchiching, and probably the Thessalon greenstone series on the north shore of Lake Huron, to be equivalent to the Keewatin of the Lake of the Woods, and so far as this is true, they should be called Keewatin.

For the granites and gneissoid granites which antedate, or protrude through, the Keewatin, and which are Pre-Huronian, the term "Laurentian" is adopted. In certain cases this term may also be employed, preferably with an explanatory phrase, for associated granites of large extent which cut the Huronian, or whose relations to the Huronian cannot be determined.

The following succession and nomenclature are recognized and adopted :— Summary of report.

CAMBRIAN—Upper sandstones, etc., of Lake Superior.

Unconformity

PRE-CAMBRIAN

Keweenawan (Nipigon)[1]

Unconformity

Huronian { Upper (Animikie)

Unconformity

Middle

Unconformity

Lower }

Unconformity

Keewatin

Eruptive contact

Laurentian

Alphabetically signed by the committee as follows :—

FRANK D. ADAMS,
ROBERT BELL,
A. C. LANE,
C. K. LEITH,
W. G. MILLER,
CHARLES R. VAN HISE,

Special Committee for the Lake Superior Region.

REMARKS ON THE ABOVE REPORT.

The crystalline rocks treated of in the foregoing report have been studied in more detail in the three states traversed by the Committee than elsewhere, but most of them extend, not only to the Canadian Remarks on the report.

[1] Dr. Lane dissents as to the position of the Keweenawan as follows :

'The use of Pre-Cambrian above does not imply unanimity in the committee with regard to the Pre-Cambrian correlation of the Keweenawan—a topic the committee as such did not investigate."

side of Lake Superior, but far beyond to the northward and eastward. Owing to the greater number of geologists who have been employed in the three states visited and the larger means which have been placed at their disposal, the United States geologists have been able to work out in more detail than we, the rock-formations in question, as to their sub-divisions, characters, relations to each other, as to conformity, eruptive contacts or otherwise; whether certain rocks of similar description may not be of different ages, and *vice versa*, and as to various other matters, all leading to a complete classification and correlation. On the other hand, the Canadian geologists had examined the continuation of these rocks over greater distances and areas and could contribute their knowledge as to the relative extent, volume and importance of the various divisions.

This International Committee, therefore, consisted of a council, the members of which were able, after their joint field-work, to bring together the various kinds of experience necessary to arrive at more complete and harmonious conclusions as to the correlations of the rocks in question than has hitherto been found possible.

We recognized as good natural units of classification certain divisions by the United States geologists of what we had hitherto coloured on our maps as a single group or system of rocks under the general name of Huronian. Our knowledge of the differences which exist among these rocks in all parts of their distribution will enable us, without much re-examination, to represent the above divisions on our larger scale maps. A geological map, coloured uniformly on both sides of the boundary line, will have great advantages over the older and sometimes discordant ones, not only for geologists, but also for the use of prospectors and mining men.

The nomenclature and general classification adopted by the joint Committee, as the outcome of the research and accumulated knowledge of a great number of geologists working in the United States for half a century, bears welcome testimony to the wisdom of the older Canadian geologists and to the extent of their knowledge, even sixty years ago, as well as to the great amount and thoroughness of the work they performed. It is satisfactory to note that the formational names adopted in the table at the end of the above report, which represents the gist of our labours, are all of Canadian origin. An American equivalent is given in one case.

PRACTICAL CHARACTER OF THE WORK OF THE DEPARTMENT.

Economic character of the work.

As already stated, our labours are all in the direction of economic geology, although, to some persons this may not always be obvious. In the last Summary Report of this Department, a list was given of no fewer than 605 reports, etc., on economic geology, which had been published by the Geological Survey up to that date. The negative results of our work may be as important as the positive, by showing what areas or in what rocks useful minerals are not to be looked for, as well as those in which they may be found; for in this way the waste of much labour and capital may be prevented. It was estimated that the amount saved in one year in England, through its Geological Survey, by preventing the hopeless search for coal, alone, was more than the whole cost of that Survey from its inception. Similarly in Canada, much has been saved, owing to our own Survey having been the means of preventing profitlesss boring for coal in Ontario and Quebec. A geological Survey may be utilized to indicate the prospects for discovery and also of continued productiveness or otherwise of any mineral occurrence in the future. True and reliable geological descriptions of mineral occurrences or of mining districts are indispensable for the intelligent investment of capital for their development.

Although the direct and immediate search for individual 'mines' is not the principal object of the Geological Survey, yet numerous examples could be given of the discovery of valuable minerals and of other results which have been attained by its means. One of the earliest of these was the laying out of Woods' Location on Lake Superior by the advice of Sir William Logan, the first Director. It was on this location that the famous Silver Islet mine was afterwards discovered, which yielded immense quantities of the precious metal. Another example was the discovery of corundum in south-eastern Ontario, where it exists, of the best quality, in quantities which promise to outrival all other sources for the world's supply of this mineral.

Nickel at Sudbury.

Nickel was first found in 1848 by the late Alexander Murray, chief assistant on the Geological Survey, in the very heart of what is now the richest part of the Sudbury mining district, when this locality was far back in the midst of the dense primeval forest, which stretched from the then uninhabited shore of Lake Huron all the way to Hudson Bay. This discovery, and also that of rich nickel ore at the Wallace mine, on the coast of Lake Huron opposite to Sudbury, are fully described by Mr. Murray and also by Dr. Sterry Hunt in their respective reports for that year.

Bruce mines.

The development of the copper vein at the Bruce mines was due to the careful personal examination and the favourable opinion of it by Sir William Logan at the outset. The working of these mines led to the discovery and development of the Wellington and the Huron Copper bay mines adjoining them to the west. The wealth in copper of the southern portion of the province of Quebec was first made known and fully reported upon by the Survey.

Petroleum.

The natural laws governing the mode of occurrence of petroleum and terrestrial gas were demonstrated at an early date by Dr. Sterry Hunt and other officers of the Department, and this demonstration led to the economic exploiting of these products, not only in Canada, but also in the United States and other countries. The deep source of the petroleum of southern Ontario was first suggested by the writer in 1887 and his opinion is now verified by the recent discoveries at Leamington, and by other circumstances. The site at which to bore the famous natural gas well at Kingsville, in the County of Essex, was pointed out by Mr. Eugène Coste before leaving the Geological Survey. The locality is on the crown of a great but low anticlinal, described in the Geology of Canada, 1863.

Salt.

The probable existence of salt in the Onondaga formation on the east side of Lake Huron was repeatedly mentioned by members of the Geological Survey and the municipality of Goderich was encouraged to bore for it in that town. A contract for the purpose was let by the corporation to the late Mr. William Whitehead, and in 1865 rock salt was struck at a depth of 1,010 ft.

Iron.

The vast deposits of manganese and iron ores on the eastern coast of Hudson bay were discovered and reported on by the writer in 1877.

Clay.

The superior quality of a certain clay occurring near Milton, Ontario, for the manufacture of terra-cotta and the finest bricks, was discovered by practical trials made in the laboratory of the Geological Survey.

Gold.

The existence of gold in eastern Ontario was first recognized by the late Mr. Henry G. Vennor of the Geological Survey in August, 1866, at an opening which was being made for copper in the township of Madoc by a man named Powell. The property became known as the Richardson mine. This initial discovery led to the making of others in the county of Hastings, and these encouraged the search in later years for the precious metal north of Lake Huron and west of Lake Superior.

The original source of the gold of the Klondike district and the causes which have led to its present distribution and mode of occurrence, as well as the prospect for future production, were first intelligently pointed out by Mr. R. G. McConnell of the Geological Survey.

The true nature, extent and origin of the gold-bearing veins of Nova Scotia, which are similar in all the gold districts of that province, were first demonstrated by Mr. E. R. Faribault, also of this Survey.

A striking example of the value of a scientific knowledge of geology, derived from actual investigation, is the one referred to in a previous part of this report, of the recent finding of a thick seam of coal in Cumberland county, Nova Scotia, after boring in a previously untried area, through a great depth of barren rock, on the advice of Mr. Hugh Fletcher of this Department. This discovery may prove to be worth many millions of dollars, owing to the increase in the value of the large tract of land which may now be, for the first time, assumed to be underlaid by coal. Value of geology.

It is of great importance to be able, even now, to form some general idea of the prospect for finding valuable minerals throughout the vast and little-known regions which still form the greater part of the territory of Canada. Our preliminary or reconnaisance surveys all over this immense area, already enable us, in a general way, to conjecture what this may be on the mainland of the continent, even as far as the shores of the northern seas and on some of our principal islands in the arctic regions.

Not only has the Survey been of great service to Canada in giving to the civilized world a knowledge of the topography, geology and mineral resources of the country, but in an equal degree, it has promcted the building of roads and railways, the extension of agriculture and the settlement of the country. Use of the Survey.

When the construction of the Grand Trunk Pacific railway was first proposed in 1902, the region to be traversed was found to be already fairly well known all the way from Quebec to Winnipeg, as to elevations, topography, soil, timber, climate, fauna, flora, etc., as well as in regard to its mineral resources, through the work of the survey which the writer had been carrying on in nearly all parts of that region during the previous thirty-five years. The results of all this work, which had been fully reported and illustrated by maps, enabled our public men to judge of the feasibility of the undertaking, and much time was thus saved in arranging for the construction of the railway.

The foregoing examples are only a few of the many which might be given in illustration of the important direct economic advantages which we have gained from the work of the Geological Survey and which far outweigh its cost, to say nothing of the many and great scientific results which form the principal part of Canada's contribution to the general progress of knowledge among the nations.

ECONOMIC GEOLOGY IN BRITISH COLUMBIA AND THE YUKON TERRITORY.

British Columbia and the Yukon.

Following up the traditions of the Department in prosecuting the methods of the Geological Survey of Canada for the purpose of ultimately discovering economic minerals, it appeared to the writer that the prospects of success in this way in British Columbia and the Yukon Territory would warrant a considerable extension of our operations in these regions, which seem to be greatly favoured with mineral wealth. Accordingly, I requested the then Minister of the Interior to provide $19,000 to meet the expenses of this work during the financial year 1904-5. This amount was granted by Parliament and a similar sum has been placed in the estimates for 1905-6 for the continuation of these investigations. Last year, a large amount of labour, in the aggregate, was performed in the above sections of the Dominion by Messrs. Joseph Keele, R. G. McConnell and his assistant Mr. F. H. Maclaren, and by Dr. R. W. Ells and his assistant Mr. R. A. A. Johnston, and by Professor R. W. Brock and his assistant Mr. W. H. Boyd. Preparations have been made, including the purchase of a supply of field-instruments, to prosecute this work with vigour during the present year.

PROVINCIAL MINING BUREAUS.

Provincial mining bureaus.

The work of the Dominion Geological Survey in economic geology is supplemented by the mining bureaus which are established in some of the provinces.

In British Columbia a large amount of information is given every year in the report of the Minister of Mines, as to prospecting, the discovery of minerals, the progress of mining, &c. This is collected partly by the provincial mineralogist, Mr. W. F. Robertson and his assistant Mr. Herbert Carmichael, from personal observation, and partly by correspondence.

The province of Ontario has a well-conducted Bureau of Mines, under the direction of Mr. Thomas W. Gibson. This is the only province which has yet done any systematic field geology. During the year 1904, the efficient provincial geologist, Professor W. G.

Miller, aided by Mr. Cyril W. Knight, mapped out in detail the distribution of the interesting series of rocks on the west side of Lake Timiskaming, where are situated the veins discovered in November, 1903, holding cobalt, silver, copper, nickel and arsenic. He has also just published a bulletin on the limestones of Ontario. Professor A. P. Coleman of the University of Toronto continued his investigations among the nickel-bearing rocks of the Sudbury district in connection with the Bureau, and Dr. J. M. Bell was again engaged in its service exploring and surveying in the country on the south of James bay.

In the province of Quebec, the government Inspector of Mines, Mr. J. Obalski, in 1904 made a geological reconnaissance in the country north-west of Lake St. John, parts of which had been explored in different years by several of the members of the Geological Survey. On this journey Mr. Obalski was fortunate enough to discover some promising occurrences of economic minerals, among them being gold, copper-ore and asbestus. The gold is in the form of free particles in a very large vein of quartz. It is very probable that other gold-bearing veins will be discovered in the same belt of rocks. In 1895 and '96 the writer brought home samples of quartz from well-defined quartz veins cutting similar Huronian rocks on the Bell river in the same region, some of which, on assay, proved to be auriferous. The copper ore consists of the yellow pyrites (chalcopyrite) in a quartz vein, while the asbestus (chrysotile) occurs in serpentine and is of a good quality. The fibre of some samples is fully three inches in length Mr. James Richardson of the Geological Survey had found copper-pyrites in a different locality in the same neighbourhood, when exploring in this district in 1870. The above minerals all occur in an extensive belt of Huronian rocks, (shown on the geological map published by the writer in 1903, which covers the basin of the Nottaway river and other portions of north-eastern Quebec.) Quebec.

In Nova Scotia, the royalties derived from coal and gold have long been an important item in the revenue of the province; and its Department of Mines has for many years issued an annual report on the condition of the mining industry. Heretofore, however, the local government has not done much in the way of purely geological work, nor as to scientific inquiry into the mineral resources of the province. But it is now proposed by the provincial authorities to institute some geological work with special reference to economics. This would supplement the work of the Dominion Geological Survey which has Nova Scotia.

been carried on for such a long period in Nova Scotia with entire satisfaction to its people and especially to the mining community.

PETROLEUM AND NATURAL OR TERRESTRIAL GAS.

Petroleum.

Our knowledge of the general distribution of petroleum and the conditions under which it has accumulated, in commercial quantities, in certain places in the earth's strata continues to increase with the progress of the scientific exploitation of these products all over the world. It appears to be now pretty well ascertained that rock oil may be looked for in unaltered sediments of any age from the Cambrian to the Tertiary, wherever certain conditions of structure and superposition of strata are present. In view of the results which are being obtained elsewhere, it is probable that new oil-fields will be found in Canada, whose vast extent offers such a variety of geological conditions.

The country lying along and to the west of the Athabaska river, from a point above Fort McMurray to Athabaska lake, is a particularly promising field. The "tar sands" which outcrop in the valleys in this region are, in places, 100 feet or more in thickness, and consist of uniformly fine sand of Cretaceous age, saturated and blackened by inspissated petroleum, which, in past times, has ascended through the underlying strata from a considerable depth. These deposits are described in my report for 1882 on the Athabaska river, and in Mr. R. G. McConnell's report for 1900. In a paper presented to the Canadian Institute by the writer in 1883 it was stated that petroleum was reported as occuring in different localities on the Mackenzie river and elsewhere in the North-west Territories beyond the Athabaska.

Inspissated petroleum is reported to have been found at Egg lake and near Morinville, both lying to the northward of Edmonton. A boring for petroleum was made by the Geological Survey at Pelican rapids on the Athabaska river between Athabaska Landing and Fort McMurray. A flow of gas, under strong pressure, was struck at this boring in 1898 and it has been blowing off with a roaring noise ever since. Experiments for the finding of petroleum are to be made this year by the Canadian Northern Railway Company in the region lying immediately to the north of Edmonton.

Small quantities of petroleum of fine quality come to the surface in several places near Pincher Creek in the south-west angle of the Province of Alberta and also on some of the tributaries of Flathead river in the south-east angle of British Columbia and not far from the same neighbourhood. The geological conditions, in the two localities just mentioned, seem to resemble those of the oil district in Colorado. If the crown of an anticline with low or moderate dips could be located at some distance out from the foot of the Rocky mountains in this latitude, it might prove a profitable experiment to bore into it in search of petroleum. In this connection, it is important to ascertain the strike of any undulations which may exist in the strata underlying the great plain east of the Rocky mountains in Alberta. Indications of petroleum have been reported from other places in British Columbia; also from Vancouver island and the islands of the Queen Charlotte group. At Medicine Hat, where the Canadian Pacific railway crosses the South Saskatchewan river, natural gas is obtained in commercial quantities in Cretaceous strata at a depth of a little over 1,000 feet.

The breadth of the original oil-field of southern Ontario has been extended within the last few years by the finding of producing wells in various directions, especially at Leamington, Raleigh and Bothwell, and it is now ascertained that the oil has a more deeply seated origin than had been supposed from the experience of Oil Springs and Petrolia.

At Hepworth, about eight miles southward of Wiarton, in the county of Bruce, several holes have been bored down to the Trenton formation, which have afforded sufficient gas for lighting the houses in the vicinity, but, as yet, no petroleum has been struck. Borings that have been made during 1904 in the eastern part of Manitoulin island are said in some cases to have met with gas and small quantities of petroleum. Gas.

BOTANICAL.

The publication of volume VII of Prof. Macoun's "Catalogue of Canadian Plants" completed this important work and left the author free to attend to other botanical subjects, part of which has been the cataloguing of the large collections he made during the year—in the mountains of the National Park. Among these he finds upwards of forty species of flowering plants new to botany, the Compositæ and Cruciferæ being the most largely represented. Besides these, there is a still greater number of new species among the lower orders, especially the mosses. Botany.

About twelve new species of violets have been discovered by the botanists of the survey in the last few years and have been described and figured in the *Ottawa Naturalist*. Many species of flowering plants not previously known to occur around Hudson bay were collected in 1904 by Mr. Spreadborough, assistant to Mr. O. O'Sullivan, in surveying the shores of James bay. Descriptions and illustrations of the eleven new flowering plants obtained at different times, by the officers of the Survey, around Hudson bay, have been written and will be incorporated in a bulletin on the flora of the bay, which is being prepared.

Our field men, going to all parts of the Dominion, are asked to make notes on the forests. The finding of a new birch tree by Mr. McInnes in the Winisk River region shows that important discoveries may still be made in this department. Mr. J. M. Macoun spent the year at important in door work in Ottawa, with the exception of an investigation of the aquatic plants of the St. Lawrence, an investigation which had some interesting results.

WORK AT HEADQUARTERS.

Work at Headquarters

Dr. Hoffmann and Mr. Wait performed all the work of the chemical laboratory during the year, Mr. R. A. A. Johnston having been withdrawn for other duties. In the metallurgical laboratory, Mr. Connor worked, under instructions from the Minister of the Department, most of the year for another branch of the public service. In the mines section, Mr. Ingall and Mr. Denis, having been engaged, part of the summer, in field-work, the results of which required their attention in winter, a greater share than formerly of the duties of the section were performed by Mr. McLeish and Mrs. Sparks. It will be seen by Mr. Senecal's report that a large amount of map making and engraving has been accomplished. The numerous maps issued by the Survey still maintain their high reputation for accuracy and usefulness and for the excellent character of their execution. During the year, we have added considerably to our stock of surveying instruments. The services of Mr. Broadbent, Museum assistant of the Department, were given to the Exhibition commissioners for the whole year, with special reference to the St. Louis' Exhibition. He had acquired a knowledge of where to obtain good specimens of our economic minerals, and continuing to follow the methods of the Geological Survey, he secured an excellent collection, which served to illustrate Canada's great mineral wealth. During the summer Mr. R. A. A. Johnston acted as Dr. Ells' assistant in both Nova Scotia and British Columbia. Soon after his return he was instructed to make a study of Canadian meteorites. This has had the effect of bringing to light and recording a great deal of very interesting information which would otherwise have been lost. Mr. Johnston is preparing an illustrated bulletin on the subject. Up to a few years ago we had definite information as to only three or four meteorites which had fallen in Canada. Mr. Johnston's investigations enable him to describe at least fifteen well-authenticated falls of these

Meteorites.

bodies, beside disposing of a number of supposed meteorites which proved to be something else.

Palæontology

In the Palæontological branch, Dr. Whiteaves' report describes the progress which has been made in connection with invertebrates; and Mr. Lambe's as to vertebrates. Commander Low, during the cruise of the *Neptune* in our northern waters, obtained some collections of fossils of much interest, most of which, on his return, were placed in Dr. Ami's hands to be examined and reported upon. Some valuable additions have been made to our zoological collection, the principal one being that of the skins of six musk oxen obtained by Mr. Low from the region lying to the west of his winter quarters. They embrace three bulls, two cows and a calf. Mr. J. B. Tyrrell generously presented to the Museum the skins of three specimens of the northern species of Rocky Mountain goat, representing the male, female and young. The large collection of insects which was purchased some years ago from Col. Geddes was overhauled last autumn by Mr. C. H. Young who restored most of it to a better condition. Our archæological collection received a most important addition during the year through the purchase, by a special appropriation, of the large collection of Mr. D. G. Price, of Aylmer, Ontario. Mr. Price had been many years in making this collection. In all, there are approximately 9,000 pieces, including damaged and fragmental specimens. The principal part of it consists of stone, bone and burnt clay articles from the region lying along the north side of Lake Erie, illustrating the life and habits of the extinct Tobacco Nation, and, from its completeness, it has a special value.

Archæology.

Museum.

Our present Museum is so much overcrowded that none of the new additions can be properly displayed, and but few of them can be exhibited at all. All that we can do at present is to secure as much good material as possible and store it up for exhibition in the Victoria Museum, the building of which has at last been commenced.

Mineral collections.

We have, as in former years, supplied a considerable number of named collections of good mineral specimens to educational institutions in all the provinces. It would be impossible to send these collections to all who ask for them. But we endeavour to supply such High schools, Collegiate institutes, etc., as evidently make a special feature of teaching mineralogy and geology. In the hands of competent teachers these collections induce pupils to take a real interest in the study of mineralogy, and they may gain a knowledge of the subject that will afterwards be of practical value to them.

Work of Acting Director.

In addition to my field-work as a member of the International Committee of Geologists on the Crystalline rocks of the Lake Superior region, I took sufficient time from the arduous duties of the office to attend the 8th International Geographical Congress at St. Louis, Mo., in the latter part of September, to which I had been delegated by the Geographic Board of Canada. I afterwards visited New York to endeavour to induce a portion of the delegates of the British Iron and Steel Institute to visit Canada, but found that, much to their regret, the time at the disposal of the members would not admit of their doing so. During the Christmas holidays I attended a meeting of the above mentioned International Committee of Geologists in Philadelphia to further consider our report on the rocks of the Lake Superior region. During this period I also attended the annual meeting of the Geological Society of America as one of the delegates to invite the society to hold its next annual meeting in Ottawa, which invitation was accepted. In the first days of January, I was present, by request, as a delegate of the Canadian Forestry Association, at the Forestry Congress held in Washington.

OFFICERS' REPORTS.

THE KLUANE MINING DISTRICT.

(South-western Portion of Yukon District.)

By Mr. R. G. McConnell.

The Kluane mining district is situated along the north-eastern slopes of the St. Elias range, in the vicinity of Kluane lake, Yukon. It includes creeks such as Bullion creek and Burwash creek, draining the north-eastern slopes of this range, and also creeks such as Ruby and the Fourth of July, which traverse and obtain their auriferous supplies from the bordering ranges on the north. Situation

Indians reported the presence of gold, on streams tributary to the Alsek, early in the summer of 1903, and on July 4 of that year Discovery claim, on Fourth of July creek, was staked by Dawson Charlie, a well known Indian from Cariboo Crossing. Two days later Discovery claim on Ruby creek was staked by W. H. Weisdepp, and discoveries on other creeks in the vicinity quickly followed. In the same season coarse gold was found on a number of the smaller streams draining the north-eastern slopes of the St. Elias range. Bullion creek, a tributary of Slims river, was staked on September 28 by a party of miners consisting of Messrs. Altamose, Ater, Smith and Bones; members of the same party staked discoveries on Sheep creek, near the head of Kluane lake, in October, and on Burwash and Arch creeks in May, 1904. The former flows into the Kluane river a short distance below Kluane lake and the latter into the Donjek river. All the streams draining this portion of the St. Elias range are tributary to White river. Besides the streams mentioned, discoveries have been staked on Kimberly, Telluride, Canada, Vulcan and other streams of the St. Elias range, and on McKinley, Dixie, Marshall, Gladstone and other streams draining the Ruby range. The area of coarse gold discovery extends along the base of the St. Elias range for a distance of over seventy-five miles, and has a maximum width of about thirty miles. Discovery.

The district is reached by waggon road from Whitehorse, the terminus of the Whitehorse railway. The road from Whitehorse follows a rolling plain bordering the left bank of the Lewes river to the crossing of the Takhini river, from which point a wide, continuous valley, Access.

occupied successively by the Takhini river, the Dezadeash river, Bear creek and Christmas creek, extends through to Kluane lake. Between Bear creek and Christmas creek a summit about 900 feet in height is crossed. The road from Whitehorse to Kluane lake has a total length of 143 miles. The Takhini river is navigable for light draught steamers, and the haulage of freight can be reduced about fifty miles by bringing it up this river on boats to Mendenhall landing, the point at which the road leaves it.

Previous explorations.

Previous explorations in the district are limited to the expedition of Messrs. W. J. Peters and A. H. Brooks of the U. S. Geological Survey in 1899 from Pyramid harbour by way of Kluane lake to Eagle city, on the Yukon, and the topographic work of Mr. J. J. McArthur, Department of the Interior, Canada, in 1900. A report on the principle features of the geology and topography of Mr. Brooks' route is published by him in the twenty-first annual report of the U. S. Geological Survey 1899-1900.

Topography.

The district is varied in its topographic features; it includes a portion of the St. Elias range and extends north-eastward across the Shakwak valley into the flanking ridges and mountain groups.

The St. Elias range is exceedingly rugged in character. Viewed from the hills on the north it presents a complex of sharp, broken crest lines irregular in direction and rising in places into bold, rocky projections, some of which reach a height of over 10,000 feet above the sea. The numerous small streams which drain the northern slopes of the range in the vicinity of Kluane lake occupy deep, rock-walled valleys, scarcely wide enough in places to permit the passage of the streams. The larger drainage channels, on the other hand, such as Duke and Slims river, possess large valleys and are bordered by wide flats, which extend back into the range for many miles. The central part of the St. Elias range is covered with almost continuous snow fields, pierced in places by dark rocky points; smaller snow fields survive the summer on all the principal mountain groups and ridges. Glaciers occur at the heads of all the principal streams. The great Kaskawulsh glacier, the largest in the district visited, descends from the central nevé, and has a length of over twenty miles. Two large rivers issue close together from beneath this glacier, the Kaskawulsh, one of the main branches of the Alsek, and Slims river, one of the sources of the Yukon.

Interlocking valleys.

The country stretching northward and eastward from the St. Elias range is characterized by broad interlocking valleys enclosing mountain groups and ridges usually from 3,000 to 5,000 feet in height.

The valleys are much older than the present drainage system. They have a width of from two to five miles or more, are flat-bottomed, and are floored with glacial deposits. The rivers which occupy them at present flow in narrow secondary valleys seldom excavated to sufficient depth to reach bed-rock.

Shakwak valley.

The great Shakwak valley at the foot of the St. Elias range is an important topographic feature. Its origin is unknown. It is now occupied by a number of different streams and lakes and is crossed transversely by the valley of the Dezadeash. Kluane lake, a large sheet of water forty miles long and three miles wide, with two arms, one twenty-seven miles in length, is situated in this depression. North-east of the upper end of Kluane lake are the Kluane hills, a worn ridge with an elevation of about 5,000 feet above the sea. These hills are bordered on the north by the wide valley of Upper Jarvis river, Kloo lake and Cultus creek, beyond which the country rises again into the Ruby range. Farther to the south a prominent elevated mass is enclosed by the Shakwak valley, Dezadeash lake and the great bow which the Dezadeash river makes to the east. The name Dezadeash mountain is proposed for these elevations. The summits of these mountains and the Ruby range reach elevations of about 7,000 feet above the sea. They probably represent erosion remnants of an old low level plain, since elevated some thousands of feet and partly destroyed.

Drainage.

The drainage of the district flows partly north by way of White river to the Yukon and partly south by the Alsek to the Pacific. Dezadeash river heads in Dezadeash lake, and after making a great bend to the east, turns westward towards the St. Elias, and through it to the sea. It is joined, after entering the mountains, by the Kaskawulsh river, heading in the Kaskawulsh glacier, the two streams forming the Alsek river. Jarvis river, like the Dezadeash, also enters the St. Elias range from the lower region bordering it on the north. It is tributary to the Kaskawulsh river and drains the southern slopes of the Ruby range and a portion of the Kluane hills. The White river drainage system is represented by Slims river, the principal feeder of Kluane lake, and by a number of other smaller streams flowing from the north and south into Kluane lake and its outlet, Kluane river. Slims river heads in the same glacier as the Kaskawulsh river, and the two streams occupy portions of a wide continuous valley connecting the White river and Alsek drainage systems inside the mountains.

Alsek river.

The Alsek river has twice been dammed in comparatively recent times, probably by the extension of glaciers across its valley, and long deep lakes were produced which extended far up the valleys of the Dezadeash and Kaskawulsh rivers. Fresh lake beaches, cut in loose talus slopes and still covered in places with drift wood, line the valley of the Dezadeash at the point where it enters the St. Elias range up to an elevation of 150 feet above the present water level; older, more worn beaches occur up to an elevation of 300 feet. The older beaches are covered with the ordinary forest growth of the region, and probably date back some hundreds of years, while the younger ones support only a few young spruces, seldom exceeding three inches in diameter, and groves of willows, small aspen and balsam poplar. The upper limit of the young beaches is plainly marked all along the valley of the Dezadeash, up to a point about midway between Marshall river and Canyon river, by this sudden change in the forest growth. Judging from the character of the beaches themselves, the undecayed driftwood, the young vegetation and the stories current among the Indians, it is probable that the lake which produced these beaches existed less than a hundred years ago.

Forests.

The forest trees of the district consist only of the white and black spruces, the aspen, the balsam poplar and an occasional birch. As elsewhere in the Yukon territory, the white spruce is the most important tree. Considerable groves exist along the lower part of Slims river, on Kluane lake, on Silver creek and other places, but the district, as a whole, cannot be considered well wooded, and the supply of timber suitable for mining and building purposes is limited. The tree line in the St. Elias range has an altitude of about 4,200 feet above the sea, and the bordering ranges of about 4,700 feet. The upper portion of most of the auriferous streams rises above the timber line and much difficulty is experienced in obtaining the fuel and lumber reqired.

GENERAL GEOLOGY

The district reported on includes two distinct geological provinces, namely, the St. Elias range and the flanking ridges and hills which border it on the north.

The country lying along the northern base of the St. Elias range is underlaid by a series of dark gray quartz-mica schists resembling in colour, composition and degree of alteration the argillaceous members of the Nasina series as developed along the Yukon river. These schists will be referred to as the Kluane schists.

Kluane schists.

The Kluane schists outcrop over a considerable area; they occur all along the Kluane hills which border the northern shore of Kluane lake and they extend eastward across the valley of the Jarvis river and Kloo lake into the Ruby range. The eastern boundary of the formation crosses the Dezadeash valley at Aishihik river. The Kluane schists have not been followed south of the Dezadeash valley, but must extend a considerable distance in this direction as they cross the valley in a band fully twenty miles wide. They were traced northward to a point near the lower end of Kluane lake, where they are replaced by gray granites and green schists.

The wide Shakwak valley, at the base of the St. Elias range, is floored with gravel, and the junction between the Kluane schists and the rocks forming the St. Elias range was only seen in one section. North of the point at which Jarvis river enters the St. Elias range, micaceous schists, which are referred to the Kluane series, occur at the base of the range underlying less altered dark and green slaty rocks and schists. They were not found in the interior of the range either in place or in the wash of the streams, and it is doubtful if they outcrop again towards the southwest. Shakwak valley.

The general strike of the Kluane schists is W. N. W. and is approximately parallel to the direction of the St. Elias range. The strike is very regular except near intrusive masses. The dip of the schists, both in the Kluane hills and in the southern slope of the Ruby range is N. N. E. or away from the St. Elias range at angles of from 30° to 60°. Near the eastern limit the influence of a great granite mass east of Aishihik river is felt; the dips become steeper and, in places, the beds are overturned. The schist, in the single exposure found along the base of the St. Elias range, dips to the south under the range or in the opposite direction to the inclination of the beds in the Kluane hills, the first foot-hill range to the north. The intervening valley has probably been excavated along the crest of a wide anticline. Kluane schists.

The Kluane schists consist almost entirely of a great series of well foliated quartz-mica schists, varying somewhat in colour and degree of alteration, but very homogeneous throughout. Like the Nasina series they are ancient clastics, partially and, in places, entirely, recrystallized. They differ from the Nasina series in the absence of quartzite and limestone bands. Mineralogically they consist essentially of lines and small lenticular areas of quartz and feldspar grains separated by curving lines of biotite and a white mica. A specimen from an exposure north of Jarvis river, where it enters the St. Elias range, con tained, in addition to the usual minerals, numerous grains of glaucophane and epidote.

The Kluane schists, with the possible exception of a band of granite gneisses, which borders them on the north, are the oldest rocks in the district. They are pierced in several places by granite areas resembling the coast range granites, and probably belonging to the same period.

The geology of the small portion of the St. Elias range hurriedly examined during the past season is exceedingly complicated and is, as yet, imperfectly understood. The bedded rocks are broken at frequent intervals by intrusions of various kinds, and the sequence of the formations differed in all the valleys ascended. It was found possible to discriminate four great series of rocks, none of which are probably older than Upper Palæozoic. North of Jarvis river the Kluane schists are overlaid at the foot of the range by several thousand feet of green schists interbanded with dark shaly beds. These are probably the oldest rocks in the portion of the range examined. They have a wide distribution, being found on the lower part of Kaskawulsh river, on Slims river, on Bullion creek, and along the foot of the range on Burwash creek and Duke river.

The green schists of this series differ greatly in the degree of alteration they have undergone. In a few places they are completely altered into glossy chloritic schists, while in many of the sections their fragmental origin is still evident in hand specimens.

Limestone bands.

The green schist series is overlaid by alternating bands of limestone, green schists and dark slaty rocks passing in places into a hard cherty variety. A few fragments of corals collected on Bullion creek indicate a carboniferous age for this group. The green schists of this series are similar in appearance to those in the underlying group. The limestone, when unaltered, occurs as a hard, dark, compact rock, but in most instances it has been partially or wholly recrystallized into a gray granular variety, and in extreme cases has been altered into a snow-white, even-grained marble. A wide band of limestone at the head of Sheep creek has been shattered and crushed into a rock difficult to distinguish from an agglomerate. The crushed limestone often carries iron, and, when weathered, displays bright red colours.

The mountains bordering the Dezadeash river, from the point where it enters the St. Elias range to its junction with the Kaskawulsh, a distance of seven miles, are built almost entirely of a great series of tufaceous beds which are probably younger than the schists of the preceding group. These beds form a definite group and will be referred to as the Dezadeash series. They have a thickness of fully 10,000 feet. They occur both in heavy beds, usually gray, and in thin alternating dark and grayish bands, the former hard, compact and occasionally cherty, the latter coarse, granular and soft. The lowest beds of the series occur along the base of the outer range, where they are altered into hard flags, and, in places, are almost schistose. The higher beds, except where pierced by a couple of intrusive masses, show only slight traces of alteration and are often soft and friable. The tuffs of the Dezadeash series are replaced, ascending the Kaskawulsh river, by green schists. The character of the contact was not ascertained.

Tufaceous beds.

The fourth subdivision of the rocks of the St. Elias range largely consists, like the preceding one, of beds of tufaceous origin, but include, gray sandstones, grits, conglomerates, dark shales and occasional lignite seams. Two areas of these rocks occur in the portion of the range examined, one on Kimberley and Telluride creeks, two tributaries of Jarvis river, and the other at the head of Sheep creek. The Sheep creek beds are less indurated than those on Kimberley creek, include a larger proportion of tuffs and occur in brightly coloured alternating green, red and brown bands.

The rocks of this group are very similar to the lignite-bearing beds in the vicinity of Dawson, which have been referred by Dr. Knowlton, of the United States Geological Survey, on the evidence of fossil plants, to the Eocene. They are strongly folded and have participated in the principal mountain-making movements which produced the range.

A great variety of massive igneous rocks occurs in the St. Elias range. The specimens collected have not yet been examined in detail, and only brief descriptions can be given here.

Granite.

Granite.—A small area of gray medium-grained granite cutting limestones and green schists occurs at the south end of Kluane lake. Large areas of granite must occur in the interior of the range, a large proportion of the material brought down by the Kaskawulsh glacier consisting of granite pebbles and boulders.

Diorite.

Diorite.—Areas of diorite occur at the mouth of Vulcan creek, on the lower part of Bullion and Sheep creeks, on the Dezadeash river, and at the upper canyon on Burwash creek. Diorite pebbles were also found in the wash of a number of streams heading in high peaks which were not visited. The diorites vary from a quartz diorite consisting essentially of hornblende, biotite, labradorite and quartz to a gabbroic or diabasic variety in which quartz is absent and the hornblende has the appearance of being derived from augite.

It is interesting to note that the Italian expedition which ascended Mt. St. Elias in 1897 under the direction of H.R.H. the Duc d'Abruzzi found the summit of the mountain to consist of diorite, and diorite probably occurs in many of the higher peaks of the range.

Pyroxenite.

Pyroxenite.—A large, coarse-grained, intrusive mass consisting mainly of augite and iron ore cuts the Dezadeash series of the St. Elias range on the Dezadeash river.

Diabase.

Diabase.—This rock occurs at the canyon on Sheep creek and also at the head of Kluane lake.

Dunite.

Dunite.—A small area of dunite was found on Burwash creek. The olivine of this rock is partly altered to serpentine.

Andesite.

Andesite.—Andesites occur principally in connection with the lignite-bearing tertiary areas. A vesicular variety of this rock outcropping on Telluride creek was found to contain small quantities of bitumen.

Rhyolite.

Rhyolite.—Light-coloured rhyolite rocks occur in small areas on Kimberley and Bullion creeks.

Effusive volcanics.

Effusive volcanic rocks.—Large areas covered with successive sheets of lava of various kinds occur in the interior of the St. Elias range. The largest of these, in the district examined, commences near the junction of the Dezadeash and Kaskawulsh rivers, and extends southward for many miles. It has not been outlined, but must cover several hundred square miles. A second large area crosses Duke river valley near the upper forks.

The lava sheets are level or incline at low angles, and are evidently younger than the main mountain-making movements. They are, however, of considerable age, being traversed by wide valleys and having been worn into ridges and peaks closely resembling those in other portions of the range.

The varieties of the effusive rocks collected include dark diabases, gray andesites, white ryholitic-looking rocks, and red, black and gray vesicular lavas. Indurated tuffs and agglomerates occur with the effusives.

Structure.

Very little is known in regard to the structure of the St. Elias range. The general strike of the bedded rocks is nearly magnetic east and west, or parallel to the trend of the range. Local deviations from this direction, due to the numerous intrusive masses, are, however, frequent. The beds are steeply tilted, but are seldom, so far as observed, overturned or broken; they dip in both directions. No evidence of great over-thrust faulting, such as obtains in the Rocky Mountain range, was noticed. The effect of over-thrust faulting is to reverse the normal sequence of the beds and to place older formations above more recent ones. For instance, in the Rocky mountains the palæozoic limestones of the front ranges often rest on Cretaceous beds. In the St. Elias range, on the other hand, the bordering plains and ridges are underlaid by old schists, while the mountains are built of much younger rocks. It is noteworthy that, notwithstanding the strongly folded condition of the beds in the St. Elias range, the old Kluane schists are nowhere brought to the surface. It is possible that the upheaval of the range and the folding of the beds are due in large measure to the repeated invasions of the district by igneous rocks and not to great general earth movements due to compression, such as produced the Rockies. Normal faulting probably occurred along the base of the range.

All the lowlands of the districts reported on were buried beneath ice during the glacial period, but there is no evidence that the higher ranges were overridden. The ice poured down from the St. Elias range, the main gathering ground, through every opening in the outer ridges. It moved down northward-sloping valleys, like those of Bullion creek and Slims river, and up southward-sloping valleys, like those of Jarvis river and the Dezadeash. It flooded the great Shakwak valley at the foot of the range to a depth, in places, of probably 3,000 feet, and streamed eastward up the broad valley of the Dezadeash to the low Dezadeash-Tahkini divide, and then down the latter valley to the Lewes. Smaller streams flowed up the steep valleys, incising the southward slope of the Ruby range, and, in some instances, as at the head of Lake creek, crossed this range and descended into the valley of the Aishihik. Glaciation.

The Kluane hills, with an elevation of, approximately, 2,650 feet above Kluane lake, and 5,150 feet above the sea, were completely covered with ice, as shown by the presence of rounded foreign boulders and pebbles on the highest points. Ruby range was glaciated up to an elevation of about 5,200 feet above the sea. Below this point the contours are rounded and foreign drift material is always present. Above it the topographic angles are sharper and the slopes and summits are strewn with angular frost-riven fragments derived from the underlying schists. Kluane hills.

The deep wide valleys traversing the region north of the St. Elias range are bottomed everywhere with glacial deposits, principally boulder-clays and silts, to a depth, in places, of several hundred feet. The boulder-clay is usually interbanded with stratified gravel beds. It is confined to the valley flats and bordering terraces, and does not occur on the summits and upper slopes of the ridges.

The boulder-clay is almost always overlaid by heavy beds of white silt and is occasionally interbanded with it. These white silts are precisely similar to the fine glacial material from the Kaskawulsh glacier now being carried away by Slims river and deposited in the upper end of Kluane lake and the lower sluggish part of the river; there is little doubt that they originated in the same way. Kluane lake will eventually, if the present conditions be maintained, become filled up and will be replaced by a silt plain similar to those bordering portions of the upper Lewes, the McMillan, and most of the other rivers draining the glaciated highlands surrounding the Yukon plateau.

Glaciers.

The glaciers of the St. Elias range are now receding, but not very rapidly. Undisturbed moranic groups occur in front of the Kaskawulsh glacier for a distance of at least half a mile, and long lateral moraines, heading in glaciers, border some of the tributaries of Telluride creek. Reasons have been given, on a previous page, for believing that a long lake lately covered the valley of the Dezadeash from a point below its junction with the Kaskawulsh nearly up to the Aishihik river. This lake must have been produced by an ice dam across the valley of the Alsek, and indicates a pronounced advance of the glaciers of the range less than a century ago.

ECONOMIC GEOLOGY.

Gold.

Placer gold has been found in the district in two groups of creeks, one heading in the outer ridges of the St. Elias range, and the other in the Ruby range, situated between Jarvis river and Aishihik river. Ruby creek, Fourth of July creek and McKinley creek are the most important creeks so far discovered in the latter group, and of these Ruby creek is the only one which has produced any considerable quantity of gold.

Ruby creek heads in the summit of Ruby range and flows southward, emptying into the Jarvis river after a course of about nine miles measured along the valley. It is a steep mountain stream with a large volume of water in spring and early summer, but gradually dwindling in size as the snows in the upper regions disappear, and in late summer the flow is reduced to a couple of hundred miners' inches or less. In its lower reaches Ruby creek has its course across the wide drift-filled valley of Jarvis river, and its valley is shallow and cut in boulder clay. In the upper mountain portion it occupies a great narrow-bottomed depression from three to four thousand feet in depth cut out of the old schists of the Kluane series.

The valley of Ruby creek is floored in the lower part with boulder clay and other drift deposits, and in the central portion with a shallow covering of stream gravels and boulders. In the upper portion the grade is so steep—in places exceeding 400 feet to the mile—that the gravel is often washed away and the bed-rock is exposed.

Mining on Ruby creek during the past season was practically confined to the central portion, extending from Claim No. 22 above Discovery to the mouth of Little Ruby creek at Claim No. 34 above Discovery, a distance of about three-quarters of a mile. The wash in this portion consists mainly of flat schist pebbles and angular slabs of the same material, with occasional large granite boulders often several feet in diameter, and a few quartz pebbles and boulders. It is shallow, seldom exceeding ten feet in depth on the claims now being worked, but is irregular in this respect, owing to the rough hummocky character of the bed rock surface on which it rests. Some sluicing was done during the past season on most of the claims between No. 28 above and No. 34 above, and on some of them pay was reported, but no particularly rich gravel was discovered, and the total yield did not exceed a few thousand dollars. Ruby creek.

The gold, which is of local origin and is derived from the quartz veins cutting the Kluane schists, is coarse, rough and occasionally crystalline; it is more irregular in size than the Klondike gold, but nuggets have been found weighing nearly half an ounce.

The portion of Ruby creek at present being mined cannot produce any large quantity of gold; the body of gravels is small and has not proved high grade. Further down the valley the conditions are different, and it is possible that considerable bodies of workable gravels may exist under the boulder clay. Several attempts have been made to sink to bed-rock, but without success. Two shafts, one on Claim No. 15 above, and the other on Discovery Claim, have been sunk to depths of seventy feet and forty feet respectively, without reaching bed-rock. There is, of course, no certainty of finding gold under the boulder clay, as the stream gravels may have been swept away during the glacial period, but the chances of important discoveries are favourable and seem to warrant the expense of a deep shaft. Drifts across the valley from the foot of the shaft would be necessary for a fair test, for it is unlikely that the present stream follows the exact course of the pre-glacial one. The valley is, however, narrow and the deviation cannot be great.

There is little chance of finding pay-gravels in the Ruby creek valley below the point at which the stream leaves the mountains, the present course of Ruby creek across the wide valley of Jarvis river being probably entirely different from the pre-glacial one.

Fourth of July creek.

Fourth of July creek is practically a continuation of Jarvis river. It is a much larger stream than Ruby creek, its flowage in early summer amounting to several thousand miners' inches, and it differs from the latter in dividing up, after entering the mountains, into several branches. It has cut a great valley back into the Ruby range much larger than the Ruby creek valley, and the various branches also occupy great rounded depressions sunk deep into the southern slope of the range.

The gravels in Fourth of July creek are similar to those in Ruby creek. The valley is floored with boulder clay up to a point about three quarters of a mile below the mouth of Snyder creek, where it disappears. Farther up, the wash consists of coarse angular and sub-angular fragments of schist with some quartz and occasional boulders of granite. Above Snyder creek, the wash is shallow and bed-rock is often exposed. The proportion of quartz-pebbles and boulders in the wash is greater than in the Ruby creek gravels.

Fourth of July creek cuts the schists of the Kluane series through its entire course. The granite boulders were brought into the valley by ice, probably from the south, as the movement of the main ice sheet of the glacial period was northward, or up-stream.

Fourth of July creek and all its tributaries have been staked nearly to their heads, but so far very little effective prospecting work has been done. Colours of gold occur all along the creek : on claim No. 62 above, encouraging prospects are reported from the surface gravels. On claim No. 54 above, a shaft twenty-eight feet in depth has been sunk and pay-gravels are reported to have been found resting on boulder clay. That so small an amount of work has been done is largely due to the excessive cost of mining in this remote region. Freight rates will probably be greatly reduced during the coming season and it is expected that the creek will receive a more thorough test. A deep shaft, to test the gravels under the boulder clay in the lower part of the valley, but well inside the mountains, is desirable.

McKinley creek, like Ruby creek and Fourth of July, has been staked almost to its head, but very little prospecting has been done on it and no pay-gravels have been discovered. It is a large stream, about equal in size to Fourth of July creek; it enters Jarvis river a few miles above Kloo lake. A large tributary, known as Dixie creek, joins it a couple of miles above its mouth. McKinley creek occupies a wide, basin-shaped valley running for the greater part of its length parallel to the general trend of the Ruby range. Its grade in the longitudinal portion of the valley is low, but after bending to the south to join Jarvis river it falls rapidly and, in places, has cut a small canyon in a granite area which it crosses. McKinley creek.

Boulder clay and other glacial deposits extend up McKinley creek for several miles. The depths to bed-rock along the greater portion of the valley must be considerable, and the great width of the valley will necessarily render prospecting for pre-glacial auriferous gravels a difficult and expensive undertaking.

Besides the streams mentioned, coarse gold has been found in the vicinity on Gladstone creek and some of its tributaries, on Marshall creek, a tributary of the Dezadeash, and on Printers creek, a small steep stream tributary to Cultus creek.

AURIFEROUS STREAMS OF THE ST. ELIAS RANGE.

Nearly all the streams flowing from the St. Elias range, in the district examined, carry coarse gold. Considerable work, mostly of a prospecting character, was done during the past season on Bullion, Sheep, Burwash and Kimberley creeks.

Bullion creek is a typical St. Elias range stream. It heads in small glaciers at the summit of the range separating Slims river and Kluane lake from Duke river, and empties into Slims river after a course of about ten miles. It is a large, swift-flowing stream, very variable in its flow, but carrying under ordinary conditions about 2,000 miners' inches of water. Its grade is steep, averaging over 200 feet to the mile, and in flood it assumes a torrential character. Bullion creek.

The valley of Bullion creek is a huge steep-sided gorge, narrow, but widening somewhat towards its mouth and bottomed with bare gravel flats. Midway in its course Bullion creek forces a passage for half a mile through a deep canyon so narrow that at a short distance it looks like a mere cleft in the rocks. This remarkable natural feature is due to a change in the course of the stream at the end of the glacial period. During that period the old valley was filled with boulder-clay and other glacial deposits to a depth of 1,000 feet. After the ice receded the stream began re-excavating its old channel and has succeeded in cutting through the glacial deposits, and in the lower part of the valley has also cut some distance into the bed-rock beneath. At the canyon the stream was forced to the north by the wash brought down by Metalline creek, which comes in at this point from the south, and in place of clearing out its old channel, as in other portions of the valley, it has sunk a new channel through limestone.

The rocks displayed along Bullion creek valley are exceedingly varied in character. They include green and dark schists, dark slates, gray limestones often weathering red and yellow, white marbles, diorites and a light coloured eruptive rock, probably a rhyolite. Bullion creek valley, as stated above, was filled with glacial wash during the glacial period to a depth of 1,000 feet. The stream has not succeeded in completely cleaning out its old valley, and narrow bands of boulder-clay and glacial gravels still cling to the steep slopes on both sides.

Bullion creek valley is bottomed all along, except in the canyon, with a layer of loose gravel, usually from six to ten feet in thickness. Near the mouth of the valley the depth to bed-rock is somewhat greater. The gravels are coarse and are intermingled with numerous granite boulders, some of huge size. No granite outcrops along the valley, and the boulders must, therefore, have been brought by ice from the interior of the range.

Claims on Bullion creek.

Claims on Bullion creek were being worked or prospected at the time of my visit at intervals from No. 31 above down into the fifties below. The discoverers of the creek are reported to have cleaned up forty ounces, mostly in very coarse gold, as the result of a few days work in some shallow ground at the foot of the canyon. The promise afforded by this find has not been borne out by subsequent experience on the creek. The gravels have been prospected at intervals all along the valley. They carry gold throughout, but have seldom, if ever, proved rich enough to pay wages under conditions at present prevailing in the camp. The distribution of the gold is very irregular. Bunches of gravel carrying good values occur on most of the claims prospected, but the general average yield is low, and seldom exceeds, according to the information obtained, \$3 to \$5 a day per shovel.

While very little pick and shovel dirt has so far been found on Bullion creek, it is probable that the gravels along the central part of the creek, at least, are rich enough to hydraulic. A company under the name of The Bullion Hydraulic Company was formed during the past season to take over most of the ground below the canyon and work it by this method. The conditions are favourable, on the whole, as the valley has a good grade and water is abundant, but some trouble will probably be experienced in removing the large boulders and in disposing of the tailings. The experiment is important, as, if successful, it will lead to similar undertakings on other creeks in the district.

The only prominent benches on Bullion creek are the narrow flats marking the upper limits of the boulder clay. Some of the gravels with the boulder clay are reported to be auriferous but have not been worked.

Bullion creek gold is coarse, and is worn much smoother than Ruby creek gold. It occurs mostly in flattened pellets, often of considerable bulk. Some fine gold is also present. Nuggets up to an ounce in weight have been found. The grade is high, averaging about $18 per ounce. Copper nuggets are often found with the gold in the concentrates.

Sheep creek, in many respects, is a duplicate of Bullion creek, but is a smaller stream. It heads with Congdon creek, and follows a course nearly parallel with Bullion creek to its junction with Slims river. It is a steep creek, the grade exceeding 300 ft. to the mile. The lower part of the valley has the usual gorge-like character of the smaller valleys of the St. Elias range, and at one point contracts into a rocky canyon, but the upper part traverses an area of soft rocks and opens out into a considerable basin. Sheep creek.

The rocks cut by the valley in its lower reaches are similar to those on Bullion creek. In the upper part the valley enters a Tertiary area, and tufts, sandstones, shales, conglomerates and occasional lignite seams are exposed.

Very few claims were being worked on Sheep creek during the past season, and only one, No. 53 above, reported pay values.

Burwash creek is situated near the lower end of Kluane lake. It heads in the St. Elias range but has most of its course across an elevated plain which borders the range from Kluane lake to the Donjek river. It heads in glaciers, and in ordinary circumstances is a swift mountain stream from 15 to 20 ft. in width, but, like all glacial streams, its daily and seasonable flow is very variable, depending on the strength of the sun, and in times of flood it becomes a raging torrent. Its grade is less than that of Bullion creek, amounting in the central part of the valley to about 125 ft. per mile. Burwash creek.

Burwash creek has cut a deep, trough-like depression in the lower part of the upland across which it flows, and in two places its valley contracts into narrow, rock-walled canyons difficult to penetrate except in low water.

The rocks outcropping along Burwash valley are extraordinarily varied. The varieties noticed, in a distance of about eight miles along the central portion of the valley, included bands of green, striped and dark schists, slates and shales, intruded at frequent intervals by diorite, andesite, rhyolite, diabase and dunite. In addition to these, a copper-stained amygdaloid occurs in the lower canyon. Quartz veins are rare, and few quartz pebbles occur in the wash.

Coarse gold occurs along Burwash creek from the foot of the lower canyon up stream for a distance of eight miles or more, but no very rich ground has so far been found. The miners were greatly hampered during the past season by the excessive cost of supplies, and most of them were obliged to stop work even before the short season ended. On this account very few, if any, claims were fully prospected, and on most of them only useless assessment work was done. Good prospects, and in some instances small amounts of gold, were obtained from several claims, and it is expected that considerable work will be done on the creek during the coming season. The gravels are shallow, are usually rather coarse, and contain numerous large boulders difficult to move. They are not frozen, and seepage water occasions considerable trouble.

A number of narrow, rock-cut benches supporting beds of gravel occur along Burwash valley at different heights above the creek, but usually low. The prospects from a number of these were considered very satisfactory, and, on several, pay gravels were reported and some mining was being done.

Burwash creek gold differs from that of Bullion creek in being much flatter. Most of the larger grains have been worn into smooth thin plates, and bulky nuggets are rare. The largest reported was valued at $3.

Smaller creeks.

Some prospecting was done during the past season on Kimberly, Telluride and Canyon creeks. The last was not visited by the writer. Kimberly creek is a tributary of Jarvis river, from the south-east. It is a steep, swift, glacial stream bordered below with bare gravel flats, but inclosed in a narrow, steep-sided valley above. The gravels in the narrow part of the valley are shallow, loose and coarse. Gold to the value of $100 was reported to have been taken out of Claim No. 14

above as the result of a few days work. No work was being done on this claim at the time of my visit. Some work was in progress on the claim immediately below, but no pay gravels had been found. Good prospects were reported on Discovery claim and preparations were being made for sluicing. The result of the season's operations is not known. Telluride creek enters Jarvis river immediately opposite Kimberly creek, and is similar to it in general character. No mining has been done on this creek and very little prospecting.

The total production of gold in the Kluane mining district probably did not exceed $20,000 during the past season. The small production cannot be considered satisfactory, but it must be borne in mind that mining in the district is still in its initial stages, and that only a few claims in the whole district were worked during the past season, and these only for short periods. Also, while there was a considerable mining population in the district, most of the miners spent the summer, or a large part of it, in doing assessment work, most of it useless, on several claims, instead of fully testing one claim. Supplies could only be obtained in the district at prices prohibitive, so far as most of the miners were concerned; the freight rates alone from Whitehorse to Kluane lake amounted to thirty cents per pound, and to Burwash creek to over forty cents. Conditions during the coming summer will be more favourable; some of the claims are now roughly equipped and it is expected that, as a result of the construction of a government road into the district, freight rates to Kluane lake will be reduced to about ten cents a pound.

The discovery of coarse gold in so many creeks distributed over such a wide area is a fact of considerable importance even in the unlikely event of no large bodies of gravel rich enough to work by ordinary placer mining being found; portions of some of the creeks, at least, are certain, sooner or later, to be worked by more economical methods.

OTHER MINERALS.

Galena. Galena occurs in small quantities in the wash on Bullion creek, but was not found in place.

Copper. Native copper is found with the gold on Bullion, Sheep, Kimberley, Burwash and, in fact, on nearly all the creeks in this portion of the St. Elias range on which any mining has been done. It occurs in rounded nuggets and slabs, the largest seen weighing about a pound and a half, but is nowhere very abundant. A quartz pebble enclosing native copper was found on Bullion creek, indicating a vein origin for a portion at least of the mineral. No native copper has, so far, been found *in situ* in the district. Copper-pyrites occurs in crushed zones on Telluride creek, impregnating a green, amygdaloidal rock in Burwash creek canyon and in small veins on Bullion creek. None of the occurrences seen are of commercial value. A belt of copper-bearing rocks appears to follow the St. Elias range northeast to the International boundary and beyond. It has only been roughly prospected so far, but now that access to the region has become much easier will probably receive more attention.

The lignite-bearing beds on upper Sheep creek, referred to on a previous page, enclose several lignite seams, one of which measured over four feet in thickness. The lignite is of excellent quality and burns freely in an ordinary Yukon box stove. There is no wood along the upper portions of the creek, and lignite is used by the miners for fuel. Lignite also occurs on Kimberley creek, but is not well exposed.

The Duncan Creek Mining District.

(Stewart River, Yukon Territory.)

By Mr. Joseph Keele.

INTRODUCTION.

Introduction.

The earliest record of prospecting in the Duncan creek mining district is mentioned by Mr. Ogilvie in his report on the Yukon district. In the autumn of 1887 Mr. Ogilvie met and conversed with a miner who had spent the summer of that year prospecting and exploring on the Stewart river and some of its tributaries.

From the description of his travels this man, Alexander McDonald by name, appears to have ascended Mayo river to Mayo lake, afterwards going up Duncan and Lightning creek. From the head of Lightning creek he crossed to the Ladue river, down which he floated on a raft for two days, but finding this stream flowing in a northeasterly direction and not south, toward the main branch of the Stewart as he expected, he abandoned the raft and returned to the point of his departure.

After prospecting for a time on the Gustavus mountains, he crossed to the McQuesten river and floated down that river to the Stewart.

McDonald gave the name to Mayo lake and river after Mr. Frank Mayo, one of the partners in the firm of Harper, McQuesten and Company.

Early prospecting.

In the summer of 1898 many hundreds of prospectors made their way up the Stewart. They were in search of the rich gold placers reported to exist in the vicinity of that river. For several years fine gold had been obtained in paying quantities on the bars of the lower Stewart, and in 1895 coarse gold was found on Haggart creek, a tributary of the McQuesten.

Some of the prospectors of 1898 reached the mouth of the McQuesten river, and a few of the more enterprising ascended that stream to the McQuesten lakes, prospecting on the small creeks as they advanced.

Among the latter were a party of three Swedes; these men appear to have been energetic prospectors. They located on the canyon on Duncan creek, about eight miles from the McQuesten river, after having satisfied themselves that this ground was the best in the neighbourhood. Here they built their cabins and erected a saw-mill, which was worked by water power, and for over two years worked undisturbed, making an occasional trip to Dawson for supplies. Being in such a remote and secluded position they never thought it necessary to stake their claims and record their discovery.

On September 12, 1901, a discovery was staked in the canyon on Dnncan creek by a party of four prospectors. This discovery was staked during the absence of the Swedes and included the ground already worked by them.

Since the Klondike was made known this is the most important discovery made in the lower Yukon country.

During the year 1902 Duncan creek was staked from its head waters to the Mayo river. Cabins were built on almost every claim and active preparations were made to develop the ground.

A good waggon road was constructed by the Government from the mouth of the Mayo river to Duncan creek, a distance of twenty-four miles. Road houses were established at several points and two rival town-sites were located at Mayo river and Gordon landing on the banks of the Stewart river.

A good deal of prospecting was carried on over the surrounding country, and in the spring of 1903 Minto creek was staked. During the autum of the same year five discoveries were made on the smaller creeks flowing into Mayo lake. Highet creek, a tributary of Minto, was also staked about this time.

PREVIOUS SURVEYS.

Previous surveys.

In 1898 Mr. J. J. McArthur, of the Dominion Topographical Survey, made a reconnaissance survey in this region. He mapped the upper portion of the Stewart river and part of the surrounding country.*

In the summer of 1900 Mr. R. G. McConnell made an examination of the Stewart river as far as Frazer falls.†

In 1903 Mr. A. J. McPherson, D.L.S., of the Dominion Surveys branch at Dawson, was instructed to take the necessary surveys for the purpose of establishing base lines on the various creeks already staked by miners in the district.

Mr. McPherson carried a chain and transit line from Dawson to the east end of Mayo lake by way of the White pass and Yukon winter road, and the Stewart and McQuesten rivers, to which he has connected the base lines of the creeks and by means of which he has fixed the position of the principal mountain peaks.

GEOGRAPHICAL POSITION.

Geographical position.

The Duncan creek mining district includes the Stewart river and its tributaries from Mayo river eastward, the Mayo river and its tributaries, and the north and south branches of the McQuesten river and their tributaries.

The Stewart enters the Yukon river from the east at a distance of fifty-eight miles south of Dawson. The McQuesten and Mayo rivers are two of the principal tributaries of the Stewart. They enter the latter at distances of 100 miles and 170 miles respectively from the Yukon.

Means of access.

The district can be reached by steamboat from Dawson to either Mayo or Gordon landing, on the Stewart river, and thence by waggon road to Duncan creek or Mayo lake, or during winter with dog teams by way of Dominion creek to Clear creek, thence up the Stewart river on the ice.

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* Report of the Department of the Interior, 1899.

† Geol. Sur. Can. Summary Report, 1900.

GENERAL DESCRIPTION.

The portion of the Duncan creek district here described lies east of the Tintina valley and west of the Rocky mountains. Its characteristics are well developed interlocking valley systems, which isolate small mountain groups, and areas of well dissected upland.

Stewart river.

The Stewart river is the master stream of the area. It occupies a valley of mature erosion, the floor of which is a graded flat from two to three miles wide, but which attains a width of almost six miles at its junction with the Mayo and Talbot creek valleys. Innumerable small lakes and ponds are dotted all over these plains.

The next depression of importance is that occupied in turn by the Mayo river and Mayo lake, Rupe river, Ladue river and the south branch of the McQuesten. This valley is blocked with glacial debris in some places, and has a steeper grade than that of the Stewart river. The highest elevation of the floor of this valley is on a wide undulating flat, from which the waters of the Ladue and McQuesten rivers divide. This valley is intersected by another and shorter valley lying north-west and south-east, occupied by Ross creek, some lakes at the head of Mud creek, Janet lake and Janet creek. Another very pronounced depression is that extending in an east and west direction from the Mayo valley to the McQuesten and occupied by Minto creek and lake and Bear creek. A branch of this valley extends in a southwesterly direction to the Stewart river and contains Moose creek.

Mayo lake.

Mayo lake is the largest sheet of water in the district. The main body of the lake is twenty miles long and from one and a half to two and a half miles wide, and lies in an east and west direction. A narrow arm of the lake, twelve miles long, extends to the southeast The northern shores of the lake rise in gradual slopes to the Gustavus mountains. The shores to the south-east of the lake are abrupt and in places cliff-like, while those to the south-west are low and rise gently to ridges which are mostly below timber line.

Rupe river.

Rupe river enters Mayo lake at its eastern extremity. It is a sluggish stream of about 150 feet wide and four or five feet deep. About one and a half miles from the lake it is joined by Edwards creek, a swift stream flowing from the south-west. The lower portion of Rupe river runs through a wide, flat-bottomed valley containing numerous lakes. Following this valley northward Ladue river can be reached by a portage of about seven miles from Rupe river. Ladue river flows in a north-easterly direction and enters the north branch of the Stewart river about 125 miles above Frazer falls.

Nelson creek. Nelson creek enters Mayo lake at the extremity of the south-east arm. This stream is about seventy-five feet wide and two feet deep, and enters the lake without any perceptible current, but a few miles up the stream the current becomes swift.

The valley of the south arm of the lake extends up Nelson creek, gradually trending in an easterly direction. This valley also extends southward towards the Stewart river. Its bottom is a wide undulating flat, bordered by gravel terraces and contains a number of small lakes at various levels.

Most of the numerous streams that enter Mayo lake from the surrounding hills are short mountain torrents, throwing down considerable debris which they deposit in flabellate deltas extending into the lake. Mayo river, the outlet of the lake, at its western extremity, has cut through a wide gravel bench which previously formed a dam across the valley. This bench extends eastward along the lake shores as far as Keystone creek. Near the mouth of Edmonton creek are beaches raised in successive steps, the highest of which corresponds to the bench at the outlet.

Mayo river. The Mayo river, meandering through a wide valley, deeply floored with drift materials of various origin, has a fall of about ten feet to a mile. Wide benches rising to a height of 350 feet above the stream border the valley. They are continuous all along the eastern side and have diverted the waters of Janet lake from the Mayo river. About ten miles below Mayo lake, Field creek crosses the Mayo valley through a striking arrangement of eskars, kettle holes and mounds, and all the topographic characteristics of a terminal moraine. The material of the moraine is principally well-rounded pebbles three to six inches in diameter. About two miles below Minto creek the Mayo river in the course of its meandering became superimposed on two rock-spurs projecting from the western slopes. The river has sawn a channel into the rock, thus forming canyons with walls 200 feet high and each about a mile long. The only other exposure of rim rock on the river occurs about a mile below Mayo lake.

The flow of water in the Mayo river was measured by Mr. Beaudette on June 20, 1903, and found to be 124,400 miners' inches (Californian).

Gustavus mountain group. The Gustavus mountain group is completely surrounded by wide valleys and forms a prominent topographic feature in the district. They are deeply dissected by streams which radiate from them in all directions. The head waters of the streams have worked back into the steeper slopes, leaving sharp edged ridges and peaks of a generally ruinous appearance. A deep ravine, cut down by Granite and Keystone creeks, divides them into smaller groups. Of the group overlooking Mayo lake, the highest point is Mount Albert, at 6,500 feet above sea level, while Mount Hinton, of the Duncan creek group, is the highest point of all, being about 7,000 feet above sea level. The northward facing slopes are, as a rule, precipitous. The slopes that face the south are less rugged and have easy grades. On the higher levels, in position sheltered from the sunshine, a good deal of snow remains throughout the summer. North-east of the Gustavus mountains, but separated from them by the wide valley of the Ladue river, rise the Davidson mountains, some of whose peaks are as high as Mount Hinton. This group is a spur from the Rocky mountains, whose higher peaks appear in the distance in continuous array, sweeping in a great curve towards the north-west Twenty-two miles west of Mount Hinton and rising from the valley of the McQuesten, is Mount Haldane, a very prominent feature, invisible from many points on account of the wide valleys which lead to and surround it. This mountain is known by the miners as Lookout. Its height is over 6,000 feet above sea level.

The upland areas bordering on the Stewart and Mayo valleys are composed of broad back ridges with curving profile breaking off more or less abruptly towards the valleys. These ridges have an altitude of from 3,500 to 5,000 feet above sea level, but small erosion remnants project from them to a much higher elevation.

GENERAL GEOLOGY.

The rock bed of the gold placer diggings of the Duncan creek mining district is composed of an essentially schistose series, consisting partly of crushed eruptives and partly of rocks having a sedimentary origin. The schists derived from eruptives occupy the greater area, extending from Nelson creek at the south end of Mayo lake in a westerly direction to the McQuesten river. Their extension east and west of this area has not been determined. They outcrop on the Stewart river near Gordon landing and extend northward to upper Duncan creek and Haggart creek. Rocks of the placer diggings.

These rocks are principally derived from quartz porphyry and vary from a massive and only slightly deformed phase of this rock to a soft, foliated, sericite schist. The freshly fractured rock has a pale yellowish green colour, but becomes a reddish brown when exposed to weathering. The most abundant mineral present is quartz, and a typical schist is composed of thin parallel layers of quartz separated by films of mica, generally sericite. In many cases the quartz layers are not continuous, but are lens-shaped with thinly drawn out edges. Kidneys of quartz with blunt ends and wrapped with layers of mica. schist are also characteristic of large masses of the rock. These quartz kidneys vary in thickness from one to twelve inches and are arranged parallel to the general direction of foliation in the rock. On weathering a slaty cleavage is most in evidence, but in the massive varieties the jointing is more pronounced and the rock then breaks down in slabs and blocks. Rocks similar to these occur in the Klondike mining district. They are described by Mr. McConnell under the name of the Klondike series.* The Duncan creek rocks will probably be correlated with this series when the field work over the intervening area is completed. To the east of the south arm of Mayo lake, about half a mile from the shore, the rocks just described cut through a series of older rocks which are evidently of sedimentary origin. They now consist of massive and banded quartzite mica-schists and graphitic schists and extend across Mayo lake, forming the eastern portion of the Gustavus mountains and are the bed rock in upper Duncan creek. In this last locality they contain banded crystalline limestones. These rocks have a marked resemblance to a series occurring on Indian river and elsewhere in the Klondike district, which are described by Mr. McConnell under the name of the Nasina series.

This older series are intruded by dark, green-coloured rocks which are mostly actinolite diorites, much decomposed. Around the heads of Ledge and Edmonton creeks these eruptives occur as dikes and stocks, protruding through the schist. They have a well-jointed structure and the surface blocks are all loosened from the mass. Similar eruptives are found invading the schists on the Gustavus mountains, on Lightning creek, on Haggart creek, and in the canyon on Mayo river.

Small masses of gray granite occur on Rupe river near Granite creek at the head of Dublin gulch, and on Rudolph gulch at the head of Highet creek.

Several dikes of biotite andesite cut through ths schists in the vicinity of Bennett, Highet and McLaghan creeks. In the neighbourhood of Mayo lake the general strike of the schist is north-west with a dip to the south-west at an angle of 20 to 40 degrees. On Duncan creek the rocks are nearly horizontal. On Minto creek and its tributaries the strike is variable but has a prevailing direction to the north-east with a dip of from 10 to 40 degrees. In no case was a dip of more than 45 degrees from the horizontal observed.

* Preliminary Report of the Klondike Gold Fields. R. G. McConnell, B.A.

Very little folding or warping of the rocks was noticed, but indications of normal faulting were occasionally seen.

Glaciation.

There is sufficient evidence to show that during the glacial epoch an ice sheet of considerable thickness occupied all the valleys and submerged most of the intervening ridges. It is doubtful if even the highest peaks of the mountain groups were uncovered during the period of its maximum development.

The effect of the glacial action was first to widen the valleys and to disturb and transport the bulk of the loose material, then to generally disarrange the pre-existing drainage system and to profoundly affect the economic conditions. Scarcely any remnants of ancient high level river gravels remain. These have been shifted to lower levels and redistributed along the main valleys. Portions of former river and creek channels of lower level are often concealed beneath the great thickness of this material, and irregularities in bed-rock are frequently due to the gouging action of the ice sheet.

The glacial drift deposits consist of boulder clay, gravels, sand, silt and clays. Their distribution is irregular, and varying conditions have affected their arrangement.

DESCRIPTION OF CREEKS.

Duncan creek.

Duncan creek is economically the most important stream in the district. A great deal of development work was done on this creek, and from it was taken the greater part of the gold which the district has produced.

The head waters of this creek have their source among the highest peaks of the Gustavus mountains. These small streams on assembling form upper Duncan creek which flows through a wide valley in a north-westerly direction for a distance of four miles. It passes out of this valley through a narrow canyon and then enters the main valley of Duncan creek where it is joined by Lighting creek. It then runs in a south-westerly direction for nine miles and empties into the Mayo river at a distance of five miles from Mayo lake. Two important tributaries, Parent creek from the east, and Williams creek from the west, enter Duncan creek about five miles from its mouth. The fall from Lightning to Parent creek is about 250 feet, and from Parent creek to the Mayo river the fall is about 450 feet.

Flow of water.

The flow of water in Duncan creek, as given by Mr. Beaudette's measurements on June 20, 1903, was 18,250 miners' inches. This was during the stage of high water.

The lower portion of the creek cuts through heavy deposits of gravel, sand and clay, and remnants of benches of these materials still cling to the hillsides to a height of 300 feet above the stream. In the neighbourhood of Williams and Parent creeks these deposits disappear from the valley bottom, and low rock terraces, covered with a thin coating of rolled gravels, are exposed. Above Parent creek the valley is wide and has a deep covering of drift on the bottom. About a mile below Lightning creek the valley becomes contracted and rock benches are exposed for about two miles up stream. The main valley continues in a north-westerly direction to the McQuesten and is occupied by the lower part of Lightning creek and by Christal creek.

About 500 yards from the mouth of Lightning creek upper Duncan creek issues from a narrow canyon. This canyon is nearly one mile long, with an average width of twenty-five feet on the bottom, and walls about 120 feet high. The canyon walls contract towards the lower end, and an almost vertical fall of eighteen feet occurs. The total fall through the canyon is about 350 feet.

Drift deposits.

The drift deposits which clog the valley of Duncan creek are principally of glacial origin. The frost does not strike down to such great depths here as it does in the Klondike district, so that the lower unfrozen layers of the glacial material afford constant passages for underground water.

The readjustment of the stream during the withdrawal of the ice from the valley is probably the cause of the cañyon on upper Duncan creek, the stream being superimposed on a rock bench, through which it has since cut out its channel. The former channel appears to have been on the left limit and to have entered lower Duncan creek above Forty creek. It is now concealed by a thick deposit of gravels and clays. The old creek channel is not uncovered by the present stream at any point, except possibly at the low rock barrier which crosses the valley near Parent creek.

The channel at claims Nos. 124 and 125 below Discovery is new, being cut into a rock bench. The old channel is probably on the right limit, and is now deeply covered by gravels.

Coarse gold.

The discovery of coarse gold was first made in the canyon in the year 1898. The original discoverers worked secretly and never recorded their claims, but are said to have taken out not less than $30,000 during the three succeeding years. In the summer of 1903, the year of greatest activity on the creek, the sum of $30,000 was produced from the canyon claims, and in 1904 the amount produced was $15,000.

The cañyon bottom above the falls is now all worked out, as is also a pot hole immediately below the fall. The pot hole, which is about twenty feet in depth, was mined at a considerable loss, no gold being on bedrock and very little in the gravels.

The conditions under which pot holes are formed are unfavourable for an accumulation of gold. The grinding action, consequent on the churning and rotary movements of the loose material brought over by the waterfall, tends to wear away and remove the metallic contents which may happen to be detained in the pot hole for any length of time. Pot holes.

The gold in the canyon lies on the bedrock, which is slightly folded and without much dip. Hard bands of quartzite, six to ten inches thick, alternate with soft schists, so that natural riffles are provided in which the gold is accumulated. Lying on bedrock are from one to three feet of boulderets, slates and coarse gravel. Large sized boulders are frequent toward the upper end of the canyon.

The gold occurs in flattened and rolled particles without quartz, and is evidently the finer portion transported from a pay-streak up stream. The assay value is $16.58 per ounce. About $28 to the shovel per day was the average result on the canyon claims. Occurence of the gold.

A portion of the gravels on the lower benches at the upper end of the canyon has been washed down. These gravels do not contain much gold, but pay is found in the hollows of the underlying rim rock sufficient to afford fair wages. Above the cañyon the creek bottom is about fifty feet wide. No proper attempt has been made to locate the pay streak on this ground.

At claim No. 17 above Discovery, or about a quarter of a mile above the canyon, shallow ground with good pay is being worked. Judging by the work done on adjacent ground and by the nature of the surroundings, it appears that the stream at this point is flowing across a rock bench. Overlying the bedrock on this claim are from three to twelve feet of boulders and coarse gravel, with a matrix of blue clay. The gold is found imbedded in the clay, a little above bedrock. It is very coarse, nuggets about the size of Lima beans being often found. The largest piece obtained was found this summer, and was worth $67.50. The nuggets were all worn smooth, and contained no quartz.

Above this point the valley widens out considerably and is floored with a great thickness of gravels and blue clays. Several shafts have been sunk to depths of from sixty to 120 feet without reaching bed rock.

Result of the small claims.

The only result of the difficult and expensive exploitation of lower Duncan creek during the year 1903 was to demonstrate the impossibility of one individual miner working his 250 foot claim. The difficulties met with were mainly the deep mantle of drift which lies on the valley, and the underground water. Many of the shafts were sunk to a depth of over 100 feet, and 130 feet was reached on No. 104 below Discovery without getting to bedrock. The depth alone would not have deterred the miners from further sinking, but in every case they were forced to abandon their shaft on account of the heavy water encountered when certain layers of unfrozen gravels were pierced.

During the summer of 1903 Claims Nos. 53 and 54 below Discovery were grouped. A shaft sunk on 53 at some distance from the creek on the left limit reached bedrock at a depth of ninety-eight feet. In the winter drifting was continued toward the creek, the rock bottom yielding gold in small quantities. The water entering the drift during the progress of the work was got rid of by pumping, but the flow increased beyond the capacity of the pump, and the miners were forced to abandon the drift just as good pay was struck. The total amount cleaned up was $1,200.

On Claim 105 below Discovery good pay was obtained on the left limit quite near the creek at a depth of sixteen feet below the surface of a gravel bench. The gold rested in a layer of gravel overlying boulder clay. On the same claim another shaft reached the outer edge of a concealed rock terrace at a depth of forty feet. While drifting from this shaft toward the stream a pay-streak was found in the deeper gravels beyond the rock rim. This was a paying proposition, but had to be abandoned on account of water, no pumps being available. At Claim 124 below Discovery the creek flows between steep rock benches for about the length of four claims. The creek bottom is wide and has a layer of three to twelve feet of small boulders and gravels on the bedrock. The miners have confined the creek to the side of the valley by means of a head dam and trench and a bed rock drain two claims long has been constructed. The bedrock is a soft micaceous schist, dipping against the stream at an angle of about 30 deg. A sufficient area of bedrock has been cleaned up to prove it of very little value, and the undertaking has been unprofitable.

These are the only instances in which gold has been produced on the main creek, and although the value of the ground on bedrock has not been determined, many of the miners who failed on the creek still retain their confidence in it.

The owners of almost all the claims continued to do the annual assessment work necessary to hold the ground, either with the hope of selling out or finding someone to install machinery to test the creek.

Suggestion regarding combination of claims.

The cost of placing the necessary machinery on the ground in such a remote district would be too great an initial expense for the individual holding only a 250 foot claim, especially as the richness of the ground is an unsettled question. A company which could acquire from one to two miles of the creek bottom at a reasonable price would be working on a different basis. One pumping plant of sufficient capacity to dispose of the underground water, or a well timbered bedrock drain, would serve for the whole workings. Diligent prospecting might reveal benches carrying good pay both on rim rock and in the overlying gravels, which, after the creek bottom had been worked out, could be mined by the hydraulic method.

Lightning creek.

Lightning creek carries more water than upper Duncan creek. It heads in the northern slopes of the Gustavus mountains, and flows through what appears to be a continuation of the main Duncan valley. About one mile from its mouth it emerges from a box canyon, somewhat similar to that on Duncan creek. Above the canyon, the creek bottom widens out to a broad flat bordered with high gravel terraces.

In pre-glacial times Lightning creek evidently discharged into the McQuesten river by way of Christal creek. The gravels on the right limit of the creek above the canyon occupy the old channel and contain very little clay. Some of the Lightning creek water still finds its way through them, and, rising to the surface near Christal lake, flows down Christal creek.

The canyon on Lightning creek is difficult to work on account of the great flow of water and the immense blocks of rock which have fallen from the walls. The bedrock is composed of banded quartzite and quartz-sericite schists shelving with a slight dip across the stream. Its attitude and the nature of its surface is generally unfavourable as a receptacle for gold.

Several shafts have been sunk in the creek bottom both above and below the canyon but without result, work being suspended in every case on account of water.

Claims were staked on Forty pup, Williams and Parent creeks. Some development work was done, but no gold was produced.

Parent creek.

Parent creek has cut a recent channel through a rock bench bordering on Duncan creek, and has formed a short canyon nearly 100 feet deep. The bedrock of this canyon has not been tested, although it appears to be under shallow ground. The old channel of Parent creek probably entered Duncan creek about half a mile further up stream than the present one. A shaft has been sunk in the gravels over this old channel, but as it was found to be too deeply buried the work was abandoned.

The rock bench, which rises to about 100 feet above Parent and Duncan creeks, is covered with a layer of gravels with well-rounded pebbles, mixed with clays and sands. They have a rough stratification on top, which suggests former flood plain deposits. These gravels have been tested by several open cuts made through them to bedrock. No definite information regarding the gold tenor of the gravels could be obtained, the owners being absent, except in the case of one property where the prospects were said to be good enough for hydraulic operations.

Ledge creek.

Ledge creek enters the south-east arm of Mayo lake on the east side at a distance of four miles from the end of the arm. About three-quarters of a mile from the lake the stream emerges with a low fall from a narrow rock gorge. Above the gorge the stream flows through a narrow canyon for a distance of about half a mile. Beyond this point the valley widens out, but still presents a gorge-like aspect. Rim rock is seldom visible on this portion of the stream, being hidden by the loose material which slides at intervals from the hillsides.

Discovery claim is situated immediately above the gorge and occupies the greater portion of the canyon. The bedrock consists of dark-coloured quartz, mica-schist and graphitic schist, with numerous inclusions of quartz. From six to twelve feet of loose, unfrozen material rest on bedrock. This material consists of boulders of diorite from the heads of the stream, fragments of schist, gravels and clay. The gold has sunk in loose bedrock to a depth of about one foot. It is all coarse, the general run being about the size of dried peas, while nuggets weighing an ounce or more are frequently found. Most of the pellets of gold are coated with hydrated peroxide of iron, which gives them a dark brown colour. This incrustation on the gold is probably due to the decomposition of iron pyrites, small cubes of which are abundant in the bed rock. The assay value of the gold is $16.95 an ounce.

Four men worked during fifty-five days on Discovery claim this summer, their average production being $25 a day each.

Two claims above and two claims below Discovery were also worked this year with good results.

This constitutes practically all the productive ground on the creek. Above and below this portion the depth to bedrock is too great to allow the ground to be worked by open cuts, and underground water nterferes with drifting.

As the creek bottom is narrow, there is often great difficulty in obtaining space on which to pile boulders when opening drains and cleaning up bedrock.

Gold in paying quantities is said to be found on some of the benches. These benches can easily be worked after the creek bottom is exhausted of its pay.

The creek has a steep grade, and the heavy rainfall ensures plenty of water for sluicing all through the season.

Cascade creek, which enters the south arm of Mayo lake about two miles south of Ledge creek, is a small mountain torrent descending by a series of rapids through a narrow rock-gorge. The creek bottom is littered with large blocks of rock, which have fallen from the walls of the gorge. The material lying on bed rock is composed of well-rounded boulders of diorite and quartzite, fragments of schists and gravels. Cascade creek.

Discovery claim is situated about half a mile from the lake. Work was begun on this claim and a small quantity of gold was obtained, but freshets, resulting from the heavy rains during last July, interfered with mining operations.

Steep creek enters the south arm of Mayo lake about eight miles from its southern end. It heads in a cirque carved out of the highest portion of the ridge bordering the lake on the west. The productive portion of the creek occupies a deep channel cut through rock-waste and glacial drift containing a good deal of clay. During low water in summer the stream is occupied in removing the material which is constantly creeping down the steep slopes. In time of flood the bottom is scoured out to bedrock in places. Steep creek.

The bedrock is a compact quartz-sericite schist, weathered to a light brown colour. The dip is down stream at an angle of about 40 deg. This attitude of the bedrock with regard to the stream is preferred by the miners, because once the gold becomes deposited water action cannot remove it except by actually eroding down the rock. Glaciated boulders from various sources, gravels and sands, and a stiff yellowish clay overlie the bedrock.

Four men were working last July on claim No. 2 above Discovery. Bedrock was easily accessible, but as it scarcely yielded wages the claim was abandoned. The gold from Steep creek is in small bright coloured particles of great purity. The assay value was $19.57 an ounce. A large quantity of black sand accompanies the gold.

Edmonton creek.

Edmonton creek heads in northward-facing slopes of the same rugged uplands as Ledge creek, but drains the larger area. It enters Mayo lake about two miles from the eastern end. The principal country rock on the creek is a dark-coloured quartzite schist without marked slaty cleavage. Several diorite dikes cutting the schists are also eroded by this stream. The creek bottom is floored with a mass of well rounded boulders and angular blocks of diorite, accompanied by the usual gravel and clays.

During the early part of the summer four men worked on Discovery claim. Operations were commenced by thawing and washing down a frozen gravel bank which overlaid a low rock-bench beside the stream. This work was abandoned in favour of drifting, the latter being more economical. A bedrock drain was also commenced and other preparations made for next summer's work. The prospects were said to be encouraging.

Keystone creek.

Keystone creek is the largest of this group of small creeks. It heads in the Gustavus mountains and enters Mayo lake about five miles from the outlet. The lower portion of the creek occupies a deep and fairly well developed valley without the gorge-like aspect which characterizes those just described. Rim rock is rarely exposed along the stream. The valley bottom is floored with a thick deposit of boulders and gravels, and considerable loose material clings to the slopes above the creek, near which a few shafts have been put down. Bedrock was not reached in any of the shafts, as the underground water interfered with a continuation of the work. It is doubtful if this creek can be worked by the open-cut method. The benches above the stream are easy of access and may yield good results, but they have not been prospected. The fall of the stream is five feet in 100. No gold was produced on this creek.

Haggart creek.

Haggart creek is one of the principal tributaries of the McQuesten river. It enters the south fork of the latter at a distance of eighty-five miles from the Stewart river. It heads in high ridges near the north fork of the McQuesten, and occupies a very large winding valley with a flat floor. During 1898 several miners worked claims on Haggart creek, and are said to have sunk twelve shafts to bed-rock. From some layers of the gravel good pay was obtained, but very little gold was found on the bedrock itself. Underground water caused considerable trouble. Work in this creek is now abandoned.

The bedrock on Haggart creek is principally a dark-coloured, quartz-mica schist. A diorite dike, cutting the schists, crosses the creek a short distance above Discovery. A highly altered and well mineralized dike, the nature of which has not been determined, also crosses the creek at the mouth of Dublin gulch, north of which the country rock is a white bedded quartzite, apparently of later origin than the schists to the south. These quartzites continue northward to the north fork of the McQuesten. No gold is found in the streams which cross these quartzites.

Dublin gulch.

Dublin gulch, a small tributary of Haggart creek, enters on the left limit about twelve miles from the McQuesten. Work has been carried on here every year since 1898, but only two men were working here during the past summer. They were engaged on Claim 15 above Discovery. The work consisted of washing out the gravels in the valley bottom by means of a small hydraulic plant.

The surface gravels are here composed of small granite boulders and angular schist fragments with fine gravels. This is recent stream-wash, and carried fine colours of gold. The depth of this deposit is about six feet. Beneath this surface deposit lie two or three feet of blue clays with angular pebbles, under which is a seam of about a foot thick of fine yellow gravels carrying gold. Below the gravels are from two to three feet of yellowish gravels and clay, evidently of glacial origin, which contain small particles of gold. These glacial clays rest on old creek gravels. No bedrock has been exposed. A trench about 200 feet long and forty feet wide, cut down to the old stream gravels, has been worked out. The yield was small, amounting to about the wages of the country, which are $7 or $8 a day.

The gold on Dublin gulch is fine and of a bright colour. The particles are of a wiry form or in small scales. It is accompanied by a quantity of heavy white sand, consisting of rounded grains of scheelite (tungstate of lime), from which it is difficult to separate the gold. There is also a run of flour-gold which is not saved in the sluice-boxes. It is possible that hydraulic mining could be successfully operated on this stream by a company acquiring a concession to cover the whole creek. There is a large body of the deposits, both on the benches and in the creek bottom. The boulders being generally small, not many of them would require breaking. The creek has a fall of five to eight feet in 100, but the supply of water is scarcely adequate for hydraulic operations on a large scale.

Highet creek.

Highet creek is one of a group of creeks which drain the deeply dissected upland lying between the Mayo and the McQuesten valleys. The headwaters of the creeks on opposing slopes have cut back deeply on the watershed, leaving residual domes, the highest of which stand about 5,500 feet above sea level. The southward-facing slopes of this upland overlook a wide depression containing Minto creek and lake, also the heads of Bear and Moose creeks. The streams issue from narrow gaps in these slopes and flow across the bottom of the depression to Minto creek, which stream enters the Mayo river about ten miles from the Stewart.

Highet creek flows in a southeasterly direction and joius Minto creek about two and a half miles below the lake, its entire length being about seven miles. At two miles from Minto creek the stream issues from a short canyon, the bottom of which is strewn with large blocks of rock fallen from the crumbling and receding walls that rise on both sides to a height of about 250 feet. Above the cañyon the creek flows through a narrow valley bordered by clay and gravel terraces which conceal the rim rock on which they rest. The headwaters of the creek are two small mountain-torrents, each carrying about a sluice-head of water. The one on the left limit is known as Rudolph gulch. The total fall from this point to Minto creek, a distance of five and a half miles, is 900 feet.

Considerable deposits of drift material adhere to the slopes above Highet creek to a height of 400 feet. These deposits consist of glacial clays and gravels, slide material due to the disintegration of the underlying bedrock and sands and silt. Masses of this material slide at intervals into the creek bottom. The bedrock is mostly composed of a sericite schist resulting from quartz porphyry. The rock is very compact in places and has a well-developed cleavage.

On the upper part of the creek several andesite dikes cut the schists. A small mass of granite has been exposed by erosion at the head of Rudolph gulch. Massive quartz-porphyry, only slightly deformed, occurs on the west side of the creek above the canyon.

Although Highet creek was prospected during several seasons and a number of shafts were sunk in the creek bottom, it did not produce gold in paying quantities until this summer. Late in the autumn of 1903 coarse gold was discovered on a rock bench opposite the mouth of Rudolph gulch. No discovery was allowed, on account of the proximity of the ground to discovery on Minto creek. The claims number from the mouth of the creek up, none of them being more than 250 feet long

Work was carried on, during the summer of 1904, on the benches on the right limit of four claims between 98 and 110. The lower edges of these benches are from one to twelve feet above the creek. The bedrock has a hummocky surface which rises with a slight incline toward the hillside. The upper edges have not been uncovered.

The gravels of the benches immediately above bedrock consist of well-rounded boulders of diorite, quartzite, granite and andesite, and slabs of schist with rounded edges. Gravels and sands.

Fine gravels and sand mixed with a stiff yellow clay fill the interstices between the larger fragments. Above these gravels is a layer of sandy clay in which fragments of schist from the country rock are embedded. These loose schist fragments have a parallel arrangement, probably due to the slow, creeping movement with which they descended the hillside.

On claim 105, situated opposite the mouth of Rudolph gulch, a portion of the bench, to a distance of seventy feet from the creek and about eighty feet long, was worked out last summer. The inner face of the gravels was about twelve feet high. Water for sluicing was carried in a flume from a point a short distance up Rudolph gulch.

As the gravels are frozen, stripping and ground-sluicing are done as far as possible in advance of the mining, so as to allow thawing action to go on. Fires are built against the gravel faces as the mining progresses.

On beginning sluicing operations the tailings are allowed to go into the creek bottom. When enough ground has been cleaned up, the tailings are piled on the bench. Disposal of tailings.

Mining will be carried on by drifting on bedrock when the deposits toward the upper edges of the benches become too steep.

The gravels for a few feet above bedrock contain gold, but the principal source is from the bedrock crevices. The gold is of a rich, bright colour, the particles, as a rule, being water worn and smooth, but many of them are angular and wiry, and are found adhering to fragments of schist or quartz. The yield of the benches averages about one dollar to the square foot of bedrock.

The loose material which occupies the creek bottom is an unsorted mass of deposits similar to those on the benches. Attempts to reach bedrock in the creek bottom have not been successful, on account of underground water.

The water difficulty.

A shaft which reached bedrock at a depth of twenty feet below the creek was sunk some years ago on claim 66. Gold in paying quantities is said to have been taken from this shaft, but underground water prevented further working. Above this point some of the claims are being grouped, and it is said that an effort will be made next season to work the creek bottom by means of a bedrock drain.

The owner of Claim 56 has a small pump on the ground and intends to sink a number of prospecting shafts across the creek during the winter.

Minto creek.

Discovery claim on Minto creek is situated about one mile below the lake. The valley is comparatively narrow at this locality and a few exposures of rim rock occur. The creek is about twelve feet wide and flows with a sluggish current through this portion of the valley. Gravel terraces, at various levels to a height of 350 feet, border the valley. Layers of fine silt and sands occur on all the terraces, overlying an unsorted mass of rounded pebbles, fine gravels, sand and clay. The pay ground on Discovery claim consists of the flood plains adjoining the creek. These flood plains or bars, about 1,100 feet wide, have been tested to a depth of about eight feet and found to yield from three to five cents to the pan. Sluicing was done on a portion of the claim last summer, the water supply being taken from McIntyre creek, a small stream on the left limit, carrying about a sluice head of water.

The great difficulty in working this ground is to secure a sufficient head of water and enough fall for the disposal of tailings, the elevation of the bars being only ten to fifteen feet above the creek.

While this property could not be worked by the hydraulic method, it seems to be an excellent dredging proposition. The gold occurs principally as small, bright-coloured scales, and appears to be due to the concentration of the surrounding benches.

Good prospects are also obtained on the lower gravel benches which border the lake.

Some shafts have been sunk in the wide valley of Minto creek below Discovery, but failed to reach bed rock. A soft blue mud, which rose in the shaft, was struck at one point at a depth of about 100 feet. All this creek, except the Discovery group of claims, is abandoned.

Some work was done on Eight creek and Jarvis creek, two small streams on the left limit above Discovery. These streams cut through the high gravel terraces and have concentrated a small supply of gold from them, but not enough to pay wages.

Johnson creek, which heads with Highet, flows in the opposite direction into McQuesten river. This stream was prospected during 1898-9. Several shafts were sunk in the creek bottom, but the usual underground water was encountered and the work was abandoned. It is the intention of some of the miners from Highet to test the benches on this creek during the winter. Johnson creek..

The workable portions of Ledge, Cascade and Steep creeks and the canyon on Duncan are all shallow diggings. The mining is carried on in the primitive manner and with the implements usual to remote and partly developed placer districts. Only the richest and most available ground is worked and the gold is not all saved. The method of mining is as follows : Method of mining.

After ground-sluicing all the upper loose material to within a foot or so of bedrock, a timber dam, three or four feet high is built, across the creek at the upper end of the claim. A board flume, large enough to carry all the water in the creek, is fitted into the dam. This flume is generally about 200 feet long, but the length depends on the fall of the creek and the depth to bedrock. After the dam and flume are completed, an open cut which serves as a bedrock drain, is made in the creek bottom. This drain is started at such a distance below that its grade will strike bedrock at the lower end of the flume. After ample drainage has been secured for the bedrock, a line of sluice-boxes, connecting with the flume for the water supply, is placed in position. The boxes are fitted with pole-riffles to save the gold, and a grade of eight inches is allowed to each box.

Shovelling into the sluice, boxes is begun a little above the lower end of the flume, and a clearing is made on bedrock on which the tailings are piled. When the clearing is large enough to allow good drainage, it becomes no longer necessary to handle the tailings.

The large boulders are piled along the edge of the stream, those that are too large to handle being broken with sledge hammers or by fire.

Loose fragments of bedrock are put through the sluice-boxes and the solid portions are carefully scraped. The boxes are generally cleaned up every three or four days.

The total amount of gold produced by the Duncan creek mining district during 1904 was estimated at $32,000. Of this amount, upper Duncan creek contributed $15,000, Highet creek $10,000, and Ledge creek $7,000. Amount of gold produced.

The gold was practically all produced on nine claims, and represents the work of about thirty men during sixty days. The season was unusually shortened owing to a late spring, heavy and persistent rain in summer and hard frosts which occurred early in September

The total population of miners in the district in 1904 was about eighty. The greater number of these were engaged in doing assessment work on various creeks.

Minerals associated with the gold.

The sluice-boxes on every creek in the district catch grains and pebbles of hematite; they are exceedingly smooth, of a dark brown colour, and many of the pebbles have fragments of red jaspilite adhering to them. Hematite also occurs as a brown sand, from which the gold has to be separated by "blowing."

The miners are apt to apply the name "tinstone" to any dark, heavy and smooth pebbles found in the residues, and that name has been erroneously applied to the hematite pebbles throughout the Duncan creek district.

Native bismuth, in small rounded and flattened nuggets, is of common occurrence with the gold on Highet creek.

Scheelite, in small water-worn nodules of yellowish colour, is caught in quantity in the sluice-boxes on Highet creek. The white sand which so often accompanies the gold on Dublin gulch is composed of rounded grains of this mineral.

Other minerals.

Zinc-blende, with which is associated a small quantity of copper pyrites, occurs at Discovery claim on Duncan creek. This ore is exposed on the cañyon wall below the falls, and occupies a vertical fracture in the schists. The ore body is about two feet wide and contains traces of gold.

A deposit of stibnite occurs on a small stream flowing into the Stewart river, about five miles above Gordon landing. The ore, which is associated with quartz, is deposited in the fractures of a thrust-fault in the schists.

Only a small amount of ore is exposed. It contains gold to the value of $1.40 per ton,

Quartz mining.

An important quartz ledge occurs between the heads of two small streams, known as Twenty pup and Forty pup, which flow into Dublin gulch, a tributary of Haggart creek.

This quartz ledge outcrops on a sloping hillside about 500 feet below a mass of granite, and can be traced along the surface for a distance of 600 feet.

The granite and the quartz-lead both cut the country rock, which is a quartz-mica schist, with a strike north-east and a dip toward the west, or down hill, at an angle of about 40 deg.

An open cut, eight feet deep at the upper end, has been made on the surface, exposing the ledge for a width of twelve feet. The extreme width of the ledge is unknown.

The ledge or lead is composed of a number of vertical stringers of quartz, two to four inches wide. Between these stringers are portions of the country rock.

The quartz is impregnated with arsenical pyrites, is much weathered, and portions of its surface have a granular or pitted appearance. Its prevailing colour is green, due to a thin coating of a hydrous-arsenate of ferric iron. Occasional small specks of free gold, which appear to have weathered out from the pyrites, are visible. About 100 feet below the vein, a tunnel has been driven about forty-five feet into the hillside, with the intention of tapping the lead, but is still in the country rock. An assay, from samples taken over about six feet of the vein exposed in the open cut, was made by Mr. Connor, of the Geological Survey, and gave gold to the value of $10 to the ton.

In addition to the claim known as the "North Star," on which the above work was done, eight other claims have been staked on the supposed extension of the ledge.

Several quartz veins occur at the head of Highet creek and on Rudolph gulch. Some of them contain no gold, but a sample from one vein, which carried a little arsenopyrite, yielded gold to the value of $2.60 per ton.

No development work has been done at this locality.

Our knowledge of the bedrock geology is far too incomplete to afford a sufficient foundation of facts in an inquiry as to the source of the gold. Origin of placer gold.

Diligent search in this district has, so far, failed to reveal free gold in the quartz or in the country rock, but many quartz veins and stringers have been discovered, which, when assayed, show traces of gold, and often as much as $7 or $8 to the ton, but none of payable value. Fragments of vein quartz and schists, with particles of gold attached to them, are of frequent occurrence, showing conclusively that they are of vein origin or from impregnated zones.

The wiry and angular appearance of the gold sometimes found in the placer deposits indicates a local source.

On Highet creek and on Dublin gulch it is believed that the gold has its origin in the drainage basins of these streams. On Ledge creek the evidence points the same way, but it is not so conclusive. On Duncan creek the gold has suffered greatly by attrition, is much water-worn, and contains no quartz. But this stream has a large drainage basin with steep grades, and sufficient causes have been at work to reduce the gold to its present state without precluding its local origin.

The fine gold in the benches of wide valleys and in the river bars has its source, in all probability, in an older drainage system, and, having been carried by ice and water in company with gravels, has become finely divided by the time it reached its present destination. It is generally well understood by miners and prospectors that the present concentration of gold in placer deposits is due to the slow wearing and carrying away of immense quantities of bedrock, and that the gold, being indestructible and so much heavier than the material that contained it, slowly accumulated.

Yet surprise is still often expressed that, in a country so rich in placer gold no payable quartz is found, or, if quartz leads are found, they are so frequently barren. It should be further understood that the visible amount of bedrock worn away, that is, the amount which has been removed to make the present valleys, did not furnish all the gold, but that hundreds, probably thousands, of feet above that have been eroded. The question of time, which enters into all geological problems, is so profound that to many individuals the source of the gold will forever remain a mystery.

While, hitherto, prospecting has not revealed any payable quartz veins, it is by no means implied that they do not exist. The amount of bedrock exposed to the prospector's view is very small, and is only seen at intervals in such places as cañyon walls, here and there on streams, or on a few ridges above timber line; everywhere else, it is concealed beneath the forest covering, the moss and the drift. Another adverse factor is the shortness of the season during which the ground is uncovered by snow and prospecting for quartz can be carried on.

Pro pecting.

In consequence of the reverses met with by the miners on lower Duncan creek, and the Tanana stampede of this year, which drew many of them to Alaskan territory, no prospecting for new creeks was done last summer, and no new discoveries were recorded.

The experience of the miners during the last few years has given them a better knowledge of the conditions peculiar to the country and the kind of ground most likely to afford good pay.

The gold bearing rocks are widely distributed, and a great deal of the country underlain by these rocks is still unprospected.

To work to advantage in this country the prospector should be equipped with at least one year's outfit of provisions and clothing.

Freight from Dawson is delivered by the steamer *Prospector* at Mayo or Gordon, on the Stewart river, at the rate of ten cents a pound. In winter this freight is delivered on the principal creeks at from three to six cents a pound. During summer the rate is fifteen cents to Discovery on Duncan creek, or eight cents to Highet creek. There are stores at Mayo and Duncan creek where clothing and provisions may be purchased.

An excellent road, with good grades, suitable for either summer or winter travel, was located and partly cut out this summer by Messrs. Gordon and Davidson from Gordon to Duncan creek, a distance of eleven miles. If a bridge were built over the Mayo river at the outlet of Mayo lake this road could be continued at a small cost over the low divide to Duncan creek near Beliveau creek. The distance then to Duncan creek would be only fifteen instead of twenty-four miles by the Mayo road to the same point.

Pack animals can be used to advantage over most of the country. Fodder is plentiful on the creek bottoms and on the benches, and in many localities hay can be stored for winter use.

Loaded boats or canoes can be poled and tracked up the McQuesten river to the McQuesten lakes.

Miners working in the vicinity of any of the lakes can keep themselves supplied with fresh fish without much trouble. These lakes are all stocked with an abundance of salmon trout, whitefish, pike and grayling.

Moose are numerous in various parts of the district, and are depended on as a regular source of food. Moose.

In addition to these, but not to be depended on for a regular food supply, are the caribou, brown and black bear, and above all, the mountain sheep.

Forest.

Timber.

An adequate supply of white spruce timber of a size sufficient for mining and building purposes can be obtained almost anywhere in the district.

Especially fine groves of this timber were seen on the alluvial flats of the Stewart river, on the north shore of Mayo lake near the eastern end, at the mouth of Duncan creek and at the mouth of Haggart creek. In these groves are many trees of twenty inches diameter, with individuals as large as thirty inches in diameter.

A few small groves of the black pine (*Pinus Murryana*) were observed on the benches above Mayo river, on the shore of Minto lake, and on the south arm of Mayo lake. The pine is small, none of the trees being more than nine inches in diameter.

Timber line was estimated to be from 4,250 to 4,500 feet above sea level. The balsam fir was the only species represented at that elevation.

Nicola Coal-basin, B.C.

By Dr. R. W. Ells.

Routes to Nicola.

In accordance with instructions, I left Ottawa on June 26 with my assistant Mr. R. A. A. Johnston, of this department. Reaching Kamloops, a day was spent in examining the coal outcrops south of that place, (described by Mr. J. McEvoy in the report of Dr. G. M. Dawson, for 1894, pp. 168-169) and the rocks at the Iron Mask copper mine. On July 1 we proceeded by the stage road to Coutlee, which is situated about one mile west of the forks of the Coldwater and Nicola rivers and near the principal coal outcrops of that district.

Areas examined.

The areas more particularly under examination during the season are known as the Nicola and Quilchena coal-basins. They lie to the south of the Canadian Pacific railway and are at present reached by the stage road from Kamloops to Nicola lake and thence out to the railway again at Spence's Bridge station. The eastern or Quilchena basin is about fifty miles from Kamloops, while the lower or Ten Mile creek basin, which is the western extension of the Nicola basin proper, is thirty-six miles from Spence's Bridge.

Rock formations.

The rocks of the area have been described in considerable detail by Dr. G. M. Dawson in his first report on the district, 1877-78, and in his later report, 1894. They are divisible into two groups, volcanic and sedimentary, the former consisting in large part of diabase, porphyrite, rhyolite, andesite, felsite and agglomerate, with which in places large masses of granite of later date occur. The sedimentaries, comprise conglomerate, sandstone and grit, shale and beds of coal, which are partly a lignite of fair quality as at Similkameen, but in other places pass into the bituminous variety, as in the Nicola valley, and form important deposits of great value.

The volcanics occupy the greater part of the country between the line of the Canadian Pacific railway and the Nicola river from Kamloops to Spence's Bridge, and extend for some miles south, in the direction of Princeton. In places, these rocks display a schistose structure, owing to later crustal movements which have also affected the sandstone and associated coals, and produced faults of considerable extent, more especially in those portions near the contact with the volcanic rocks. Volcanics.

The name "Nicola series" was given by Dawson to the volcanic portion, and "Coldwater group" to the rocks of the coal basin. To the north and west, other volcanics are found which were regarded by Dawson as newer than the rocks of the coal formation, since in places these were found as overflows upon the latter. Of these newer volcanics there is no direct evidence of their presence in the area under discussion. Nicola and Coldwater groups.

The elevation of Nicola lake is given by the C.P.R. as 2,127 feet, and that of the valley, in the vicinity of Coutlee, is given by Dawson as about 1,830 feet above sea level. The surrounding hills rise from 1,500 to 2,000 feet and in some cases, as in Iron mountain, to over 3,000 feet above the valley. This mountain, which is situated a short distance south of the forks of the Coldwater and Nicola rivers, is stated to have an elevation by aneroid (Dawson) of 5,280 feet above the sea. Elevation.

The statements made in the earlier report (1877-78) as to the age of the volcanic rocks of this district were modified in the later report (1894). Thus, in the map accompanying the first report, part of these rocks are coloured as of Tertiary age and part as Triassic, while in the map accompanying the later report they are all regarded as of Triassic or Lower Jurassic age. Some confusion has resulted from the statement that certain portions of the volcanic rocks are newer than the sedimentaries, and as a consequence several coal companies, acting on the suggestion made in the earlier report, are working on the hypothesis that by boring though the volcanic rocks which surround the Nicola basin they will reach, at some depth, the sandstone and coals Dr. G. M. Dawson's report.

which are there exposed. This contention, however, is not maintained by a careful reading of the text in the reports in question; since, if the volcanics are of Triassic age and the coals and associated strata are of Tertiary age, the latter must of necessity be of later date than the former. Moreover, the sandstones are seen to rest upon the volcanics at a number of points around the coal basin.

Limestone. With the rocks of the Nicola series (volcanics) are associated small areas of limestones which are partially altered but which have apparently been deposited upon the volcanics.

Fossils. These contain traces of fossils such as crinoids and shells, but specimens are rare. The general aspect of these, however, would assign them to a position beneath the coal bearing rocks. From this evidence, therefore, it may be assumed that any attempts to reach the body of the Coldwater sandstones and shales by boring through the surrounding volcanics will be fruitless.

Conglomerate. In so far as the rocks of the Nicola (volcanic) formation were studied, they appear to present great similarity in character over a large area, and certainly underlie the sedimentaries throughout their entire extent. This is seen in the composition of the conglomerates and grits which are exposed at intervals around the basin and which contain pebbles of the underlying volcanics; and is also shown by the fact that in several places, where contacts with the volcanic rocks are exposed, the sedimentaries rest unmistakably on them. Some of these conglomerates, as on the upper Coldwater, have a thickness of several hundreds of feet and form masses of considerable extent. In many places, however, the conglomerates are interstratified with the grits in the lowest exposed portions of the series.

In the course of the work it was found that the possibly productive coal areas of the district could be arranged roughly into four groups, viz.:—

Coal Basins of Nicola valley.

1. That of the Lower Nicola or Ten Mile creek basin, about three miles below Coutlee.

2. That of the Coal gully, containing several seams, one of which has been opened up and mined locally for some years.

3. The Coldwater seam about a mile and a half to the east, where one seam is exposed in two outcrops on the bank of the stream at an interval, between the two exposures, of nearly a fourth of a mile. These two are sometimes known as the Garesche-Green area.

4. The Quilchena basin, which is entirely separated from the others, and distant about ten miles to the east.

The lowest, or Ten Mile area, has also an outcrop on the south side of the Nicola, on what is known as Lindley creek, where a thin and badly broken outcrop of coal is exposed on the bank at an elevation of about 500 feet above the river flat.

These areas were all carefully examined, and the extent of the coal bearing rocks mapped. The probable extension and value of the contained coals were estimated as closely as possible.

Supposed coal areas.

Other areas of supposed coal lands have been taken up on the high ground to the west of the Coldwater along the road to McInnis ranch. The rocks in this area are all volcanics of the Nicola series, but upon the surface, at several points, there are small patches of basal sandstone and grit, practically an arkose. These patches do not, however, represent part of the coal basin proper. Boring operations are now in progress at several points to demonstrate the idea that the coals will be found beneath these volcanic hills.

Drift and denudation.

Great difficulty was found in arriving at accurate conclusions as to the actual extent and value of the several coal seams at different points, owing to the heavy mantle of drift, chiefly boulder clay, with sands and gravel in places, which covers the surface of the country, not only in the level portions of the basin but reaching to the higher elevations of the surrounding hills. The denudation has been very heavy and rock outcrops are few. Thus, on the Coldwater river, which rises about thirty miles to the south, and joins the Nicola about one mile and a half east of the village of Coutlee and seven miles west of the foot of Nicola lake, the only outcrops of rock, in the coal basin proper, are seen at the big bend about two miles above the forks with the Nicola. Above this the banks are often high, but consist entirely of clay. The coal rocks are apparently cut out about two miles further up stream by the converging areas of volcanics on both sides. Thence up river, for some miles, the rocks on both sides are volcanics, partially diabase, to near the Sixteen-mile post on the road, or eighteen miles from Coldwater forks. Here, detached areas of a coarse conglomerate, made up of debris of the underlying volcanics, in a grayish gritty paste, form a somewhat prominent ridge with a dip N. 80° E. $<$ 40°-60°, but no shale was observed in connection with this outcrop. These rocks appear on both sides of the river. Some reported shale outcrops were examined in the vicinity, but proved to be dark coloured crushed volcanics. Similar crushed volcanics are seen in a large gully on the west side of the river, about a mile above Olsen's house.

Rock of the Coldwater river.

Shale outcrops.

About three miles above this, and near King's place at the Eighteen mile post, several exposures of black carbonaceous shales are seen on the west bank of the Coldwater, underlaid by heavy bands of arkose grits with conglomerates, the latter holding large pebbles of the volcanics. In the bed of the stream, these rocks contain several black silicified tree stems, and in small seams of coal and shale in the west bank, which have been opened for a short distance by short drifts, plant stems are recognized. The coal seams are of no practical importance and the so-called sandstones are the basal beds of the formation resting on a small outcrop of volcanic rocks, and dipping both to the north and south.

About two miles above this, there is another small outcrop of arkose beds resting directly on volcanics, with a dip of N. 40° E. $<$ 15°, which show for a few feet only, and also contain silicified tree trunks. The rocks on both sides of the river are volcanics and the sedimentary deposits are very limited and newer. On the hill sides, and even near the summit of the hill ranges, sandstones are reported as occurring in patches, sometimes of considerable extent. These were not examined, but they may possibly occur, as in the case of similar patches on the mountains north of the Nicola, above Coutlee. In some cases the rocks which are called sandstone by the prospectors have proved, on examination, to be a grayish diabase, while the accompanying so-called shales are crushed volcanics. Specimens of reported coal from some points have the aspect of a black, impure manganese ore.

Outcrops north of the Nicola.

This occurrence of sedimentary rocks on the mountains has been noticed at a number of points surrounding the Coldwater-Nicola basin. On the hill range between Nicola lake and Coutlee, outcrops of arkose sandstone were observed at several points, and on the south flank, but near the crest of the ridge, three miles west of Nicola lake post-office, small areas of shales, associated with dolomitic limestone, are found. In these shales, fossils such as ammonites and shells occur, and a number of specimens were collected for determination at this office. The associated rocks are apparently older than the sandstones of the coal basin.

Ten Mile creek.

On the Nicola river, between the foot of Nicola lake and the mouth of Ten Mile or Guichon creek, no rock outcrops were seen. The valley is filled entirely with drift material comprising clays, sands and gravel. The thickness of these deposits is very great, since borings to a depth of nearly 300 feet have failed to reach the underlying rock. On the Ten Mile creek, no rock outcrops are seen, or but rarely, till we reach the Eight Mile creek, which is about nine miles from the junction of this stream with the Nicola. At a point about midway, however, shales and sandstones of the coal formation are exposed on the east side, a few rods from the bank of the stream, and show that the area is probably underlaid throughout this distance by the rocks of the Coldwater formation. On the south side of the Nicola, on Lindley creek, a narrow basin of these rocks already referred to extends up the stream for a mile or more and contains coal which outcrops in a small but irregular seam at an elevation of about 500 feet above the river valley. A short distance above the outcrop, the sedimentary rocks are cut off by the volcanics of the mountain against which the former appear to rest. Lindley creek.

Extent of coal basins.

The length of the main coal basin of the Nicola-Coldwater area, from the foot of Nicola lake to the south limit on the Coldwater, in a southwest direction, is about ten miles, and the greatest breadth is about three miles. The western portion, from the forks of the Coldwater to the volcanics of Ten Mile creek or Lower Nicola, is about five miles, with an extension, north and south, along the creeks of about ten miles. The length of the eastern or Quilchena basin is about seven miles from north to south and the maximum breadth apparently about two and a half miles.

Faults.

At all these places, the sedimentary rocks composing the coal basins rest directly upon the volcanics, without indication of any overflows. At several points there are well indicated lines of fracture, which have evidently been caused by movements subsequent to the period of deposition and hardening of the rocks affected, and in several cases the coal seams are broken across abruptly.

Section.

The best natural section of the coal-bearing strata is seen in what is called the Coal gully, a small stream and ravine situated about one mile and a half south of the forks of the Coldwater. Other sections are exposed at the big bend of the Coldwater river, where the coals of that stream outcrop, along with a considerable thickness of yellowish, gray sandstone; on the upper part of Hamilton creek east of the road crossing from Nicola lake to the Aspen Grove or Princeton road; and in a gully north of Nicola lake post-office, a short distance west of the Mill-stream (also called Clapperton creek). Additional information has been afforded by two boreholes sunk in the Nicola-Coldwater area, one near the Coldwater river and the other about two miles east, on the bank of the Nicola river, neither of which, however, reached the base of the formation, but passed through several hundred feet of sandstone and shale with several thin seams of coal in the Coldwater boring, while in the Nicola hole the sandstone was largely replaced by conglomerate. In the former boring a seam of coal was reported at 190 feet, thus:—

Boreholes 1891-93.

	ft.	in.
Slate	1	6
Coal	3	8
Sandstone, gray	0	6
Coal	1	4
Sandstone	0	8
Coal	0	7
Coal	5	7

In the Nicola boring the seam was struck at 137½ feet and was as follows :—

Coal.

	ft.	in.
Shale	8	6
Coal	0	8
Shale, dark	1	1
Coal	0	6
Slate	0	4
Coal	4	4
Coal	5	6

Borings(1904).

While the aggregate of coal in each of these borings is about the same, it will be noticed that in the Coldwater boring the thick portion of the coal is at the top, while in the Nicola hole it is at the bottom. Whether this feature is due to change in the character of the seam, both representing one and the same, or whether it indicates two distinct seams of practically the same thickness is not determined, and it would be very desirable that other borings should be made in the immediate vicinity to settle the question. Unfortunately, of several borings made during the season of 1904, none succeeded in penetrating the drift, and as the underlying rock was not reached, no light was afforded as to the structure of this part of the basin, other than that a considerable area has been largely denuded, owing to the action of the two streams already mentioned.

Around the margin of the coal basin, high hills of volcanic rock rise on all sides. On the north, between Nicola lake and Coutlee, these reach an elevation of over 2,000 feet above the river valley. The rocks consist of diabase, porphyrite and occasional small areas of granite, and contain small showings of copper and iron ore. On the summit of these ridges small isolated patches of sedimentary rocks, which sometimes contain remains of plant stems in a coarse gritty or arkose paste, are occasionally seen.

Limestone.

They indicate that the volume of these sediments was at one time very great and that the areas which occur along the Nicola and Coldwater rivers now represent the portion remaining from the erosion of many hundreds of feet of sediments which, at one time, probably filled the valley. On the road over the hills to the west of the Coldwater in the direction of McInnis ranch, similar patches of arkose rock are found, as also small areas of limestones, which rest on the volcanics. On the road south east to Princeton, the limestones also outcrop at the Nine-mile post, which is the highest point in this direction. These are similar to the limestones described by Dr. Dawson as occurring on the ridges east of Quilchena creek. They contain obscure forms of fossils, and the rock is somewhat shattered, though not changed to a crystalline limestone.

The volcanic rocks of the district contain small deposits of copper and iron ores at many points. Opposite Coutlee several openings have been made in the face of the hill to the south, but the quantity of either mineral in this area appears to be insignificant. Two principal areas, however, exist which are known as the Aspen Grove camp and the Aberdeen. The former is on the road to Princeton and is about twenty miles south-east of Coutlee, the other is on the west side of the Ten Mile creek about ten miles from the post road to Lower Nicola. The ores and associated rocks have been carefully examined, principally by Mr. R. A. A. Johnston, and will be described later. On the summit of the range north-east of Coutlee a small deposit of specular ore was opened several years ago but found to be irregular and of but small extent. On the summit of Iron mountain also small irregular veins of similar ore were observed, but the observed quantity did not appear to be of economic importance. A small and irregular deposit was also seen on the north flank of the hill south of Coutlee. The ore is specular but the occurrence is unimportant. This seems to be the principal variety of iron ore seen in the district. Copper.

THE COAL GULLY ROCKS.

(Garesche-Green area.)

The most interesting series of outcrops in the Nicola basin is found in what is called the Coal gully, a ragged ravine which cuts the face of the hills west of the Coldwater and about a mile south of the forks with the Nicola. The rise of the hill is steep, the elevation at the top of the main gully, in a distance of 35 chains, being 400 feet above its mouth on the flat area west of the river, while, in the next 35 chains, to the contact with the volcanics, there is a further rise of about 350 feet. A small side gully comes in from the west at the mouth of the main gully, and on both of these the rocks are well exposed. The Coal gully section.

On the Coal gully proper four coal seams are displayed, with interstratified beds of grayish sandstone and shale, with some conglomerate. On the side gully there is a contact of the shale with the volcanics ten chains south-west of the junction with the main gully, the rocks in this portion being principally shales, gray, brown or black and carbonaceous. Four coal seams exposed.

The section given by Dr. Dawson in his report for 1877-78, pp 124-125, of the rocks of the main Coal gully is as follows, beginning at the upper end of the ravine.

Section by Dr. G. M. Dawson.

	ft.	in.
Soft yellowish sandstone in thin beds	32	0
Coal, laminated, rather soft	15	4
Sandstone, rather soft with some shale	89	0
Coal	5	4
Sandstone, with a considerable thickness of shale at the base	141	0
Coal, about	3	0
Sandstone, generally in thin beds	136	0
Coal, about	2	5

This gully was examined during the past season and a survey was made from the mouth at the junction of the small side gully to the contact with the volcanics. This section may be divided into two parts, of which the upper, from the top of the main ravine to the contact of the grits with the underlying rocks, shows no coal.

At the upper part near this contact the outcrops of the coal formation consist of grayish grits and fine conglomerate which dip N. 4° E. $<$ 65°. These sweep round in a few yards at the small stream and dip N. 40° E. same angle. The actual contact with the diabase is not seen here, there being a concealed interval of about fifty yards.

Rocks of the upper section. On the stream in the gully, flaggy yellowish-gray sandstones dip like the last and extend down stream for seven chains. Here the gully runs out on the flat, but ten chains to the north-east the gully again begins and has a depth of about eight feet, in which a small section of shales and sandstones is exposed. The upper part of this section shows fine-grained grits and conglomerate, dip S. $<$ 35°. At fifteen paces the angle increases to 55°-60°, and at twenty paces more the dip in carbonaceous shales is S. 12° W. $<$ 35°. At fifteen paces further, grits and fine conglomerates dip S. 38° W. $<$ 40° indicating a syncline in this portion of the section. Below this the gully runs out on a flat and no outcrops are seen to the head of the main gully about fifteen chains north. The structure of the upper portion is therefore synclinal and of the other portion to the head of the main gully probably anticlinal. The descent of this part of the section is, by aneroid, 320 feet.

The lower section. The second or main gully has a length of about thirty five chains in a nearly north direction. It is rough and deep, with abrupt walls cut in part through rock and in part through boulder clay. In this section coal is seen at six points, but of these probably the three lowest outcrops are on the same seam. From notes of the survey the following descriptions may be given.

Section on Coal gully. The lowest part of the gully, for a distance of fifteen chains from the mouth, rises quickly, displaying, for the most part, yellowish-gray grits and sandstone with some bands of fine conglomerate, showing in places much false bedding. The dip varies considerably, and ranges from S 80° E. < 12° at the lower part through N., to N. 60° W. < 15°-20°, S. 70° W. and N. 20° W. < 15° to the outcrop of the first coal. An anticline is apparent in the lower portion, the beds on the west side of the creek dipping S.W. < 12°-20°. While the dips are generally low, the beds are somewhat disturbed.

Faulted coal seam.

Thirteen chains south of the mouth of the gully the first outcrop of coal is seen on the west side about forty paces distant from the brook. An opening made here shows the presence of a fault which cuts off the coal sharply at this place, with a direction of about N. 30° W., the western wall being sharply defined and consisting of grayish grit. The coal at the east of the fault dips N. 60° E. < 13°. The beds in the upper part of the hole are somewhat crushed. The elevation of this place is about 200 feet above the mouth of the gully.

On the east side the same bed has been opened up by a drift driven along the coal to a distance of eighty-five feet, starting at about fifteen feet above the bed of the brook. A section of the coal, as measured in the tunnel, gives :

Coal seam No. 1.

Sandstone forming the slope of the hill above :—

	ft.	in.
Coal	5	0
Shale parting	1	6
Coal	13	6

Tunnel in coal.

The dip varies considerably. A short distance in the tunnel, where a small side drift has been made to the south, the dip of the coal, which here has a shale parting of two and a half feet, appears to be N. 70° E. < 15° and S. 80° E. < 15°, showing a low fold. These outer beds may, however, be somewhat crushed, as they form the eastern slope of the gully. The coal at the entrance to the drift is also crushed Below this coal there appears to be about 175 feet of the grayish sandstone. At the inner end of the tunnel the dip of the coal, as nearly as could be ascertained, is N. 70° E. < 10°, and the drift cuts obliquely across the coal bed starting from the bottom, and at the inner end reaching the roof. The coal itself appears to be of good quality, yielding large blocks, and has been mined for several years for local consumption. Its extension eastward cannot be traced at the surface, but it probably underlies the hill to the east, which we may call Coal Gully hill. It appears to be the lowest seam in this area, and should underlie to the north-east the flat west of the Coldwater, unless it has been removed by denudation, a point which can only be proved by boring in that direction.

Anticlinal structure.

On the west side of the gully the coal outcrop at the fault apparently represents the west side of an anticline, which extends a few degrees east of south along the lower part of the ravine, the opposing south-west dip being seen at several points. A third outcrop, three and a half chains south of the tunnel on the east bank, may represent a still further extension of the same seam. The dips along this part of the section show considerable divergence, and may represent additional faults or a disturbed anticline.

About eight chains south of the tunnel another seam outcrops on the east side of the gully. The roof appears to be of shale and shaly sandstone and the outcrop as measured gave at the top :—

Coal seam No. 2.

	ft.	in.
Coal	5	5
Shale	4	0
Coal	3	4
Shale	..	..

This may be styled Seam No. 2.

Owing to the bed of this stream and the sides of the gully being much encumbered from the sliding down of the banks, the exact measurements of these seams are difficult to determine in some places. The dip of coal No. 2 appears to be south-east $<15°$-$20°$, and a short distance above, on the brook, the overlying shales dip south $<15°$, showing a sharp change in direction, which may indicate the further extension of the anticline noted on the lower part. Some exploratory work has been done on this seam, but the sides have fallen in, and but little can be ascertained as to the exact nature.

Coal seam No. 3.

Above this point the course of the gully inclines to the south-east, and four chains further there is another outcrop of coal on the east bank, which appears to measure 17 to 18 feet, capped by gray, marly shales with a dip of S. 55° E. $<20°$. This may represent the upper seam of Dawson's section which he gives as 15 feet 5 inches, underlaid by sandstone. Of the details of this seam and its extension, nothing can be said, very little work having been done at this place. It may be styled Seam No. 3.

Coal seam No. 4.

Further south, near the head of the main gully, a fourth seam is exposed on the east side with thin bedded sandstone, showing a thickness at the outcrop of about three feet, the lower part being concealed in the bed of the stream. No work has been done at this place, and it is apparently not included in Dawson's section. This part of the gully is shallow and may not have been excavated at the time of his visit. The dip of the seam appears to be slightly to the north of east, and the sandstone a short distance below dips N. E. $< 20°$. It is possible that a small outcrop along the road to the south-east may represent the extension of this seam, which may be styled Seam No. 4.

Measures concealed.

The structure west of the head of the gully, in the direction of the section exposed in the upper portion, is probably an anticline, and if seams occur on the west side, they are concealed by drift. Without boring or heavy trenching no definite information can be given as to such extension, and it is possible that in this area the several seams described on the lower portion may be cut out by faults which apparently occur near the contact of these rocks with the volcanics along the west border of the basin.

Outcrops on Coal gully hill.

The elevation of the crest of Coal gully hill, east of this ravine, is not far from 450 to 500 feet above the flat area at the base to the north, and as all the seams in the ravine dip to the east or possibly north-east, they should underlie the hill, unless affected by faults. The presence of large outcrops of the sandstone on the east flank of the hill, a short distance west of the road to McInnis ranch, with a dip of N. 4° E. $< 60°$, indicates a possible disturbance of this sort, but as there are no intermediate outcrops in this direction, the structure must be conjectural. Twenty-five chains south of this last exposure of sandstone, and on the side of the road, is the small outcrop to which reference has already been made. A good bore hole sunk on the crest of this hill is very desirable, but the scarcity of water at present renders such work a difficult matter.

Western limit of coal basin.

The western limit of this basin has been fairly well outlined by the contacts near the mouth of the Coal gully and by the sandstone ridge on the road near the head of the upper section. The land in the intermediate space is high, and the extent of the coal rocks in this portion must be limited. To the north of the mouth of the gully, the volcanics come to the line of road from the forks of the Coldwater to this point, whence the range of the hills trends to the west and keeps along the south side of the Nicola to Lindley creek and on to Ten Mile creek on the north side. On the small side-gully already mentioned, near the mouth of Coal gully, the excavations show the actual contact at a point ten chains south-west. The basal beds of the sedimentaries at this contact are made up, for a few yards, of the volcanic debris passing upward into shales, gray, brown and black, and quite carbonaceous in places. The dip is north-east at angles of 10 to 20 degrees, and at two chains from the contact there is a marked disturbance in these rocks, probably indicating the continuation of the fault seen in the coal seam to the south. Below this the shales are grayish

Contact of volcanics.

and dark coloured as far as a small pit, sunk during the past summer to a depth of twenty-three feet, the dip of the shales at the bottom being N. 55° E. <35. These shales contain plant stems, ferns and thin irregular patches of coaly matter. There is an apparent upthrow from the north-east at this place.

Coldwater hill.

The structure of another hill eastward of Coal gully hill which we have styled Coldwater hill, since it terminates on the Coldwater river, can only be inferred from the few outcrops of sandstone which show on the north and east slopes, and from those seen along the bank of the stream in which the Coldwater coal-seam is exposed.

This hill has an elevation of about 350 feet above the river flat. It is quite steep on the north and east, but slopes to the south for about half a mile to the Coldwater river. In this part no rock exposures are seen.

Coal outcrops in Coldwater river.

On the north side the rock outcrops are all of the yellowish sandstone like that at the mouth of the Coal gully, with fine conglomerate bands. The dips vary from N. 60° E. to N. 30° W. <15°-25°, showing a shallow syncline in the north-east part. Along the banks of the Coldwater, from near the line of Blair's lot southward for about forty-five chains, these sandstones are almost continuously exposed, and form a bluff from 20 to 30 feet high. In this distance two outcrops of coal are exposed, which probably represent portions of the same seam which here shows a shallow synclinal structure. The dip at the southern end of the section is to the north-east at an angle of 25 or 30 degrees and at the other outcrop the dip is S. 61° E. <15°. The south outcrop has been described by Dr. Dawson (report, 1877-78, pp. 123-124 B,) as follows:—

Section of Coal seam.

	ft.	in.
1. Sandstone	0	0
2. Shale	0	10
3. Coal, good with occasional silicified stumps somewhat laminated, cleat in two directions	4	0
4. Sand, not continuous	0	0¼
5. Coal, weathered but probably good quality	0	9
6. Soft sandstone	0	0½
7. Coal	0	6
8. Soft gray sandstone, 6 inches to	0	7
9. Coal	1	4½
10. Coal, soft	0	2
11. Coal, shaly	0	9½
12. Hard fine-grained sandst. gray, with some obscure plant impressions, variable but generally about	0	4
13. Coal, laminated	0	3½
14. Shale with obscure plants and remains of insects	0	9
15. Sandstone	0	0
	10	5¼

The supposed repetition of this seam is found at the foot of the sandstone bluff about nineteen chains distant on a bearing N. 20° W. mag. At this place the coals and sandstone have changed their dips to the south-east, showing the presence of a shallow syncline facing to the east. The thickness of this outcrop as given by Dr. Dawson is as follows :—

Section on Coldwater lower outcrop. G.M. Dawson.

	ft.	in.
1. Sandstone at top, at least	10	0
2. Gray shale	2	0
3. Coal	1	5
4. Coal with shaly partings	1	6
5. Coal	2	0
6. Soft brown shale	0	1
7. Yellowish sandy shale	0	8½
8. Coal with occasional thin lenticular shaly partings	0	11
9. Shale	0	6
10. Coal	0	8
11. Coal with about a third shaly partings	0	11
12. Fine-grained gray sandstone, equivalent to No. 12 in former section, the insect bed being absent, about	0	4
13. Yellowish sandstone, rather soft, at least	10	0
	31	0½

While there are some minor points of difference in the character of these sections there is but little doubt that they represent the same seam. At the time of our visit the lower outcrop on the stream was inaccessible, as the opening was filled in with river wash. Portions of the upper opening were also hidden, but at one point an entrance was effected and a drift was followed to the end. In this drift the dip of the coals at one place was found to be N. 10° E. $<28°$ but the seam appeared to be somewhat crushed as if by the weight of the overlying sandstone. The length of the drift is about fifty feet, and the total thickness of coal was nearly eight feet.

Section of upper seam, 1904.

	ft.	in.
Sandstone roof	..	..
Coal with shaly and sandy partings	5	6
Coal	2	0
Shaly sandstone	1	0
Coal	1	0
Sandstone floor	..	..
	9	6

At the head of the tunnel the dip is apparently N. 55° E. $<30°$, and on the south side of the excavation there appears to be a roll making the dip on that side S. 20° E. As the interior of the drift was not cleared out the exact measurements could not be taken. A few hundred tons are removed during the winter and with the spring floods the workings are nearly filled in with wash from the Coldwater, the openings being but little above the level of the stream.

Bore-hole 1891.

The structure of the rocks at this place appears to present the following features:—The syncline along the river bank at the big bend is suddenly changed to an anticline a few rods to the north of the lower outcrop of coal. The dip changes from S.E. to N. 30° W., so that the outcrop of this coal seam should follow along the north side of the Coldwater hill, and might be supposed to underlie the area in G. Blair's lot, No. 172. In support of this view a bore-hole, put down in 1891 near the bank of the Coldwater and at a distance of about thirty-five chains N.W. from the lower coal outcrop, passed through what is probably the same seam at a depth of 195 feet. The section of the coals in this boring, taken from the log, is:—

Coal seams.

	ft.	in.
Drift	55	0
Shales and sandstone	135	0
Coal	3	8
Sandstone parting	0	6
Coal	1	4
Sandstone parting	0	8
Coal	0	7
Coal	5	7
Sandstone and shale	15	6
Coal	1	5

Below this the hole was carried down to a total depth of 600 feet, and showed underlying coal seams as follows:—

	ft.	in.
Coal, at 269 feet	0	10
Coal, at 338 feet	1	5
Coal, at 449 feet	0	7
Coal, at 456 feet	0	6
Coal and shale at 588 feet	1	7

The boring ended in sandstone and shale.

It will be seen that it is practically impossible to correlate the Coldwater seam with those at the Coal gully, unless indeed the thin lower seams of the bore-hole represent the thick seams in the lower part of the gully greatly reduced. In this case the seam worked on the Coldwater might represent the highest or No. 4 of the gully section, and the seams on the Coldwater area would be repeated by faulting which has thrown the eastern portion of the section upward.

To the eastward no outcrop of the coal-bearing rocks is visible at any point in the Nicola valley, with the exception of a small section exposed on the upper part of Hamilton creek, just above the road from Nicola post-office to the road leading to Aspen Grove and Princeton.

A bore-hole was put down in 1892-93 near the bank of the Nicola river, at a point a mile and a half north-east of the outcrop on the Coldwater, or about one mile east of the boring just described. In this hole, which reached a depth of 562 feet, coal was struck at a depth of 137½ feet, the section as given in the log being. :— Bore-hole 1892-93.

	ft.	in.
Drift clay and sand	80	0
Sandstone and shale	57	6
Coal	0	8
Shale, dark	1	1
Coal	0	6
Shale	0	4
Coal	4	4
Coal	5	6

Coal seams.

Beneath this, coal was struck at several points, thus,

	ft.	in.
Coal at 166½ feet	1	11
Coal at 219 feet	0	5
Coal at 334½ feet	0	7

with sandstone, shale and conglomerate to the bottom of the hole, which did not penetrate the measures.

From a comparison of these two borings it will be seen that the character of the large seam struck varies widely. Thus, in that near the Coldwater the thickest portion (3 ft. 8 in.) is in the upper layer, while in the Nicola boring the thickest bed (4 ft. 4 in) is at the base. Unless the character of the seam has entirely changed in the distance of a mile, the correlation of these two seams can be made with difficulty. The character of the lower seams also presents considerable divergence, but this may be expected in coals of this horizon, and it is quite possible that the different bands of the principal coal seam have materially and locally changed. It is to be regretted that these holes were not continued to the contact of the coal measures with the underlying volcanics. Difference in character of coal seams.

In comparing the nature of the sediments passed through, there is also a manifest difference in the two borings. Thus, in the Coldwater hole the thickness of sandstone is given as 440 ft., and of shale 77 feet, with one foot of conglomerate. In the Nicola hole the sandstone totals 276 feet, the shale 66 feet and conglomerate 125 feet. This would indicate a great difference in local deposition of the sediments at the two places, provided the logs have been correctly kept.

Samples of coal from the Coal gully (tunnel seam) and from the upper outcrop of the Coldwater were secured, as also from the Quilchena

Analyses of coal.

basin and have been analyzed in this department, the results being as follows :—

G. S. L. No. 272
1904.

Mem. re certain coals collected by Dr R. W. Ells : —

Coal gully.

(a) From tunnel on lower seam of Coal Gully—

Water	3·04
Volatile combustible matter	37·18
Fixed carbon	52·05
Ash (reddish-white)	7·73
	100·00

Coke, per cent 59·78. Yields a compact firm, coherent coke.

Quilchena.

(b) From lot 1267. On creek running into Quilchena creek—

Water	6·95
Volatile combustible matter	37·21
Fixed carbon	47·95
Ash (pale reddish-brown)	7·89
	100·00

Coke, per cent 55·84. Yields a firm, coherent coke.

Coldwater river.

(c) From southerly outcrop of seam on Coldwater river—

Water	3·17
Volatile combustible matter	35·73
Fixed carbon	55·25
Ash (light reddish-brown)	5·85
	100·00

Coke, per cent 61·10. Yields a firm, coherent coke.

(d) From the Coldwater river, near its junction with the Nicola, near Coutlee. Lower tunnel. C. H. Keefer, Esq.—

Water	1·37
Volatile combustible matter	38·24
Fixed carbon	54·25
Ash (light reddish-brown)	6·14
	100·00

Coke, per cent 60·39. Yields a compact, firm, coherent coke.
Analyses by fast coking understood.

(Signed) G. C. H.

Hamilton creek.

Hamilton creek, which flows from a chain of small lakes lying to the north of the Princeton road, and nearly three miles east from the fork of the road from Nicola with that from Coutlee, furnishes a small section of coal-bearing rocks. To the north of the Lundbaum lakes at the head of the creek, there is a high hill known as Sugarloaf or Lundbaum head, composed of diabase and porphyrite with some granite. Along the course of the creek, about the lakes, and for some distance below them, these rocks are well exposed. They continue down stream to within a mile of the Nicola road, where they form the bed of the stream and are in part covered with a heavy deposit of clay.

The first rock seen on this creek upon the eruptives is a yellowish-gray sandstone of the usual type, with a dip of S. 35° W. < 25°, but between this outcrop and the volcanics there is a space of about 500 yards, the banks being of clay and gravel. A fault cuts across the creek near the sandstone outcrop in a direction N. 25° W. The sandstone is interstratified with shale, in places carbonaceous, and these outcrops extend down stream for about 400 yards with the same dip, though the angle increases to forty degrees. Indications of faults are seen at several points. Below this, the dip swings to the south and the sandstones are in part replaced by carbonaceous shales. About midway on the line of section, the dip is South < 30°-40°, and from this to the end, where the ravine meets the plain near the road-crossing, the dip continues to change regularly till it reaches, in the lowest exposures on the stream, S. 75° E. to East < 25°. The character of the formation remains practically the same throughout. No coal seams were observed, but the trunks of trees were seen near the lower end of the outcrops, and in a boring sunk at this part a seam of a few inches of coal was reported. The log of this boring has not been secured. The stream is very hard to traverse, being much choked with driftwood and boulders along the greater portion of the line of section.

Section on Hamilton creek.

From the dips it would appear that these rocks lie in a shallow syncline dipping to the south-west in the direction of the Coldwater. The thickness of the formation is apparently not very great, and it is bounded on the north by a ridge of eruptives consisting of diabase and tufaceous rocks which lie in alternating layers and form a bold escarpment facing on the Nicola river for several miles. The Hamilton creek area is therefore a small side basin extending north-easterly from the Coldwater area, and with a maximum breadth of about one mile, terminating north-eastward at about two miles east of the road crossing from Nicola lake.

Synclinal structure.

Borings are now being made in the volcanic rocks on the upper part of this creek.

The valley of the Nicola shows no rock outcrops from near the foot of the lake for some miles, the drift deposits along its course being very heavy. To the north-west of Nicola post-office a road, which extends up the Millstream, or as it is sometimes styled, Clapperton creek, traverses a flat area for nearly three fourths of a mile till it meets a ridge of volcanic rocks. On the Millstream, the lower part, for half a mile or more above the post-road crossing, shows no ledges, but at this distance there is a low ridge of brown feldspathic and diabase rock which shows on both sides of the stream. Two hundred yards above

Section north of Nicola post-office.

this there is a small outcrop of the basal beds, (arkose) of the sedimentary rocks on the west side. No exposure of the grits or shales is seen in this area, and above to the old mill, four miles from the mouth, nothing was seen but volcanics of the usual aspect. In places traces of copper are visible.

Volcanics north of Nicola road.

A traverse was made across the hills south-west from this place and showed them to be entirely of volcanic rock. In a gully which cuts across the lower part of these hills in rear of Nicola post-office these rocks are well exposed for a short distance. They consist at the base of porphyrites and diabase, but descending towards the flat the overlying rocks are much crushed, sometimes slaty, and in one place show a recomposed mass holding carbonaceous matter, similar to the small outcrop on the millstream to the east. These probably represent the basal beds of the coal measures, since they dip toward the Nicola river and should underlie the sediments of that valley. There is no indication of coal seams in this direction, however, and no outcrops are seen on the flat area which extends to the post-road at Nicola village.

Eastern end of coal basin.

The main area of volcanic rocks, on the south side of the Nicola, gradually approaches the river in a north-east direction and meets those of the north side of the basin a short distance below the foot of Nicola lake, near the bridge, so that the village of Nicola lies at the north-east extremity of the basin. All around the shores of Nicola lake the rocks are volcanic, and no trace of the coal formation is seen to the west of Quilchena creek, about eight miles distant.

Volcanic ridge south of the Nicola.

About two miles south-west of the village of Nicola, on the road thence to the Princeton road, a side spur of the volcanics rises in a bold ridge from the river flat to a height of about 350 feet. The road to Hamilton creek ascends the ridge, which thence continues to the south-west for nearly three miles. The actual breadth of the outcrop of these rocks is not great, but the surface slopes slightly in the direction of Hamilton creek, and this ridge forms the northern margin of the basin in this area. There is no evidence that the rocks of this ridge are an overflow upon the sediments of the coal-basin. They are, apparently, like the rest of the volcanic hills, a part of the underlying series. Rock outcrops are seen on the river side of the bluff, but on the surface, south of the summit, the only exposures seen are of large blocks from the crest of the ridge. Similar rocks are seen at a number of places in the area to the south and west, as at Quilchena falls, and on Petite or Spious creek.

Southern margin of coal basin.

To the south and south-west the limit of the coal rocks is determined by the ridge of the volcanics. In this area the great mass of Iron mountain is a conspicuous feature. The supposition held by some that these rocks overlie the coal basin is not warranted in any particular, as the sandstones and associated strata rest upon these instead of passing under them. The contact on the Princeton road east of the forks with the road up the Coldwater is about one mile and a half east of that point. On the road up Coldwater, at Godey creek, it is about half a mile south, but on this road the line of the hills gradually approaches the Coldwater river and meets the volcanics of the west side about three miles south of the forks of the roads, thus limiting the basin in this direction. As the basin in this part is narrow and filled in with heavy deposits of clay, the presence of workable coal seams in this southern part of the basin is not probable. The erosive force of this stream has doubtless cut away large portions of the sedimentary rocks in this part of the area.

Northern run of the basin.

North of the Nicola the limit of the basin is well defined by the high range of hills between Coutlee and Nicola lake. For a distance of three miles west of the lake there is a margin of flat land, about half a mile in width, between the post-road and the foot of the mountain range, heavily drift-covered, so that no rock outcrops are exposed. At this place a spur of the mountain approaches within a few yards of the road, below which the mountain mass again recedes and forms a recess for a mile or so, but again reaches the road a short distance east of the forks with the Princeton road, one and a half miles east of Coutlee. Though no rocks of the coal formation are visible in this area, it is regarded as probable that, if they underlie the clays, they dip south-east away from the hill range, as elsewhere. Small areas of limestone are found on the south flank of these hills, and have been burned for lime, and the patches of fossil-bearing rocks are at a higher level to the north.

Coal rock possibly cut out at Coutlee.

West of the forks of the Coldwater and Nicola rivers the ridge of volcanic rocks west of the Coal gully, after passing the mouth of the latter as already mentioned, turns sharply to the west and extends to the village of Lower Nicola. The width of the valley opposite Coutlee is scarcely one mile, the volcanics between the Coldwater forks and that place on the north side of the river keeping close alongside the post-road to the village, whence the ridge turns off to the north-west and continues up the east side of Ten Mile creek. In the valley opposite Coutlee the river flows through clay and gravel deposits, and has probably removed the greater part of the sedimentary rocks, possibly to the underlying volcanics.

Ten Mile creek.

About a mile below Coutlee, near the Indian houses, the hills on the north side trend northerly, and a basin is formed which extends north along the east side of Ten Mile or Guichon creek for about eight miles. The bed of this stream is filled with boulders from the volcanic ridges, among which large blocks of granite are numerous. These are from the hills on the west side of the creek.

Coal and shale outcrops in Ten Mile valley.

Along a road which leads up the east side of the Ten Mile valley, after passing the flat which extends north from the post-road for about one mile, the ascent is quite rapid. There are no rocks in place with the exception of a ledge of gray sandstone about five miles from the post-road, but boulders of granite and other volcanic rocks strew the hillsides. Steep gullies cut the west slope of this valley and at a distance of about four miles from the junction of this stream with the Nicola, on the slope near the creek bottom, two outcrops, mostly of shale, are seen. The lowest of these is near the bank of the creek and consists of a bluff of gray and dark carbonaceous shale with a dip of S. 70° W. $<$ 30°, but no coal is here visible. About a fourth of a mile north-east of this another outcrop of similar shales is seen on the side of a hill which has been opened up to a slight extent and contains a bed of coal, the actual thickness of which was not ascertained, but it is reported to be four feet, the excavation being partially filled up. The coal seam at this place, however, appears to be of some importance. The dip of the rocks here is N. E. $<$ 25°, indicating an anticline between the two exposures. The shales and sandstones extend thence eastward across the road and for a mile or more beyond to the foot of the volcanic ridge. This ridge gradually approaches the creek, and at Eight Mile creek meets the volcanics of the west side of the valley, limiting the basin in this direction. This is near the northern limit of the Indian reserve. West of the creek the surface is a level bench of sand and gravel, which extends to the foot of the hills about three fourths of a mile distant, but the heavy deposits of drift effectually conceal the underlying rocks. There would, therefore, appear to be a basin of coal-rocks in this area with a length, along the stream from north to south, of about eight miles and a breadth of from two to three miles. To the south of the Nicola, on Lindley creek, (which enters the Nicola a short distance east of Ten Mile creek) outcrops of sandstone and shale are seen in the bed of the stream with a small deposit of coal near the upper level of these rocks. This has been already referred to.

Southern end of Ten Mile basin.

Coal on Lindley creek.

This coal outcrop, on Lindley creek, is about one mile south of the Nicola at an elevation of 500 feet above the river valley to the north. As seen in a tunnel, which has been driven into the west bank of the creek, the coal is broken up and inclined at a high angle. The seam does not appear to be continuous to any extent, and has apparently been largely removed by denudation, part of the tunnel being driven in clay. The dip of the associated sandstone is north-east <70°. The sandstone can be seen at intervals on t creek for some distance below this outcrop, and apparently marks the southern extension of the Ten Mile creek basin. South of the coal outcrop, the sedimentary rocks extend for about 100 yards. As the walls of this creek are quite steep in places and occupied by volcanic rocks, the indications of the presence of a large body of coal in this part of the area are not promising.

The above descriptions include practically all the rock exposures relating to the sediments of the Nicola valley basin, and their relations to the surrounding rocks. The only other available data are derived from the several bore-holes which have been put down in the area between the Nicola and Coldwater rivers.

Assuming the reliability of the logs, which have been obtained from the Mines Department at Victoria, it will be seen that the depth of the coal-bearing rocks in this part of the Nicola basin is at least 600 feet below the river level. How much more must be added to reach the base of the formation can not be ascertained until other and deeper borings have been made.

Borings in Nicola valley.

Several other borings made about the same time have given only negative results. They passed through a great thickness of drift and failed to reach bed-rock. One of these, near the bridge at the forks of the Nicola and Coldwater, penetrated the drift to the volcanics, the sedimentary rocks being entirely denuded, and another, at the north east angle of J. Garcia's lot No. 124, reached a depth of 219 feet without passing through the drift, and was abandoned.

During the past summer, several holes were put down in this area; none of them passed through the drift material to bed-rock. One of these, on W. Vogt's lot, No. 25, reached a depth of 200 feet; another, on the lot adjoining, to the south-east, near W. Charter's line, the same depth, and a third, on Armitage's small lot near the Nicola river, a depth of 280 feet. It is to be regretted that the first two, at least, were not carried down further as they might have struck the Coldwater seam, the dip of the outcrops on that river being in the direction of the bore-holes. Beyond establishing the fact that the drift deposits in this area are very heavy with consequent erosion, this work has not helped in solving the question of the extension of the known coal-seams in the Nicola valley. It can scarcely be supposed that the scouring out of this valley has removed all the coal rocks recorded in the borings of 1892-93, though it is evident that over a considerable area there has been great denudation, especially in that part where the two rivers have joined. It is also probable that in that part of the valley between the dike-like wall below Nicola lake and the post-road, the erosion has been very heavy, and the economic value of the basin will be somewhat reduced in consequence.

An attempt was next made in the valley of Ten Mile creek, the location of the drill being on Collett's ranch near his north line or about two miles north of the Nicola river. A depth of 130 feet was reached, but owing to the large size and great number of the granite boulders in the drift at this place it was found impossible to reach the underlying rock with the machinery employed. Work in this direction has therefore been abandoned for the winter, none of the holes sunk in the valley having succeeded in penetrating the drift.

Other borings.

Borings were also made in 1903 near the summit of the hills on the road west from Coldwater to McInnis ranch, with a calyx drill. The rocks of the area are volcanics of the usual type, but at the location selected on a small brook there is a small outlier of recomposed volcanics, apparently an arkose and representing basal beds of an overlying formation, which has been almost entirely removed. In this rock small traces of carbonaceous matter are observed. The boring reached a depth of about 100 feet, but from samples of cores taken from different depths the rocks passed through were all of a volcanic nature.

Other boring operations are now being carried on at a point about three miles south-west of that just mentioned. The location is in the valley of a small brook, the surrounding rocks are all volcanics, and the depth of drift in the valley where operations commenced is very heavy. The results of this boring have not come to hand, but there is every reason to infer that the true coal formation will not be reached at this point.

Conclusion.

Generally speaking it may be said that the borings recently made in the Nicola-Coldwater basin have been of little practical value. From the fact that most of these have failed to reach the underlying rock, they afford no clue as to the actual structure or lie of the coal in this direction, and if the two holes bored in 1892-93, the logs of which are appended, are of any value, it would be desirable that others should be put down which might show whether the thickness of the several seams there reported is continuous throughout the basin, or whether these may not increase in workable thickness at different points. It is therefore much to be regretted that while the drill was in place during the past summer the holes were not carried down at least to a depth sufficient to determine the extension eastward of the Coldwater seam.

NOTE.—All bearings in this report are magnetic.

In order to ascertain the value of the district as a future coal producer it will be necessary that a number of holes be put down at carefully chosen points, since only in this way can the extension of the seams found on Coal Gully and on the Coldwater be determined, owing to the widespread nature of the drift deposits. This will take several years to accomplish and could be best done by a fusion of the interests of the several companies owning mining areas in the valley.

Further borings required.

THE QUILCHENA COAL BASIN.

To the east of the Nicola-Coldwater areas and about eight miles from Nicola village, Quilchena creek, formerly known as McDonald's river, enters the south side of Nicola lake. Along this creek there is a considerable area of coal-bearing rocks comprising sandstone, shale and conglomerate with several coal seams, forming an important basin.

Quilchena coal basin.

This area is in large part owned by the Diamond Vale Coal and Iron mines, Limited. It lies along the course of the creek for some miles, and the first outcrop of the sandstone is seen on the Triangle ranch at a point nearly two miles south of the post-road at Quilchena post-office, where, in a small excavation on the west face of the hill, shales and associated coals with a thickness of about six feet, dip to the south-east. The basin extends southward along the creek from this place for about eight miles with a maximum breadth of two and a half miles. On the west side of the creek the volcanics form a series of hills in the direction of the Princeton road rising to an elevation of 1,000 to 1,500 feet above Nicola lake.

On the east side, sandstone and shale with seams of coal rise to an elevation of 800 to 1,000 feet above the creek bottom, the western slope being seamed by numerous gullies. Rock outcrops with occasional coal seams are seen in several of these, nearly to the top of the ridge. The eastern side of the basin is bounded by volcanics similar to those of the western margin, consisting of diabase, porphyrites, &c., which have been described by Dr. Dawson (Rep. 1877-78), and regarded by him as probably of Triassic age. As the coal-bearing strata are like those of the Coldwater basin and of Tertiary age it is clear that in point of time the sedimentaries are more recent and the supposition that the volcanics overlie the coal measure rocks in this area is not sustained. The two areas were probably at one time continuous along the depression of Nicola lake, but the overlying rocks of this portion have been removed by denudation. Throughout the area there are no evidences of volcanic overflows of recent date, and the structure of this basin is therefore similar to that of Nicola-Coldwater area.

Character of outcrop.

Limits of the basin.

Although the contact of the sandstone with the volcanics on the eastern margin of the basin is rarely seen, owing to drift deposits, it is probable that the basin, as a whole, is synclinal in structure. Along the west side the contact is seen at several points, and the sandstone is at a high angle with indications of faults. The northern limit is apparently defined by a deep gully on the east side of the creek, situated on the Triangle ranch about one mile and a half south-east of the post-road, and a short distance south of this, on the west flank of the hills and about seventy-five feet above the creek bottom, is the shale and coal outcrop already referred to. An excavation was made at this place and the dip of the beds found to be S. 65° E. $<$ 40° as if the lower beds of the coal formation were following the curving outline of the surrounding hills on either side. If the underlying sediments are continuous at the same inclination, there should be a thickness of about 600 feet of sandstone and shale below this outcrop to the base of the formation in this direction, but this cannot be definitely stated owing to the lack of exposures.

On the west side of Quilchena creek, outcrops of shale and sandstone are exposed in a gully about five miles from the north end of the basin where they form a recessed area. This is on the Indian reserve; and a broken seam of coal with a thickness of about three feet is reported as occurring at this place, which may represent the outcrop on the Triangle ranch. The dips vary from north-east to west at angles of 25 to 30 degrees. Near the creek east of this outcrop, and about three-fourths of a mile distant, friable sandstone, shale and conglomerate dip N. 70° E. $<$ 25°. Half a mile south of this the dip of the sandstone is S. 15° E., and about the same distance further south the dip is to the west at an angle of fifteen degrees, so that there are disturbances in this part of the basin probably due to faults. South of this, to the extremity of the basin which appears to form a somewhat elongated area in this direction, the surface is clay-covered and rock outcrops, for the most part, are obscured.

The eastern side of the creek shows better exposures at a number of points. Some of the gullies are deeply channelled and the underlying rocks are well exposed.

Outcrops on Triangle ranch.

Thus, on the side of the hill on Triangle ranch, about fifty feet above the first outcrop mentioned, there is another exposure of brown and carbonaceous shale with small partings of coal. This was not opened up. The dip is like that of the lower exposure, and still further up the slope other similar outcrops are visible. In the excavation made at the first exposure the shale, which is brown at the bottom, contains a well-defined seam of coal which, with shale partings, has a thickness, as already stated, of not far from six feet.

On lot 1267 of the Diamond Vale plan of survey several gullies traverse the west slope of the hills. In the first of these examined, large ledges of yellowish-gray sandstone, thin bedded, pass up into grayish and brownish shale with thin beds of conglomerate. Bands of dark, carbonaceous shale occur, and the dip appears to be N. 60° E. $<$ 20°, and at one point there is a band of mixed coal and shale one foot thick. Thin beds of coal also occur, but owing to clay deposits it is impossible to determine the exact succession of beds at this place. Similar rocks are seen in several parallel side gullies, and seams of coal from four to six feet in thickness are reported as outcropping at elevations of 350 to 400 feet above the creek bottom.

The Tunnel or Jackson seam.

In a gully further to the south on the same lot the shales and sandstones are well developed and contain several coal seams. One of these has been opened to some extent by a tunnel driven in for about forty-five feet transversely along the seam, which here has an exposed thickness of about six feet. Though the coal at the outcrop is weathered, the greater part appears to be a bituminous coal of good quality. The seam dips N. 60° E. $<$ 30°, and the coal contains two thin partings of one to two inches of sandy shale. The elevation at the mouth of the tunnel is given as 275 feet above the creek, and the roof and floor are of gray sandstone. This seam also outcrops on the south side of the gully, and the dip here appears to be somewhat less, or about 10 to 15 degrees. This may, however, be due to pressure of the overlying beds along the outcrop.

Above this, on the gully, outcrops of coal and shale are seen, indicating the presence of several seams, the thickness of which could not be definitely ascertained, but one outcrop near the top of the first bench is stated to have a thickness of about six to seven feet with shale partings. The elevation of this point is about 365 feet above the creek bottom.

The Palmer or Camp seam.

The highest exposed seam in this area is on a gully near the company's camp and near the top of the upper bench. The elevation is given as 775 feet above the creek and 500 feet above the outcrop of the Tunnel seam. As exposed in the gully, there is here a thickness of about fifteen feet of coal, but at the outcrop this is crushed, owing to the pressure of overlying beds and their consequent breaking down on the face of the ravine. This seam was also struck in a shaft sunk a short distance to the north-east, which found the coal at a depth of fifty-two feet, and it was also opened to some extent by a short drift, which had, however, fallen in, and could not be entered. In so far as examined, the coal at this place appears to be, for surface showings, of good quality.

Fossiliferous shales.

A short distance west of this outcrop there is a good exposure of fossiliferous brown shale with a dip of N. 30° to 60° E., the contained fossils being leaves, plant stems, fruit, &c., which have been examined and found to belong to the horizon of the Tertiary. They apparently represent the upper portion of the formation in this direction. To the east the surface of the ridge rises probably for rather more than a mile, but no outcrops were exposed, owing to drift deposits. At the end of this distance several exposures of volcanics were seen in shallow gullies, and a little beyond, in the direction of Minnie lake, ridges of similar rock are exposed, thus limiting the coal basin in this direction. The probable line of contact between the coal formation and the volcanic rocks in this part of the area is near the corner of lots 1,268 and 1,269, whence it may be carried south-west through lots 1,280 and 1,283, and the basin should terminate southward on lot 1,292 near the line of Quilchena creek. The western line of the basin from this point is fairly straight along the west side of the creek, with the exception of the small side expansion alluded to on the Indian reserve.

Volcanic rocks.

To the east of the supposed contact of these rocks with the underlying volcanics in the direction of Minnie lake, the latter form a well-defined ridge with numerous outcrops for about one mile, when the surface gradually descends towards the lake. Beyond this ridge no rock exposures are seen in this direction, and there does not appear to be much indication of a second basin of coal rocks in this part of the area.

As a whole, the character of the sandstone appears to be not very different from that observed in the Coldwater basin. There is, however, a larger development of brownish shales, and the characteristic fossil beds of the Quilchena basin were not seen in the western area. In the southern portion of the basin the sandstone is better developed, but no coals were seen. It is, however, possible, that such exist in this portion, but their presence can best be ascertained by boring.

The coal outcrops in this basin, of which seven can be recognized in the several gullies, are at a higher level than in the Coldwater district. They all occur on the eastern slope of Quilchena creek, so that the productive portion of the basin will doubtless be found on the east side of that stream. The denudation which has taken place along the valley has doubtless removed large portions of valuable coal lands, but this denudation does not appear to have been so excessive as in the area along the Nicola river where the two streams converge.

In view of the widespread nature of the drift throughout the entire area the actual economic value of these areas can only be ascertained by a number of bore-holes. Faults may exist of which there is practically no evidence at the surface, and the prospective value of the property as a producer of coals may be largely reduced from this cause.

Coal Companies.

The principal companies owning coal mining areas in the Nicola valley just described are :—

The Nicola Coal Co., Limited, with head-quarters at Spokane, Washington, U.S., owning areas on Lindley creek.

The Coutlee Coal and Iron Co., with headquarters at Colfax, Washington, U.S., owning areas in what is known as Midday valley, on the hills west of the Coldwater river, near McInnis ranch.

The Nicola Coal and Iron Co., with head-quarters at Vancouver, owning the Garesche-Green (Coal gully) areas and the lots along the Coldwater river from the south end of the basin down to Blair's lot, No. 172.

The Nicola, Kamloops and Similkameen Coal and Railway Co., owning areas to the south-east of the Coldwater.

The Canadian Pacific railway, owning leases of a number of lots in the valley, principally east of the Coldwater river.

The Diamond Vale Coal and Iron Mines, Limited, owning the Quilchena areas.

Copper camps.

In addition to the examination of the coal-basin proper some time was spent in investigating the copper-bearing rocks of the Aspen Grove mining camp, situated on the road to Princeton. These are located from 18 to 25 miles south-east of Coutlee and comprise a large number of claims, some of which show little more than prospects, while on others a considerable amount of development work has been done. An examination was also made of the Aberdeen mining camp situated to the west of Ten Mile creek, about twelve miles north of the post-road leading to Lower Nicola. The results of this work are given in the accompanying report by Mr. R. A. A. Johnston.

Boring No. 1, 1891.

RECORD of boring No. 1, near Coutlee, on Coldwater river, lot 123, Tp. 91, approximate elevation above sea-level, 1,996 feet.

Material.	Thickness of beds.		Depth from surface.	
	ft.	in.	ft.	in.
Gravel and clay, dark	55	..	55	..
Shale	2	..	57	..
Coarse gray sandstone	64	..	121	..
Shale, dark	5	..	126	..
Sandstone, dark	5	..	131	..
Sandy shale, dark	2	..	133	..
Sandstone, fine, dark	6	..	139	..
Sandstone, shaly, dark	49	6	188	6
Slate	1	6	190	..
Coal	3	8	193	8
Sandstone, gray	..	6	194	2
Coal	1	4	195	6
Sandstone, gray	..	8	196	2
Coal	..	7	196	9
Sandstone, carbon streaks	12	3	209	..
Sandstone, shaly, dark	3	3	212	3
Coal	1	5	213	8
Shale, light	3	4	217	..
Sandstone, 2 in. coal at top	13	..	230	..
Slate, black	1	..	231	..
Sandstone, fine dark	10	.. (?)	241	..
Sandstone, coarse, gray	11	..	252	..
Sandstone, with shale partings	8	0	260	..
Sandy shale, dark	9	0	269	..
Coal	..	10	269	10
Sandstone, partings of shale	7	2 (?) as in log.	287	..
Slate, dark	2	..	289	..
Sandstone, dark	1	..	290	..
Shale, dark	1	..	291	..
Slate, black	9	..	300	..
Shale, black	4	..	304	..
Sandstone, dark	2	..	306	..
Shale, dark	7	..	313	..
Sandstone, dark	1	..	314	..
Shale, black	2	..	316	..
Sandstone, carbon streaks	22	7	338	7
Coal, 2 in. slate in middle	1	5	340	..
Slate, 1 in. coal at bottom	1	..	341	..
Sandstone and shale, dark	3	..	344	..
Sandstone, gray	11	..	355	..
Shale, dark	3	..	358	..
Sandstone with conglomerate, 1 ft	29	..	387	..
Shale, carbon streaks, dark	2	..	389	..
Sandstone, dark and gray	10	..	399	..
Shale, dark	8	..	407	..
Sandstone, carbon streaks, gray	39	..	446	..
Slate, black	3	7	449	7
Coal	..	7	450	2
Sandstone, fine gray	5	10	456	..
Coal	..	6	456	6
Sandstone, fine gray	1	6	458	..
Shale, dark	3	..	461	..
Sandstone, gray	17	..	478	..
Sandstone and shale, dark	11	..	489	..
Sandstone, dark and gray	15	..	504	..

RECORD of boring No. 1, near Coutlee, on Coldwater river, lot 123 Tp. 91, approximate elevation above sea-level, 1,996 feet.—*Con.*

Boring No. 1, 1891.

Material.	Thickness of beds.		Depth from surface.	
	ft.	in.	ft.	in.
Sandstone, dark	3	..	507	..
Sandstone, gray	2	..	509	..
Sandstone, dark	8	..	517	..
Sandstone and shale, dark	2	..	519	..
Sandstone, soft, gray	15	..	534	..
Sandstone and shale, gray	46	..	580	..
Shale, carbon streaks, dark	8	8	588	8
Coal and shale	1	7	590	3
Sandstone and shale, dark	9	9	600	..

Begun January, 1891, finished March 17 (?) 1891.
Signed, G. L. Davis.

RECORD of boring No. 2, Nicola valley, 1893, Nicola Valley Co.

Boring No. 2, 1893.

Material.	Thickness.		Depth.	
	ft.	in.	ft.	in.
Clay and sand	80	..	80	..
Sandstone, coarse, gray	29	..	109	..
Shale, dark	4	..	113	..
Sandstone, gray	6	..	119	..
Shale, dark	3	..	122	..
Sandstone, gray	7	..	129	..
Shale, dark	8	6	137	6
Coal	..	8	138	2
Shale, dark	1	1	139	3
Coal,	..	6	139	9
Slate, dark	..	4	140	1
Coal	4	4	144	5
Shale, dark	3	7	148	..
Sandstone, gray	10	..	158	..
Shale, dark	5	..	163	..
Sandstone, gray	2	..	165	..
Shale, dark	1	6	166	6
Coal	1	11	168	5
Sandstone and shale, gray and dark	21	7	190	..
Sandstone, coarse, gray	13	..	203	..
Conglomerate, gray	12	..	215	..
Shale, carbon streaks, black	4	..	219	..
Coal	..	5	219	5
Slate, black	..	7	220	..
Sandstone, shale partings, gray	15	..	235	..

RECORD of boring No. 2, Nicola valley, 1893, Nicola Valley Co.—*Con.*

Boring No. 2, 1893.

Material.	Thickness. ft.	Thickness. in.	Depth. ft.	Depth. in.
Shale, carbon streaks, dark	10	..	245	..
Sandstone, gray	6	..	251	..
Sandstone, coarse, gray	4	..	255	..
Conglomerate, carbon streaks, gray	25	..	280	..
Shale, dark	5	..	285	..
Shale, carbon streaks, black	7	..	292	..
Shale, dark	3	..	295	..
Conglomerate, gray	2	..	297	..
Shale, black	3	..	300	..
Sandstone, carbon streaks, black	34	5	334	5
Coal	.	7	335	..
Sandstone and shale, dark	16	..	351	..
Conglomerate, dark	7	..	358	..
Sandstone and shale, gray, dark	65	..	423	..
Conglomerate, gray	3	..	426	..
Sandstone, carbon streaks, gray	4	..	430	..
Conglomerate, gray	37	..	467	..
Sandstone and shale, dark	31	..	498	..
Conglomerate, gray	39	..	537	..
Shale, dark	11	..	548	..
Sandstone, gray	14	..	562	..

On N.W. quarter sec. 14, Tp. 91, property of J. Garcia.
Certified by G. L. Davis.

LOG of the boring at Quilchena, 1904-05, Diamond Vale Coal Co.

Boring No. 1, Diamond Vale.

October—

Sand, gravel and boulders, surface to	16 feet.
Cemented gravel	24 "
Clay and gravel	28 "
Clay	46 "
Sand	47 "
Clay	66 "
Cemented gravel	74 "
Hard clay	79 "
Hard cemented gravel	83 "
Clay	98 "
Conglomerate	103 "
Reddish sandstone	107 "
Conglomerate	109 "
Sandstone	114 "
Brown shale	116 "
Dark shale with coal streaks	123 "
Sandy shale	124 "
Sandstone	125 "
Shale	172 "
Sandy shale	185 "
Shale with coal streaks	188 "
Shale	192 "

Boring No. 1, Diamond Vale.

Sandstone	193 feet
Shale	198 "
Conglomerate	199 "
Brown shale with coal streaks	217 "
Conglomerate bands in shale (3 in. at 218; 12 in. at 249.)	249 "
Shale	283 "
Hard conglomerate	284 "
Black shale	289 "
Sandy shale	291 "
Shale	305 "
Shale	308 "
Conglomerate	317 "
Shale	324 "
November 17—	
Coal, 1 ft	327 "
Shale 6 in., conglomerate 6 in	328 "
Shale and conglomerate bands	417 "
Sandstone	418 "
Black shale	423 "
Conglomerate and shale bands	434 "
Coal (4 in.) and shale	439 "
Coal, 1 ft	440 "
Black shale	441 "
Coal, 3 in.	
Shale and sandstone	456 "
Coal, 1 ft	457 "
Shale	468 "
Shale and coal	471 "
Coal, 2 ft	473 "
Shale 2 in., conglomerate 10 in	474 "
Shale	480 "
Conglomerate	481 "
Coal, 1 ft. 6 in	482½ "
Shale with small band of conglomerate	499 "
Sandy shale	505 "
Sandy shale	513 "
Conglomerate	514 "
Sandstone	515 "
Shale	517 "
Conglomerate	519 "
Dark shale	524 "
Shale	555 "
Conglomerate	556 "
Shale	558 "
Conglomerate	559 "
Shale	565 "
Coal, 1½ ft	566½ "
Shale	570 "
Conglomerate	571 "
Shale with conglomerate band at 574-575	577 "
Light shale	577 to 586 "
Dark shale	588 "
Coal 4 in., shale 8 in., coal 1 ft. 2 in	590 "
Light shale	596 "
Conglomerate	597 "
Brown shale	600 "
Light shale	606 "

Boring No. 1, Diamond Vale.

Coal	1 ft. 0 in.	
Shale	0 " 6 "	
Coal and shale	1 " 0 "	
Soft black dirt	2 " 3 "	
Coal	2 " 6 "	
Shale	1 " 3 "	
Coal and shale	1 " 0 "	
		615 ft. 6 in.
Soft brown shale		623 "
Soft gray sandstone		626 "
Shale		627 "
Fine conglomerate		629 "
Sandstone		630 "
Dark shale		631 " 6 "
Light coloured fine conglomerate		633 " 6 "
Sandstone		634 " 6 "
Coal 1 ft., shale 3 in., conglomerate 9 in		636 " 6 "
Shale, mostly hard		668 "
Gray sandstone		672 "
Light shale		678 "
Conglomerate		678 " 8 "
Coal, 6 in		679 " 2 "
Fire clay		689 " 4 "
Coal, 2 ft. 4 in		691 " 8 "
Shale		706 " 4 "
Coal and shale, 9 in		707 " 1 "
Shale, 4 ft. 3 in		711 " 4 "
Coal and shale, 1 ft. 8 in		713 "
Shale		715 "
Hard, close-grained rock		717 "
Conglomerate		719 "
Shale		721 "

Boring abandoned.

Boring not altogether satisfactory, owing to frequent caving of hole and difficulty of taking out cores, some of which were worn away. In this boring about twenty-four feet of coal were passed through without reaching the 'tunnel seam,' the boring beginning below the 15-foot seam. The log shows the presence of several seams which are not exposed on the face of the hill owing to the heavy mantle of drift over much of this area.

The Copper Claims of Aspen Grove and Aberdeen Camp, B.C.

By Mr. Robert A. A. Johnston.

Aspen Grove.

Aspen Grove camp is embraced in a ridge of low mountains forming the divide between Quilchena creek flowing to the north and Otter creek flowing to the south. Its northern limit may be set at a point about fifteen miles south of Nicola lake. From there it extends in a southerly direction for about twelve miles and covers, in all, an area of about thirty square miles.

The rock formation of the area includes an extensive development of an old igneous series now represented in the main by breccias and basic schists. These are traversed in various directions by more or less extensive dikes of porphyritic and granitic eruptives, the material of which has often been freely injected into the surrounding rock and is to be found as the paste of much of the breccia.

General character of the rocks.

Extensive alteration of the older rocks has succeeded the invasion of these intrusives, resulting sometimes in the converting of the schists into impure limestones and dolomites. Chalcedony and serpentine are often found filling cavities and crevices. Pale brownish yellow calcite and yellowish-green epidote are of frequent occurrence as druses in some of the localities. The only minerals of any economic importance so far observed are chalcocite, bornite, chalcopyrite, native copper and specular iron. These seem to be pretty generally distributed through the older rocks, but are nowhere observed concentrated in any very great abundance. Stains of green carbonate of copper are to be met with throughout the area. Iron pyrites occurs very sparingly in a few places.

Numerous claims have been staked in the area during the past five years. In the majority of cases, however, the claims have either been abandoned or such work as has been performed on them has been entirely in the nature of assessment duty. In only a few instances have any of the claims been developed to any appreciable extent.

The following notes refer only to the more important openings that have been made.

Sovereign claim.

Sovereign Claim :—On this property, a dike several feet in width consisting of a dark gray diabase felsophyre is exposed for some distance. It runs in a direction bearing N. 25 E. To the westward of this dike the rocks have been shattered and injected with material similar to that of the dike, forming a somewhat coarse pyroclastic breccia.

To the eastward of the dike the rocks show evidences of having been subjected to much pressure, so that their true character is much obscured. In general they present a purplish-brown colour, mottled here and there with darker or lighter shades. They are highly feldspathic in their composition, while small prismatic crystals of a dull green pyroxene are abundantly developed. As secondary constituents, small quantities of white calcite, greenish-yellow epidote and yellowish-white serpentine are distributed through the mass.

In a few instances, masses of native copper of several pounds weight have been found occupying fissures, while small grains of the same mineral are often observed clinging to the walls of fractures. Stainings of the green carbonate of copper are abundant; those of the blue carbonate occur more rarely.

Copper Standard claim.

Copper Standard Claim :—On this property the rocks are exposed along a bluff for two hundred feet or more in length and sixty to seventy-five feet in height. This bluff has a northerly exposure, and in a recess near its base a shaft has been sunk to a depth of fifty-five feet, and from the foot of this shaft a drift has been run in for a distance of forty-five feet. This shaft was filled with water at the time of my visit, but the character of the material displayed on the dump did not differ essentially from that of the ledge in general.

The rock consists of a fine-grained intermixture of a purplish feldspar and a pale green pyroxene traversed by thin bands of yellowish-white serpentine. Stains of green carbonate of copper are abundant on exposed surfaces of the rock.

Giant claim.

The Giant Claim :—A tunnel sixty feet in length has been driven into the north side of the mountain on which this claim is situated. The rock consists throughout of a compact gray diabase, enclosing here and there small masses of pinkish-white calcite and a very little iron pyrites. At the top of the hill, a short distance above the mouth of the tunnel, the iron pyrites becomes more abundant and stains of blue and green carbonates of copper are common.

Copper Chief Claim :—Two openings on the south side of the hill on this claim show abundant stains of blue and green carbonates of copper in a shattered mixture of diabasic and chloritic rocks.

Other claims.

Big Kid Claim :—A small excavation on this claim discloses small quantities of bornite and chalcopyrite in a gangue composed of a shattered mixture of diabase and chlorite schists with small quantities of epidote.

The Hub Claim :—At this claim occasional stains of green carbonate of copper are to be observed distributed over a dark brown brecciated andesite.

The Golden Gate Claim :—At this claim a green diabase schist dipping about N. 60 E. holds trifling amounts of chalcocite.

The Georgia Claim :—A shaft has been sunk on this claim to a depth of thirty-five feet. The material shown on the dump consists of a dark reddish-brown andesite stained with green carbonate of copper.

Copper Belle and Bluebird Claims:—The material of these two claims is precisely similar in character to that of the Georgia Claim, and consists of a gray, fine-grained andesite stained with green carbonate of copper.

Bachelor, Nicola and Highland Claims:—The material of these claims consists of a shattered coarse-grained andesite traversed by small stringers of calcite. Occasional small grains of native copper are to be found disposed along the walls of cavities.

Big Sioux Claim:—At this claim thick bands of a green diabase alternate with similar bands of a rather coarse-grained augite-syenite, dipping about N. 70 W. at a high angle. The syenite shows no evidences of alteration from pressure and may be intrusive in the diabase, which is, in some parts, brecciated and generally much fractured; alteration products of an epidotic or chloritic character are likewise more or less abundantly distributed through the diabase. In some portions small quantities of chalcocite and bornite are observable. Stains and coatings of green carbonate of copper are abundant.

A shaft has been sunk on this property to a depth of twenty eight feet and a considerable quantity of low grade ore has been raised.

The Maggie Claim:—A shaft has been sunk on this location to a depth of about fifty feet in a greenish-gray fractured and fissured diabase.

The fissures are sometimes filled or lined with a yellowish white serpentine, and in a large fissure a short distance east of the shaft fine specimens of white stalactitic chalcedony have been found. Copper pyrites occurs sparingly on this claim. To the eastward of the shaft the district is traversed by a zone of rusty weathering siliceous dolomitic schists dipping S. 50 W. at a high angle.

The Cincinnati Claim:—A tunnel has been driven into the side of the mountain for a distance of about two hundred and eighty feet. The rock is a moderately coarse grained andesite, holding small quantities of iron pyrites and showing frequent stains of green carbonate of copper.

The Portland Group:—This ground comprises the Portland, Covington, Vicksburg and Quebec claims. A shaft said to be one hundred and ten feet deep has been sunk on this property. At the time of my Portland group.

visit, however, it was partially filled with water. Somewhat extensive strippings have also been made on the property. The rock, as revealed by these strippings as well as by an examination of the material of the dump, is shown to be in general a quartz-andesite. Much of it has been fractured and recemented with infiltrated silica and green serpentine. It shows occasionally small quantities of chalcocite and specular iron while stains of green carbonate of copper are more or less abundant. Narrow dikes of a gray diabasic felsophyre cut through the andesite in a direction bearing N 10 E.

Mount Maria.

Vancouver and Westminster Claims :—In its central portion Mount Maria is traversed by a heavy dike of intrusive granite, following a course approximately N. 85 W. At the summit of the mountain the dike presents on its southern margin a sheer wall of from twenty five to one hundred feet in height and upwards of six hundred feet in length. In composition it consists of a fine-grained admixture of a light gray feldspar with comparatively minor amounts of white quartz and brown mica.

To the south of this dike, material of similar composition is seen to form the paste of a pyroclastic breccia derived from the andesite of the region. In some portions of this breccia stains of green carbonate of copper are abundant and in the case of the Westminster and Vancouver claims, which occupy adjacent positions on an elevated bench on the southern slope of the mountain, small quantities of chalcocite are also to be found. On the latter of these two claims a shaft has been sunk to a depth of twenty-five feet, but so far as could be observed the results did not seem to be very encouraging.

Buckhorn claim.

Buckhorn Claim.—This claim is situated on the summit of Bear mountain at the southern end of Aspen Grove camp. Some small openings have been made on it, disclosing abundant stains of green carbonate of copper on a moderately fine-grained, reddish-gray to dark gray andesite.

ABERDEEN CAMP.

Aberdeen camp.

Aberdeen Camp is composed of a number of claims in or about the district drained by Brom creek and its branches. Brom creek is a small rapid stream flowing down through a deep ravine from the hills to the westward of Ten Mile or Guichon creek and emptying into the latter stream at a point about ten miles from its confluence with the Nicola river.

Heavy deposits of drift material conceal, to a large extent, the underlying rocks, but where these latter are exposed they are seen to consist of a series of granitic eruptives enclosing remnants of an old greenstone series and at times forming the cementing material of breccias made up of fragments of the latter.

Granite eruptives.

These granitic eruptives are largely made up of a moderately fine-grained syenite consisting almost wholly of a mixture of a light gray feldspar and black hornblende. At different points, however, they are seen to merge gradually into a type in which white quartz becomes abundant and the hornblende is replaced by a dark brown mica. Small crystals of a pale red garnet are of frequent occurrence in this latter type. Sometimes, as a result of local disturbance, the rocks are observed to exhibit a decided schistosity and some very thin bands consist of a rather coarse-grained light reddish feldspar to the almost entire exclusion of other minerals. Small stringers and masses of white quartz and white calcite with specular iron frequently occur.

The character of the greenstones previously mentioned has been greatly obscured by the changes produced during the intrusion of the granites. In some of the less altered portions they are seen to be highly augitic but for the most part they have undergone such complete changes that their original constitution is nearly or quite obliterated. Drusy cavities lined with white or reddish white quartz are abundant. Chalcocite and specular iron are distributed through it to some extent but the quantity does not seem to be large. Stains of green carbonate of copper are frequently seen.

Aberdeen claim.

Only two of the claims have been opened up to any very appreciable extent. These are the Aberdeen and the I.X.L. The former of these claims is situated on Brom creek, at a point about a mile from the mouth of the creek, where a large mass of the greenstone is enclosed between two coarse joint planes in the granite, striking about N. 85° W. (mag). A tunnel has been driven for considerably over one hundred feet along the strike. The greenstone, coated with green carbonate of copper and carrying small quantities of chalcocite and specular iron is met at various intervals along the entire length of the tunnel, the intervening spaces being occupied by either greenstone breccia or granite. Some low-grade ore has been taken out but work for the present has been discontinued.

I.X.L. claim.

The I.X.L. claim is situated on a small creek of the same name, a branch of Brom creek, and lies nearly a mile and a half in a north-westerly direction from the Aberdeen claim. In addition to some small openings a shaft has been sunk on this property to a depth of one hundred feet. The rocks consist of a breccia made up of fragments of the old greenstones cemented in a paste of the eruptive granites. A coarse-jointed structure with a dip S. 55° E. < 45° is distinctly visible. The material holds small quantities of specular iron; stains of green carbonate of copper are found.

Examinations were also made of the King Solomon and Midnight claims which respectively occupy opposite positions on the right and left banks of Ten Mile creek, a little more than half a mile above the mouth of Brom creek. At the former of these two claims is seen a heavy exposure of a gray granitic gneiss dipping S 20° W. nearly vertical. On the opposite bank of the creek, at the Midnight claim, the same rock is seen dipping E. < 60°. It includes scanty remains of the old greenstones, and thin bands of red feldspar are to be seen intercalated with it. Small quantities of chalcocite, specular iron and green carbonate of copper are found associated with the greenstone portions but in no instance could these minerals be found traceable to the granites.

Iron Mountain.

Iron mountain.

A number of claims have been staked on or about the summit of Iron mountain and in a few instances a small amount of development work has been done. The occurrences, so far as could be observed, however, do not appear to be of any importance economically. The summit of the mountain is comprised in a series of alternating ridges with shallow valleys between. These ridges conform in direction with the strike of the rocks, which varies from N. to N. 55° W. with a dip to the west or south-west. The rock formation embraces a series of interbedded jaspery quartzites, felsophyres and brownish-coloured rhyolites. These last are also often found as the paste of a dark brown feldspar breccia. These are all frequently traversed by veins of white quartz either parallel with the strike or cutting it at various angles. These veins are sometimes seen to carry trifling amounts of specular iron, chalcopyrite and pyrite; green carbonate of copper, or malachite, is often observed either as an earthy coating or in fine radiating groups of small acicular crystals. In no instance, however, were any of these minerals noted in any appreciable amount.

The Lardeau Mining District.

By Professor R. W. Brock.

Introduction.

In pursuance of your instructions the field work for the season 1904 was carried on in the Lardeau district, in continuation of that of last year. As in the past, the topographical work was in charge of Mr. Boyd of this Survey. Captain Deville of the Dominion Lands Branch, having generously loaned the necessary instruments, this work was done by photographic methods in place of the system of sketching to scale previously adopted, thereby affecting the saving of time and securing an increased accuracy. As heretofore, the geological work and topographical surveys were carried on concurrently. Last season the continued wet weather seriously interfered with operations, while this year the prolonged drought occasioned numerous and extensive forest fires, the smoke of which hung like a pall over the country from August 6 to the end of the season, blocking the work completely for a large portion of the time. On account of these unfavourable conditions the work accomplished in the two seasons scarcely equals that of one season under normal conditions.

Nearly sufficient information was obtained, however, for an oblong map of the district between Revelstoke and Schroeder creek on Kootenay lake (the north end of the West Kootenay map sheet) for a width of about twenty miles. Included in this area are the productive portion of Fish river, the entire basin of the Lardeau river, most of the prospected portion of the Duncan river and the head of Kootenay lake.

Division of work.

The season was begun at Revelstoke where our outfit had been left for the winter. While Mr. Boyd was experimenting with the topographic camera to determine the length of exposure necessary under the climatic conditions of this district, I examined the geological section exposed in the Illicilliwaet valley from Glacier to Revelstoke to compare these rocks, which form the Selkirk series of Dr. Dawson with those obtaining in the Lardeau district. From Revelstoke we went to Trout lake. Micrometer surveys were made of Trout lake, the Lardeau valley to Kootenay lake, the head of Kootenay lake to Kaslo and of Howser lake. By the end of June, when this work was completed, the snow had sufficiently melted to permit of work on the high summits. After an excursion over Lavina mountain, to get the south, ern portion of the district properly oriented, we moved up to Trout lake to take up the mountain work where it had to be abandoned last season on account of snow. The districts about Trout creek, Silver cup mountain, and Haley and Hall creeks were finished before the smoke interfered with this part of the work. The loss of time from this cause made it necessary, in order to cover the sheet planned, to finish the south-eastern portion of the area in much less detail. While it was still too smoky for regular work, we made traverses in the neighbourhood of Poplar creek and ran a survey up Duncan river as far as Haley's ranch. While working here a slight rain cleared the smoke from the Duncan valley; we therefore hastened down to Howser lake to obtain the necessary information for the south-eastern end of the

Forest fires.

sheet. After two days the smoke again obscured the country and the season came to a close on September 23rd. Mr. Boyd, however, remained ten days longer until he secured another triangulation station to complete the topographical map.

As this season's work was the continuation of last year's, which is fully treated in the Summary Report for 1903, it will be unnecessary in this report to do more than mention the special features noted during the present year.

PHYSIOGRAPHY.

Character of the country.

The character of the country is similar to that described last year. The mountains, especially on the Duncan slope, are rugged and Alpine. The longitudinal valleys, Lardeau and Duncan, uniting to form Kootenay valley, are U-shaped, though, above Lake creek, the Lardeau is a flat V. The tributary valleys are narrow, steep and V shaped, debouching through narrow box canyons. Almost every tributary creek furnishes an example of this, although in a few instances a creek has not yet cut down to grade but falls from its hanging valley into the main artery. Beautiful fans or cones have been formed at the mouths of some of the main tributary valleys. The village of Lardo is built upon the side of one of these. The somewhat complicated topography about the head of Kootenay lake is due to a change in the strike of the rocks and to modifications produced by the Lardeau and Duncan tongues of the Cordilleran glacier.

The main valleys.

As mentioned last year, the main valleys follow the strike of the rocks, the direction of the tributary valleys being determined by the main jointage of the rocks. Above the head of Kootenay lake the strike of the rocks changes from a somewhat northerly to a more north-westerly direction; consequently, the direction of the main Lardeau and Duncan valleys is thrown out of line with regard to Kootenay valley. It is about three miles above the head of Kootenay lake to where the valley branches. The north-westerly extension is occupied, first by the lower part of Meadow creek for a few miles and then by the Lardeau river, only a low gravel terrace, which extends across the valley, preventing the river from following this valley to the lake. The north-eastern branch valley is occupied by the Duncan river. About a mile up it, the Lardeau river, which has switched over from the north-westerly valley, enters the Duncan valley. These valleys, for some miles up, are very little higher than the lake level and in high water are more or less submerged. The ridge between Meadow creek and the lower part of the Lardeau river, is only a few hundred feet high and that between the Lardeau and Duncan rivers for a few miles above their confluence is also very low and is notched by a narrow pass utilized by the road connecting Howser station and Howser lake. The Duncan valley is about one mile wide and up to Haley's ranch has a very low gradient. A short distance above the mouth of the Lardeau, the Duncan expands into Howser lake, a beautiful little mountain lake about nine miles long. Two arms on the east side of the lake, one running south-east and the other north, almost make a large island of the ridge separating them from the main lake; at their upper ends they are separated by only a quarter of a mile of low ground. Where the Duncan river enters the lake, a typical delta has been formed with numerous sloughs, lagoons, etc. Meadows, sloughs and flood-lands of the river extend almost to Haley's ranch. It is evident that considerable changes in the topography about this point have taken place during and after the glacial period. It seems probable that the Lardeau flowed down the lower Meadow Creek valley; that the Duncan meandered through the arms of Howser lake and through the gap behind Howser city to the Lardeau, and that Glacier creek formed the last stretch of the Duncan-Lardeau valley. In this case, the ridge between Meadow creek and Lardeau river represents the end of the Duncan-Lardeau divide, and the knob on the south end of the present Duncan-Lardeau divide, is the remnant of the ridge separating Glacier creek and the Duncan. The heavy glacier which filled these valleys, unable to make the sharp turns, straightened the valleys and deeply trenched them. In the Duncan valley this would result in the formation of the main Howser lake, the cutting through of the spur between the Duncan and Glacier creek, widening the mouth of the latter and truncating Lavina and Hamill spurs. In the Lardeau it would result in the cutting through of the low spur between the Lardeau and the old Duncan valley. The deep trenching of the main valleys by the ice left the tributaries as hanging valleys at least a thousand feet above the main valleys. The more active of the tributary streams have now, at their mouths, cut down to grade, forming the deep box canyons, with beautiful water-falls and cascades at the present heads of the canyons. The north ends of Kootenay and Howser lakes are being rapidly silted up by the entering streams which are still heavily laden with rock-meal and debris from the innumerable local glaciers. Most of the streams head in cirques formed by local glaciers which, in a great many cases, are still present and at work. From the cirque, there is always a steep drop to the valley level, then a reach with a low gradient and finally a steep drop into the canyon bottom.

Howser lake.

GLACIAL GEOLOGY.

Little need be added to the report for last year. Evidences of the Cordilleran glacier and its remarkable thickness were obtained at

Glacial heights.

several points, though over the greater part of the district they have been obscured by the large local glaciers.

The usual criterion for recognizing the height reached by a glacier, by the marked change in topography of the portion of the mountain above the ice from that of the portion buried under the ice, does not appear to be of use in this district. Except where local glaciers have been recently at work the change from the rounded outlines to the rugged or talus-covered slopes is found about tree line. Yet the indisputable evidence of erratics and striation shows that the thickness of the Cordilleran glacier in this district must have greatly exceeded this, and I am led to the conclusion that, although the majority of the summits have the appearance of having their heads above the sea of ice, few, if any, of them have really been nunataker. In addition to striation on high ridges and summits that could not have been produced by local glaciers, I found on Trout mountain, at 8140 feet, a granite erratic that must have been carried from the north by the Cordilleran glacier, and on the summit of Abbot mountain, 9140 feet, a typical glacial quartz pebble flattened on one side and broken with a sharp edge. The country rock all about here is white crystalline limestone; these pebbles, therefore, cannot be local, and as this is the dominating peak in the locality, no local glacier could have transported them. The general direction of the striations produced by the glacier is here about S. 14° E.

On the west slope of the Duncan valley, near the head of the lake and 1600 feet above it, three sets of striations crossing each other were observed. The oldest had a direction of S.W., the next S. 50° W., and the latest S. 30° W. These variations in direction were, no doubt, due to the effect of the Duncan valley on different thicknesses of ice.

Local glaciers.

Local glaciers abound, most of the higher peaks supporting numerous small glaciers. Some summits are almost buried under the ice, others have large nunataker separated by thin tongues of ice, while the majority support small isolated glaciers on all their sides. The small glaciers have excavated cirques, except in a few instances, when the ice is found perched on the side of a mountain where one would think no snow could collect. As the local glaciers retreat and become smaller, cirques are produced within cirques, or 'tandem' cirques, to use Dr. Daly's expression, result. Perfect cirques are formed irrespective of the country rock, so that they are found in granite, diorite, limestone and phyllite.

The largest of the local glaciers is that lying between Glacier and Little Glacier creeks, probably about eight miles long. These tongues run into Little Glacier valley and around a nunataker and unite in Glacier creek valley. This glacier, I should judge, has a maximum thickness of at least a thousand feet. Most of the glaciers are traversed by huge crevasses, and ice-falls are numerous. In the summer, the movement of the ice must be rapid. Bannockburn glacier, near the head of Hall creek, plunges over a ledge of rock, the ice from above breaking off and falling on to the lower portion of the glacier. The surface of this portion is dotted with blocks of ice that have fallen from the mass above the ledge of rocks. When examined, the last discharge of ice from above was fifty yards from the fall and the next a hundred yards farther down or 150 yards from the fall. The blocks in both cases were still angular and the snow on which they rested had not been melted by the reflection of the sun from their southern faces. Earlier breaks, now farther down on this ice tongue, show the corners of the ice blocks melted off; the snow under their south faces is melted and the ice of the glacier beneath has also suffered. As the sun at this time of the year (August) is very strong and the weather clear, the two breaks, 50 and 150 yards from the fall, could not have been long exposed to its influence.

Typical boulder clay was seen on the surface of Marquis and Gilbert claim 900 feet above Poplar creek. Lying on a fluted surface, the thickness varies greatly.

Silt, usually well terraced, is found in protected areas along the larger valleys for at least 1,000 feet above the valley bottoms.

GEOLOGY OF THE SOLID ROCKS.

Geology of the solid rocks.

The rocks met with in this season's work are similar to those described in last year's report, and consist of argillites, generally altered to phyllites or schists; limestone, dark and carbonaceous where unaltered, but often altered to white crystalline limestone; quartzite; fine-grained conglomerate; tuffs; gabbro, in places perhaps diorite; in smaller dikes, gabbro porphyrite—generally mashed to a chlorite-sericite-schist (greenstone schist); a basic eruptive that seems to have been diabase, now represented by a reddish or yellowish weathering sericitic serpentinous calcareous schist (diabase schist); aplite; pegmatite and granite. At a few points, as on Lavina mountain and Howser mountain, dikes of a basalt-like rock are met with.

With the exception of the granite and allied rocks, the above mentioned rocks are usually intimately mixed. Proceeding southward, towards Kootenay lake, the rocks gradually become more crystalline, mica and garnet are developed in the schists, the lime becomes highly crystalline and white quartzite appears. Dikes of aplite become numerous and small faults are abundant. This increase in metamorphism appears due to the proximity of granite which, indeed, is exposed on Kootenay lake about Fry creek, and not to any increased folding that the rocks have been subjected to. In fact there seems to have been a marked diminution of the pressure about the head of Kootenay lake, the rocks being arched into a low anticline dipping eastward at the east side of the valley and west on the west side of the valley, whereas, farther north, at the head of Haley lake and Hall creeks the rocks, as shown by the lime band, are tightly folded. On the Duncan river, however, the rocks beneath the "lime dike" are highly metamorphosed. East of the river they consist largely of hornblende and glossy mica-schists and gneisses, and west of the river, between it and the "lime dike," of quartzite. The "lime dike" so conspicuous at this point and north-westward gradually becomes thinner as the folding becomes less intense, and at the bend in Lake creek, sinks into obscurity.

The diabase schist which occurs in several large bands on Silver Cup mountain crosses the Lardeau about Tenderfoot creek and extends southward across Rapid, Poplar and Cascade creeks to Meadow creek basin, thus crossing the strike of the rocks at a slight angle. All around the head of Kootenay lake, as also on Lavina hill, crystalline limestone, schists and quartzite are the principal rocks. About Howser lake, schist and limestone form the bulk of the rocks, Running from Jubilee point on Howser lake to Lavina cabin on Lavina hill is a banded quartzose rock which appears to be limestone highly silicified.

Granite occurs along the Lardeau-Arrow and Slocan Lake divide. At Trout lake, it swings south-east across Five-mile creek to within, at one point, one and a half miles of the lake, then it again recedes toward the divide. On Kootenay lake it outcrops about Fry creek and for some distance south.

The rocks met with on the section along the Canadian Pacific Railway, from Glacier to Revelstoke, which Dr. Dawson named the Selkirk series, appear to be the northward extension of the Lardeau rocks. Approaching Revelstoke they become highly metamorphosed by granitic intrusions.

MINING GEOLOGY AND MINING.

Mining geology.

Along and near the summit of Silver Cup mountain, going south-eastward from the Silver Cup and Triune mines, mineral occurrences are met with, but none, so far developed, equal in size or importance the deposits of the former mines. The general character of the deposits is similar to those described in the last report.

I.X.L. claim.

The I.X.L. claim on Brown creek, over the hill from the Triune, appears to be on the continuation of the Triune lead. The vein occurs in an iron-spotted talcose schist which is probably a facies of the diabase schist. One vein runs nearly parallel with the strike of the schist but another vein runs at right angles to it. Where best exposed by development work the vein is of quartz, from one foot to one foot and a half wide, well mineralized with galena, zinc-blende, iron and copper pyrites and gray copper. The galena masses are sometimes as large as eight inches square. Crossing Brown creek valley at the I.X.L cabin is a dike or boss of diorite. It is more acidic than those observed elsewhere and may be a syenite facies of the greenstone. The Cromwell claim, in the same basin, is said to have a good showing of ore but the workings were covered with snow at the time it was visited.

On the Mabel, Alpine, I.X.L., (Trout lake slope) and Bonanza claims some work has been done on showings of ore, but these present no new features.

American claim.

On the American, near the south end of the mountain, considerable work has been done and some ore has been shipped but work has been discontinued. The ore is quartz, calcite, hornblende, and spathic iron carying galena, blende and gray copper. On the north-east face of the knob on which the mine is situated, the vein, which averages about two feet in width, strikes 235° but on the summit turns to 185°. The vein is cutting across the strike of the formation, which consists of green schists, a mixture of the diabase and greenstone schists, and phyllite. The work done includes trenches on the surface and several tunnels on both the north-east and south-east slopes of the hill.

Mineralization extends along both sides of the lime dike, or to a limited extent in the lime itself, just as in the district described last year.

Wagner claim.

The Wagner claim is situated on the divide between Haley and Caribou creeks west of tne lime dike at an altitude of over 8,000 feet. The workings are on a small knoll above a glacier which has to be crossed to reach the mine. At the time of our visit, the workings were inaccessible on account of snow. The vein is situated in corrugated slates with diabase schists. A band of lime, filled with an almost microscopic network of quartz stringers, occurs in the slates of the hanging wall which are contorted and faulted by thrusts on a minute scale. The lower body consists of several veins of quartz which unite into one mass several feet wide which splits up into small veins and stringers. The ore consists of galena with some pyrite and gray copper. The galena is cubical, sometimes fine but mostly coarse, and occurs in masses up to six inches in width. Blobs of quartz appear in the galena and, in places, crystals of quartz, up to one inch thick and two inches long, are embedded in the ore. The vein quartz is inclined to be drusy and these druses are frequently filled with ore.

Twenty feet to the south is a second vein, six inches wide, of massive galena. The workings are said to consist of a tunnel 100 feet long with a crosscut, and a winze sixty feet deep.

Other claims.

At the head of Hall creek basin, in line with the Wagner, is the Jewel. The workings here were also buried in snow.

The Abbot, on the Haley creek slope, and the Bannockbum, on the Hall creek side of the lime dike, have been developed by crosscuts to tap ore exposed on the surface, but no considerable quantity of ore has been exposed. There are numerous other claims along the southern part of the lime band, but little more work than that required for assessment or crown granting has been done. The inaccessibility of this portion of the district and its severe climatic conditions, in the absence of an influx of capital, have discouraged prospecting and development, but until a tonnage has been developed it is scarcely to be hoped that conditions will be materially improved. Gold is reported to have been found during the summer in a large pyrite vein on Hall creek.

On Lavina hill, between Hammill and Glacier creeks, a considerable amount of work has been done in surface stripping, tunnelling, &c., disclosing a network of veins, some parallel to and others crossing the formation, which consists of phyllites, bands of limestone and a few bands of the diabase schists. The banded siliceous rock spoken of as being probably altered limestone, is found in the centre of the mineralized area. The ore, which is largely galena with some pyrite and chalcopyrite, shows a predilection for the limestone, occurring usually either in a limestone band or near one. The gangue in some of the veins is white milky quartz, in others calcite. The veins were from a few inches to four feet in width. The galena which may be coarse cubical or fine wavy, occurs scattered through the gangue in masses up to one foot in diameter.

Some prospecting was in progress on the Poplar creek slope of the Lardeau from Tenderfoot creek to Meadow and Cooper creeks, the same formation extending throughout.

On the Swede group, at Poplar creek, a considerable amount of surface work has been done which has thrown a good deal of light on the occurrence of the gold. The rock is made up largely of what we have been calling diabase schists, in dikes with thin bands of phyllite between. Near the centre of this mass is a band of rather massive green schist. In the diabase schist and the phyllites is a network of quartz veins varying from almost microscopic stringers to veins several feet wide. While in a general sense these are either parallel to or at right angles to the formation, in detail they vary in dip and strike, anastomose, &c. They carry galena, chalcopyrite, siderite, pyrite and arsenopyrite. The quartz is watery, smoky and milky. The smoky quartz bears the coarsest gold and the watery is generally richer than the milky quartz. The larger veins as a rule are much less heavily mineralized, while the tiny veins are frequently very rich. The diabase schists and the phyllites, besides being full of the small quartz stringers, are impregnated with pyrite and arsenopyrite, which weather to yellow or red oxides of iron respectively, giving the country rock a spotted appearance. Where these crystals were large and are now weathered, wire, sponge and flake gold may sometimes be detected. Evidently the arsenopyrite is the heaviest gold carrier. The country rock, therefore, when spotted with iron oxide, carries gold values, especially near the stringers and veins of quartz, where the sulphides are apt to have been present in greatest quantity. Samples which we took at a number of points over a wide area gave colours by panning. The gold in the rocks is extremely fine. The richer, smaller veins, on account of irregularities and faulting, would be difficult to mine, but if, as there is reason to hope, the diabase schist and the phyllite carry pay values, at any rate near the veins, the prospects for successful operation are greatly increased. Samples of fresh unpromising looking schist assayed by Mr. Connor of this survey, gave negative results. The gold is, therefore, not evenly disseminated throughout the full extent of the schist. Swede group.

The cost of mining this rock should be low. It is easily worked and although fresh and massive when taken out, it weathers rapidly, so that after a few months exposure it may be crumbled in the hand. In what rock I saw exposed, this weathering appeared to have freed the gold from the arsenopyrite, but this point should be tested on rock from a greater distance below the surface. If the rock itself is found to carry anything like pay values, it should be submitted to first class metallurgists and mill men to determine the best method of saving the gold. On account of its fineness it is possible that cyaniding on a large scale might prove the least expensive process. Cheap mining.

Nothing was being done on the Lucky Jack, owing to litigation. Here there is an area of diabase schist impregnated with arsenopyrite crystals, as on the Swede Group, which is also auriferous, as is proved by panning.

On Marquis and Gilberts claims, on the north-west side of Poplar creek, the same schist is also arsenopyrite-bearing and auriferous. Both north-westward and south-eastward from Poplar the same schists, spotted with red oxide of iron, from Tenderfoot creek to the branches of Meadow creek, were observed at different points, so that if it prove to contain gold in commercial quantities there is an extensive area over which it may be successfully prospected for.

The Spyglass claim, about twelve miles up Poplar creek, described in last years report, has been sold to a company and is being developed.

Mother Lode claim.

On the Mother lode claim, situated on the north-west side of Poplar creek, about two miles up, there is a strong looking vein exposed. It occurs in a band of graphitoid slate between dikes of the diabase schist. The width is about fifteen feet and, with the exception of about four feet, is well mineralized with galena, blende and pyrite, carrying, it is said, good values in gold, silver and lead.

Placer mining.

The experiment at placer mining on a bar below Poplar creek, which was mentioned in last years report, was unsuccessful. Better results are said to be obtained in Lardeau creek, near Trout lake, where a small force is at work. Preparations are said to be under way for somewhat extensive operations.

Silver.

The silver mill, built last year at Five-mile on the south fork of Lardeau creek, to treat the second grade ores of the Silver Cup and Nettie L. mines, has been running all the summer. This plant, which was described in last year's report, the Manager states to be working smoothly and to have proved itself well adapted to the ores it has to treat, in which the silver is carried by gray copper. The galena and pyrite, which contain the gold, are separated on buddles from the gray copper and blende, and sent to the smelter with the high grade ores; the remainder goes through the mill. It is expected that ten dollar ore will be successfully treated by this method.

Marble.

Eight miles from Lardo, on the Trout lake branch of the C.P.R., is a quarry in the crystalline limestone operated by the Kootenay Marble Co. of Nelson. The stone is of two varieties, white and blue and white banded. It presents a pleasing appearance and is said to take a fine polish. The pronounced systems of jointing enable blocks three or four feet by two feet thick to be taken out. The stone is adapted for both building and ornamental purposes. The rock is said to burn to a good lime and three pot-kilns of thirty tons capacity were being constructed to utilize the waste and culled stone.

RANCHING.

Some land suitable for ranching and fruit raising occurs on the Lardeau and lower part of the Duncan valleys and, where a start has been made at cultivation, the results have been excellent.

FORESTS.

Fires did a great deal of damage to the forests during the summer and also to some of the mines. Some of the fires may be unavoidable in a dry season but it is certain that if the public realized the value of the forests, steps would be taken for their preservation and fires would be much less widespread and frequent. A large number of the fires noticed this summer started where there was a desire to have the ground cleared for ranching or prospecting.

Fortunately, the timber in the Duncan valley has in large part been preserved and during the season several gangs of timber cruisers have been up locating berths.

Larix, Lyellii, the high altitude tamarac, were noticed in abundance on Lavina hill near and up to timber line.

Geology of the Western Part of the International Boundary (49th Parallel).

By Dr. R. A. Daly.

On May 1, I left Ottawa to continue the preparation of a detailed geologic map and structure section through the western Cordillera along the line of the 49th parallel of latitude. I returned to Ottawa on November 1. From June 27 to August 5, leave of absence having been granted, I gave a course of lectures on physical geography at the University of California. During May and June the survey of a belt five miles broad and forty-five miles long, between Midway and the Similkameen river, was completed. This belt lies north of the boundary and is limited on the south by the International line. The second part of the season was occupied with the similar survey of a belt sixty

Area covered.

eight miles long and about five miles wide, between the Kootenay river at Port hill, Idaho, and the eastern edge of Tobacco Plains.

The total length of the boundary belt examined this season is thus about one hundred and ten miles. There now remain two sections of the belt to be studied in order to complete the whole 425 linear miles of survey across the mountains. One of these sections lies between the Similkameen river and Chilliwack lake and measures some ninety miles in length; the other section, about fifty-five miles long, extends from Tobacco Plains to the eastern foot of the Rocky mountains proper.

My best thanks are due to Mr. W. F. King, Boundary Commissioner for Canada, for permission to use photographic copies of the manuscript topographic map of the belt between Midway and the Similkameen river. This map was made by Mr. W. F. O'Hara for the Commission. Special thanks are also due to the authorities at Washington who most kindly supplied me with photographic copies of the topographic maps of the boundary belt extending from Port Hill to the Great plains of Alberta, a distance of 110 miles. These excellent maps were constructed by Messrs Barnard, Reaburn, Hefty and Truax, United States officers of the International Commission.

Value of topographic maps in geological field-work.

This season is the first in which I have been supplied with topographic maps on a satisfactory scale and of sufficient accuracy for thorough geological mapping. The experience of the four years engaged in this boundary work emphasizes the futility of attempting to combine, in one field season, the topographic and geologic surveys of a mountainous region. The topographic map resulting from such a combination of forces may indeed be a permanent asset to the government and the people, but it is safe to say that on account of complexity of the average mountain range, the geologic map constructed along with its topographic base, is, from a *structural* point of view, necessarily very imperfect, if indeed it be not quite worthless. Such a geologic map cannot be considered a permanent asset. The same area must inevitably be studied again before its map can be placed among the standard geologic maps of a government survey. This conclusion does not apply to reconnaissance surveys which can never be used in the determination of detailed rock structures except in an incidental way. On the other hand, the structure and origin of the rock formations in any area form the very kernel of the truth which should be expressed in a standard geologic map issued by a government for the benefit of the people. My own experience in this agrees with that of every other Dominion geologist working in the mountains as well as with that of the many workers in the mountains of Europe, India and the United States. True economy teaches that topographic parties should precede the geologists in such regions. The geologist must have his topographic map in his hand if he is to attack with confidence the problems of rock structure, rock origin and ore genesis.

A special economy of time and money resulted this season from the fact that I possessed the topographic map of the boundary belt. Through August and September smoke so obscured the country that a topographic corps must have remained idle. Triangulation was quite impossible; other branches of the work must have been almost as completely restricted in a rugged region where one could see but a few hundred yards in any direction. Nevertheless, with the Commission topographic map at my disposal I was able to map geologically in detail nearly 300 square miles of the belt. Without the aid of that map, half of the field season would have been lost, though the expense of the pack train and assistance were as great as during the times of active field operations.

Work carried on west of Midway.

A rapid reconnaissance of the belt west of Midway was made in 1902, and a brief account of its geography and geology was given in the Summary Report of the Geological Survey Department for that year. The work this season consisted in developing the details of rock distribution and structure outlined in the former summary. It seems inadvisable to present those details here, in advance of the publication of the final report and map relating to the district. One important determination should, however, be mentioned. In the 1902 summary it was stated that a series of gneisses, mica schists and more granitic rocks seemed to form the oldest group of formations in the area. This year, with more time given to the study of contacts, it was definitely proved that the whole series belongs to a single great intrusion of acid, igneous magma. The mass varies in composition from true granite through granodiorite to a very acid quartz diorite. The whole forms a single batholith. It is exposed liberally on both sides of the wide valley occupied by Osoyoos lake. On the west side of the lake the rocks are still generally granitic in structure, but on the east side the granitic structure has been changed by orogenic pressure into gneissic and schistose structures. Zones of intense shearing in the granites are now occupied by wide bands of fine-grained gneisses and highly micaceous schists.

The field-work of the second part of the season continued, to the eastward, the section mapped in 1903. The camp was outfitted at Port Hill, Idaho, and disbanded at Gateway, Montana. The boundary belt examined crosses the whole of the Purcell mountain range, that division of the Selkirk system which lies between the great eastern valley of the south-flowing Kootenay river and the equally important western valley of the same river as it again crosses the 49th parallel this time flowing north from its big bend in the state of Montana.

Topography of the Purcell range.

The drainage of the belt is entirely tributary to the Kootenay. A small portion of the drainage is directly carried into that river at the extreme western end and extreme eastern end of the belt. Most of the creeks, however, empty into the Yahk and Moyie rivers, which themselves discharge into the Kootenay.

Since the valleys have all been deepened by erosion, the strength of the topography is dependent on the altitude of the Kootenay river above sea-level. At Port Hill the river is about 1,750 feet above sea; at Gateway, its surface is about 500 feet higher. The height of the highest mountain measured by the Commission topographers is 7,518 feet. The total range of vertical relief is, therefore, somewhat more than 5,700 feet. With the exception of the imposing four thousand-foot cliff facing Port Hill, the mountain slopes are relatively gentle; there is seldom an approach to the ruggedness of the Selkirks west of Port Hill. The slopes are those characteristic of mountains that have long suffered the attack of general erosion. They may be called the slopes of topographic maturity.

Occasionally through the season the smoke lifted sufficiently to permit of somewhat distant views. The impression thus gained was supplemented by a study of the Commission map of the belt. The result has been to strengthen a generalization which may be made regarding the greater part of the topography in the whole stretch along the International line from the Great Plains to the Pacific ocean. In the Coast range, in the Gold range and Selkirks proper, the mountain summits were very generally found to accord roughly in altitude; locally, they are nearly uniform in height. In the Purcell mountains the same rule holds fairly well, and Mr. Bailey Willis has emphasized the law as obtaining in the range of the Rocky mountain front. This accordance of summit levels has now come to be one of the principal criteria, if not the sole criterion, for ancient peneplains which, by several authors, are supposed to have once extended over vast areas of the western Cordillera of the United States and Canada. The summit level accordance in each region is, by this theory, supposed to be due to inheritance from the surface of a former great, almost perfected plain of denudation. The existing valleys are supposed to have been cut *in intaglio* beneath such a peneplain after it was warped up many thousands of feet above its earlier position near sea level. There are, however, alternative explanations of the phenomenon which involve quite different histories for these western ranges. The problem is not simply physiographic or geographic in its bearings. A decision as to the true explanation of this widespread phenomenon is of primary importance to the interpretation of Tertiary geology. Since leaving the field, I have attempted a critical analysis of the subject; a paper embodying the principal results will appear in a forthcoming number of the Journal of Geology.

Along the 49th parallel the Purcell range was almost completely buried beneath the ice of the Glacial period at the time of maximum extension. The upper limit of general glaciation was fixed at 7,300 feet above sea-level at summits occurring in the middle of the range. The Cordilleran ice-cap had a southerly average direction of flow in this part of the boundary belt as it had also throughout the 200-mile belt stretching from Port Hill westward to the Okanagan mountains. In the closing stages of the glacial period, the general mantle of ice was exchanged for the more limited covering of local cirque glaciers and large valley glaciers. Glaciation.

The largest of the valley glaciers were those filling the Kootenay valley at its eastern and western crossings of the boundary, the one glacier terminating in Montana, the other in Idaho. Heavy deposits of boulder clay and other material were laid down in the widely opened valleys at Port Hill and Tobacco Plains. Elsewhere in the belt, glacial deposits are thin, discontinuous and unimportant. A number of cirques were found among the mountains that showed altitudes greater than 6,500 feet. The highest mountains are locally benched by the head wall growth of these cirques, showing specially rapid glacial erosion about those summits. As generally observed in the western Cordillera, the attack of cirque glaciers is most manifest on the north-west, north, north-east, and east flanks of the mountains. In many cases a decided asymmetry characterizing summits may be traced to such differential erosion which is controlled by the varying exposure of slopes to the sun's rays.

The tree-line was found to average about 7,200 feet in altitude above sea. It is higher than at any point yet observed along the boundary, between Port Hill and the Pacific shore. Apparently owing to the unusually siliceous nature of the rocks underlying the belt, the soils are thin and relatively poor. Much of the timber is, therefore, not of high grade. Undergrowth is, however, more abundant than I have seen it on the boundary, except on the Pacific slope of the Coast range. So thick is the underbrush that pack-train travel is restricted to the trails. For the same reason, progress on foot is generally slow and arduous. Had it not been for the excellent trails cut by the topographic parties, it would, in fact, have been impossible to cover the whole belt in one season.

Bedrock geology.

The bedrock geology is, in some respects, simple, when compared to that of the long section from the Kootenay valley at Port Hill to the Similkameen river. To the west of that valley, sedimentary formations are, areally, less extensive than igneous formations; the structures are those due to magmatic intrusion, volcanic action and the intense crumpling, and metamorphism of usually re-crystallized sediments. From Port Hill eastward, the staple formations are well-bedded sediments, tilted generally to moderate angles of dip, never overturned, and relatively seldom disturbed by igneous intrusions.

These sediments include an extraordinary thickness of conformable quartzite and argillites, the former dominating. The whole group has, on lithologic and stratigraphic grounds, been divided into four series. The lowest series, the Creston quartzite, is composed of 9,500 feet of wonderfully homogeneous, highly indurated, thick-platy, gray sandstones. Overlying the Creston quartzite is the Kitchener quartzite, a second series of ancient, hard sandstones and interbedded argillites carrying a high proportion of disseminated iron oxides. These rusty rocks are, relatively, thin-bedded and bear very abundant sun-cracks and ripple-marks on horizons ranging from top to bottom of the series. The thickness of the Kitchener quartzite is about 7,400 feet. It is itself conformably overlain by at least 3,200 feet of thin-bedded, red and gray argillaceous strata which, together with subordinate thin beds of light gray quartzites, make up the formation I have called the Moyie argillite. The youngest member of the four sedimentary divisions is the Yahk quartzite, composed of white to gray indurated sandstones bedded in thin to medium courses. The top of this series was not seen; the whole thickness observed is 500 feet. The total observed thickness of conformable strata is nearly twenty thousand feet. Neither the bottom of the Creston quartzite nor the top of the Yahk quartzite appearing in the sections, it is certain that this great thickness is only a minimum thickness.

The westward extension of this sedimentary series was mapped and measured during 1903 in the boundary belt immediately west of the Kootenay at Port Hill. There the strata corresponding to the Creston quartzite are conglomerates, grits and coarse sandstones as well as fine-grained sandstones, and are thus, on the whole, notably coarser than they were found to be anywhere in this season's belt. The equivalent of the Kitchener quartzite is less strongly charged with argillaceous beds than is the Kitchener quartzite east of the Kootenay. These facts point to the conclusion that the shore-line, whence the materials composing the stratified formations were derived, lay to the westward and that the open sea and deeper water lay to the eastward of the western crossing of the Kootenay river at the International boundary.

This conclusion was strikingly confirmed on carrying the section towards Gateway. It was found that both the Creston quartzite and the Kitchener quartzite gradually became charged with interleaved beds of calcareous quartzite, calcareous argillite and siliceous limestone, betokening open-water conditions during the formation of these sediments. In fact, the transition of the great quartzite series to certain of the more calcareous formations of the Rocky mountains has become the best working clue to the correlation of the rocks of the Purcell range with those of the Rocky Mountain Front. If this conclusion be confirmed by the further eastward extension of the boundary section next year, it will mean that the Creston and Kitchener quartzites and, possibly, also the Moyie argillite and Yahk quartzites are of Pre-Cambrian age. The nearest relatives of the Creston and Kitchener quartzites in the Rockies are respectively the two thick members of the Altyn limestone delimited by Mr. Bailey Willis, who, in the year 1901, carried out a reconnaissance survey on the boundary belt on the Montana side.* No fossils have, as yet, been found in these old rocks of the Purcell range, but fossils of so-called Algonkian age were discovered in the Altyn limestone.

Igneous rock formations.

The only other formations found between Port Hill and Gateway are of igneous origin. One of them, locally developed in the upper part of the Kitchener quartzite, is a contemporaneous series of amygdaloidal lava-flows and volcanic tuffs aggregating 500 feet in thickness. These rocks are well exposed on the first high ridge west of Gateway, and again at the edge of the Kootenay river floodplain near the village. Eruptive material, occurring on a very much larger scale, is represented in a number of thick sills of gabbro intruded into the Kitchener quartzite and upper member of the Creston quartzite. These sills range from 100 to 2,500 feet in thickness. Some of them can be proved to hold their thicknesses very steadily over wide areas. Field evidence seems to show that the intrusions took place before the sediments were significantly disturbed from their original horizontal position.

Faults and folds.

The sedimentary formations with the lava and gabbro sills together made an exceptionally rigid mass of rock, which was capable of transmitting the thrust of Tertiary and earlier mountain-building forces, though the mass itself refused to yield to that force in the same manner as the weaker, now mashed and contorted formations west of the Purcell

* Bull. Geol. Soc. Amer., vol. xiii., 1902, p. 305.

range. The uplift of that range has led, rather, to normal faulting and subordinate overthrusting superimposed on a few broad, open folds. In the sixty miles between the two crossings of the Kootenay river, fourteen normal faults of large throw, three thrust faults, three faulted anticlines and three faulted synclines have been observed. Structurally, as well as lithologically, the Purcell range is thus a Cordilleran division transitional from the Selkirks proper to the front range of the Rockies as these ranges are developed on the 49th parallel.

In a number of cases the structure has had manifest control over the present topography of the range. Seven of the meridional valleys are clearly located on normal faults. The wide valley of the Kootenay at Port Hill, and apparently again at Tobacco Plains, has been opened out on zones of normal faulting, in each case the faultshaving meridional trend.

The Moyie Sill.

In the present summary report of field work it is premature and inappropriate to go into detail regarding either the general geology or the petrography of the formations on the belt, but one special phenomenon deserves mention as of possible importance in bearing on the general principles underlying the interpretation of the igneous rocks throughout the boundary section. The thickest of the great gabbro sills above mentioned is well exposed on an isolated mountain forming the residual of a monoclinal fault-block immediately west of the point where the Moyie river crosses the boundary. Owing to its importance both in volume and relations, this igneous body may be given the special name of the *Moyie Sill.* It has been thrust into the Kitchener quartzite on a horizon situated near the middle of that formation. The sill, closely following the bedding plane, and retaining its thickness of approximately 2,500 feet throughout, has been traced along the strike a distance of about five miles. The main mass of the intrusion is a hornblende gabbro, often containing accessory quartz interstitially developed. The heat of the magma has rifted off thousands of fragments of the quartzites. These fragments are seen to be in all stages of solution in the magma, which, on account of its exceptional volume, retained sufficient thermal energy to continue the shattering and digesting of the invaded sediments for, apparently, a long period. The composition of the magma has, therefore, been signally altered in the sense of having grown more siliceous than it was originally. The products of the digestion are, for the most part, segregated along the upper contact of the sill where, instead of gabbro, a 200-foot zone of light gray crystalline rock was found. Microscopic examination shows this zone to be composed of a highly acid biotite granite passing into granophyre with characteristic micrographic structure, and also, by rather sudden but definite transitions, into the underlying hornblende gabbro.

The potash of the granite is contained in the essential orthoclase, soda orthoclase and microperthite, as well as in abundant essential biotite. That oxide, along with other constituents of the essential minerals, was derived from the quartzites which are slightly feldspathic and occasionally argillaceous, and which also bear minute scales of mica in considerable amount. The specific gravity of the quartzite varies from 2.68 to 2.75; that of the normal gabbro from 3.00 to 3.03. It is highly probable that the fragments of quartzite sank some distance into the gabbro when the latter was molten and then less dense than the solid quartzite. The acid material derived from the dissolving, sinking fragments was, nevertheless, evidently less dense than the gabbro magma, and rose to the upper contact of the sill. In this way, by simple gravitátive differentiation, coupled with the assertion of those definite laws of molecular attraction which control the formation of biotite-granite in general, a new crystalline rock has been developed on this upper contact by the mechanical and solutional action of gabbro on somewhat feldspathic quartzites and subordinate interbedded argillites. As expected, acidification is seen at and near the lower contact, where abundant quartz is interstitially and poikilitically developed in the gabbro; yet there the effect is relatively so limited as hardly to change the usual dark colour of the gabbro. Exomorphic contact action seems to be as pronounced at the lower contact as at the upper. The absence of a zone of granite at the lower contact is believed to be due to the process of gravitative differentiation. The excess of silica actually found at the lower contact is attributed to the solution of the quartzite while the sill was in the viscous condition immediately preceding the crystallization of the whole mass.

A similar special acidification of the internal upper zones of contact was observed in several others of the sills in the belt. The considerably smaller volume of those sills naturally involved a much less striking acidification of the gabbro magma than that just described for the Moyie sill.

Secondary origin of granite.

These observations illustrate what is believed to be a case of the formation of granite by hypabyssal assimilation of siliceous sediments by a gabbroid magma. The phenomena in the Purcell range are markedly similar to those so fully described by Professor W. S. Bayley* and by Professor N. H. Winchell† at Pigeon point and many

* Bull. No. 109, U.S. Geol. Surv., 1893.

† Minnesota Geol. Surv. Reports.

other localities in the state of Minnesota. There is another suggestive parallel in the likewise ably discussed relations of gabbro and granophyre, in the Sudbury district, Ontario.‡ The extremely simple structure and relations in the case of the Moyie sill suggest the legitimate extension of this secondary theory of granite to the much more important case of truly abyssal assimilation of siliçeous and aluminous sediments and crystalline schists by basic gabbro magma, whereby granite and allied rocks may be conceived as secondarily produced on the scale of intrusive stocks or even great batholiths.*

The experience of the season clearly points to the conclusion that there is no hope of the discovery of important mineral deposits, except in the case of beds or veins of iron ore similar to the well-known deposits at Kitchener, on the Crow's Nest division of the Canadian Pacific Railway. It is possible that such ore may be found in the Kitchener quartzite, where it crops out in the boundary belt, but none on a commercial scale was discovered this season. Quartz veins are notably rare; with very few exceptions these occur only in the gabbro sills or along the contacts of the sills. The veins are always narrow, and show no promise of giving, in assay, any important content of the precious metals.

The thinness of the soil and the general absence of level ground are such as to discourage settlement for agricultural purposes, except in the Kootenay valley, at Port Hill, and at Tobacco Plains. Permanent farms are being cleared on the wide bench east of Port Hill. The extraordinary drought of the season caused an almost complete loss of crops to the farmers settled near Gateway, except in the rare cases of those who command running water for purposes of irrigation.

Natural History of the National Park.

By Professor John Macoun.

Introduction. At the date of my last summary report I was engaged on Part III of the Catalogue of Canadian Birds. With the help of Mr. J. M. Macoun, my assistant, the proof was read and the whole work, which extends to 733 pages and includes 650 species and varieties of birds, was completed by the beginning of June. The index, prepared by Miss Marie Stewart,

‡ Rep. Bureau of Mines, Ontario, 1903 and 1904, A. P. Coleman; Geol. Surv., Canada, Ann. Rep., vol. 14, Pt. H, 1904, A. E. Barlow.

* Compare R. A. Daly, The Mechanics of Igneous Intrusion, Amer. Jour. Science, vol. xv., 1903, p. 269, and vol. xvi., 1903, p. 107.

covers twenty three pages; by its aid, any bird in the Dominion, under whatever name it may appear in the Catalogue, can be easily found, and our knowledge of its distribution and breeding habits can be at once referred to. The amount of time and care entailed in the preparation of this work has been enormous, and, but for the constant help. I received from my assistant, it could not have been carried to a successful completion in so short a time.

Thirteen years ago the writer spent a summer at Banff, (Alta.) study ing the flora and fauna of the Rocky Mountain Park. The outcome of that season's work was the establishment of a museum at Banff. A collection of birds was mounted by the taxidermist of the Geological Survey, and one of plants was prepared: both these were placed in the museum which was established in 1892. Since then, the Park has been extended to the "Great Divide" on the border of British Columbia, and the Yoho Park on the British Columbia side of the "Divide" has also been placed under the jurisdiction of the Superintendent of the Rocky Mountain Park, so that at present the Park extends from Canmore, on the east, to some distance beyond Field, on the west, on both sides of the railway.

Owing to the increasing number of visitors, it became necessary to enlarge the museum, and last year a fine building was erected and well fitted up for museum purposes. Very little new material, however, has been added to the collections of the fauna and flora since the original consignment from this Department. Banff museum

On account of the enlargement of the Park and the necessity for additional knowledge of its productions and inhabitants, I was instructed to make a further exploration, chiefly of the western part about the "Great Divide," and this I proceeded to do last season. The additional specimens necessary to complete the botanical collection are now on hand and will be added to the original consignment next spring. It is intended to complete the Rocky Mountain birds and mammals and, besides, to place in the museum as large a collection as possible of the game-birds of the prairies, including waders of all kinds, ducks and other swimming birds. The larger hawks and owls will be so set up that visitors from all parts of the world can see what we have in the matter of sport to give them.

After finishing the proof-reading of the Bird Catalogue I started for the Rocky mountains on June 17 and, after spending two days at Calgary, went on to Banff, where I spent three days going over the collections there with Mr. N. B. Sanson, who has charge of the museum and who, I found, had added many fine specimens to the original collection. The plant collection was in excellent order, but the collection of birds needed the hand of a taxidermist. Mr. Douglas, the Superintendent, saw the necessity of having the birds cleaned and, in some cases, replaced by better specimens.

Laggan camp.

I then went on to Laggan and established myself in the camp of Mr. A. O. Wheeler, who, for the next three months, gave me a home with his men and helped me in every possible way. Very frequently, rare specimens, collected on the highest mountains, were brought down by the men, and enabled me to add to my own collections.

From June 26 to 29 I collected around Laggan, and on the morning of the 29th started up the Pipestone on foot, with Mr. Wheeler's pack train. The first day we went about eight miles and camped; the next day Mr. Wheeler and his men ascended a mountain while I botanized at the base. This was the usual procedure through the summer. The camp was moved every second or third day. By July 3rd we had reached the source of the Pipestone and camped in the last grove of trees. Around us were snow-clad mountains, and nearly all the ground, except the steeper slopes facing south, was still covered with the winter's snow. For the last few miles we passed through a veritable flower garden. The ground was covered with five species of spring flowers growing in the greatest profusion and just in their prime. In many places were white Globe flowers *(Trollius laxus)* covering acres of ground and often with over twenty blossoms springing from the same root. Near by, could be seen great patches of bright yellow which were made by the flowers of the Mountain Dog's Tooth Violet *(Erythronium giganteum)*. Scattered among these, or growing in masses by themselves, were the Spring Beauty *(Claytonia lanceolata)*, the Mountain Buttercup *(Ranunculus Eschscholtzii)* and the Mountain Anemone *(Anemone occidentalis)*. The above were the leading species, but a score of others could be enumerated. Our camp was pitched above the real spring and the flowers here were truly alpine, many of them not being spring flowers at all. Dead stalks of *Arnicas*, *Erigerons* and other composites were around, everywhere, but not a bud was seen. Occasionally on a sunny spot one would stumble on a patch of the Mountain Saxifrage *(Saxifraga oppositifolia)*, or the Moss Campion *(Silene acaulis)* or, high up amongst shingle, the first flowers of *Oxytropis podocarpa*. The *Drabas* showed a few flowers both yellow and white, the former being *Draba alpina* and the latter *Draba nivalis*.

Red Deer river.

On the 4th I climbed the eastern side of the valley and was able to look down on the source of the Red Deer river, which, at this time, was still encumbered with snow. Almost under my feet and 500 feet below reposed a small lake which still retained its icy covering. The silence of nature was unbroken by bird or beast, but, occasionally, water was heard to trickle, and by noon the southern slopes were alive with little rills. In the late afternoon, water could be seen, glancing in the sun as it descended from the heights; the creek below our camp sent up an ever-increasing sound as the volume of water rushing through it grew. The sun sank behind the mountains to the west; slowly silence settled on the scene and by morning all movement of water had ceased. Day by day throughout the summer, this melting, flowing, rushing and freezing, kept on, and even late in September was being repeated at higher elevations.

Pipestone valley.

Work was finished on the 5th and we descended over 1,000 feet into the Pipestone valley, which we now found to be a series of turbulent streams of milky-looking water. These soon became one stream, and a rushing river, difficult to ford, was the result. Large collections were made on the lower slopes. As we worked our way down stream we found that the spring was fast passing into summer; and by the time we reached Laggan on July 10, having been only twelve days absent, summer had usurped the place of early spring. The species scarcely in bud on June 29 were in seed July 10. Collecting was resumed for a few days on the mountain slopes around Laggan and in the Bow valley; on the 16th I changed my headquarters to Lake Louise. Laggan is 5,037 feet above the sea and Lake Louise is 638 feet higher; the mountains rise on both sides of it at least 4,000 feet above the lake. This makes the vicinity of the lake an ideal collecting ground, and as there are horse trails in all directions there is no difficulty in getting about.

Lake Louise.

Very extensive collections were made at Lake Louise and its vicinity. Lists were made of plants that ascended above 6,000 feet and a surprising uniformity was noticed in the occurrence of the same species on all the mountains at the same heights.

Ascents were made on "the Saddle" east of Mount Fairview, on "the Moraine" at the base of Mount Victoria, on Mount Niblock, the Beehive and Mount St. Piron. Many alpine species, not found to the east of Castle mountain, were collected, and common things at Banff were altogether absent. The flora of Lake Louise itself is quite different from that of the mountains around it, being below the 6,000 feet line, which seems to be the line where a marked change takes place in the vegetation. The forests between Laggan and Lake Louise have hitherto escaped fires, and to this fact much of the attractiveness of Lake Louise is attributable. Much of the spruce *(Picea Engelmanni)* is very fine and in many places attains a good size and has a tall straight trunk.

Cascade creek. After completing my work at Lake Louise I again joined Mr. Wheeler's camp which was now near Hector on the west side of the divide. I started work here on August 1, and remained in that vicinity until the 19th. Four days were spent at Lake O'Hara and Lake McArthur at the head of Cascade creek, which enters Lake Wapta at Hector. A good horse trail leads from Hector to Lake O'Hara, eight miles distant from the railway and about 7,000 feet above the sea. Between 500 and 1,000 feet higher up is Lake McArthur. This lake is above timber line and rather south of the divide leading into Otter-tail creek. Being above timber line it remains covered with ice until late in the season. On the date of my visit, August 10, there were six icebergs floating in it and as its waters were very transparent it was possible to see the bottom at a great depth. A large glacier enters the head of the lake and it was from this that the icebergs had broken off. On the south side, a glacier on Mount Schaeffer discharged quantities of ice which, falling from a great height, were very much broken up before reaching the lake. Its outlet is obscured by morainal debris but its discharge forms the source of Otter-tail creek on the north-east. McArthur's pass and the vicinity of the lake at this time might be called, with truth, an alpine flower-garden. About twenty species were growing in the greatest profusion. Yellow, red, blue and white were the prevailing colours and the leading flowers were Arnicas, Erigerons, Castillejas, Saxifragos and Asters. Indeed, these genera are the producers of the beautiful flowers spoken of by all mountain climbers during August, and are not represented on the higher summits nor in the spring gardens of late June and July.

Mount Schaeffer.

Hector. The vicinity of lake Wapta at Hector occupied me both before and after my visit to lake O'Hara, and excursions were made to Sherbrooke lake and other points in the vicinity. On August 13, I ascended Mount Paget and made a complete list of the species. As usual, the flowers on the summit were, without exception, the same as those at 8,000 feet on the east side of the divide.

On the 19th I walked from Hector to Field. Next day I walked out seven miles to Emerald lake, where the camp was pitched. The descent from Hector (Alt. 5,207 feet) to Field (Alt. 4,064 feet) completely changed the flora and now the woods seemed to be filled with plants left at Banff and others found at Glacier in the Selkirks. The road between Field and Emerald lake passes, for the greater part of the distance, through a young forest of spruce, Douglas fir, mountain balsam, fir and pine. All the trees are tall and beautiful to look upon and range from four to sixteen inches in diameter. Around Emerald lake the forest is old; many of the trees run to three feet in diameter and all are tall and mostly sound. Should a fire ever take place any where between Field and the Lake, all the beauty of the scenery would be destroyed and the Yoho Park, instead of being, as it is, the great attraction for tourists, would become an eye-sore to be shunned.

After being settled in camp on the shore of the lake, excursions were made in all directions and Mounts Burgess and Wapta were examined and their productions noted. On September 2, men and horses ascended the trail from Emerald lake to the summit of the Yoho pass. Eight days were spent in the Yoho valley; each day, ascents were made up to the glaciers, and the vegetation was noted As usual, the high altitudes produced the same species, and, the collecting season being over, I reluctantly returned to Emerald lake on the 11th, went down to Field and, next day, proceeded to Lake Louise to settle up my business; then on to Banff for a few days, and, gathering up my collections at Calgary, started for Ottawa, reaching there on the 29th.

Since my return from the field, I have been almost constantly occupied with increased correspondence and the naming of specimens from all parts of the country, and have found no time to arrange the material brought from the field. This will be determined during the winter.

During the year 932 letters have been written.

The Cascade and Costigan Coal Basins and their Continuation Northward.

By D. B. Dowling.

The field work for the past season consisted, mainly, of topographic surveying to extend the map of the National Park, north and south, on the line of the band of coal-bearing rocks of the Bow River valley.

I left Ottawa on the first of June to meet my assistants, Messrs G. S. Malloch and F. C. Bell in Winnipeg. We then proceeded to Morley, where the horses had been wintered and, having got together the camp outfit, commenced work in the country south of Canmore.

The field work of the previous season was devoted mainly to a study of the coal measures of the Bow valley and their continuation up the

Cascade river. This series has been called the Cascade coal basin, but as it extends both north and south of the part already mapped and beyond the limits of the topographic map made by the Interior Department, it seemed necessary to add to the latter, to illustrate the southern continuation as far as the Kananaskis river and northward as far as the basin extended or time permitted. The photographic method seemed the most expeditious and a photo-theodolite of the Bridges-Lee type was ordered. This not being delivered in time for the first part of the field work, a small transit was used and sketches were made instead of photographs.

Topography south of Canmore.

As the area to the south was not large, points were selected as stations from which convenient areas could be overlooked. These stations were connected, as best we could, with known points on the map. Stations on each side of the Rundle range, from Pigeon mountain westward to those south of the Spray lakes, were occupied.

Wind mountain, one of the highest in the district, was not ascended, a convenient point being found on its northwest slope. The highest point of this group lies four and three quarter miles almost directly south of Wind mountain and has an elevation of 10,200 feet.

The geologic features were noted on our sketches, so that the map could be coloured as far as the topography would allow. Several visits were made to the new coal mines now being developed at Bankhead, five miles east of Banff; the progress in the tunnels was watched with interest, it being expected that the strata might, in places, as at Canmore, be badly bent, faulted or crushed.

After finishing the work planned, south of Canmore, we moved to the Cascade river and made excursions to the east of this stream, to further outline the geologic features. A visit to Minnewanka lake was included, as well as a climb to the summits of the hills at the north end of the Cascade mountain, to observe the strata of the face of the Vermilion range and of the intervening valley. On August 1st the photo-theodolite arrived at Banff and we immediately posted north.

Photographic survey north of Panther R.

Two reference points on the topographic map, near its northern limit at Lat. 50° 30′, were used as the ends of a base, and a system of small triangles was carried northward to near the Red Deer river. A few points were also taken on each side of the valley of the Panther river east of the continuation of the Cascade basin. The Palliser range, which is a continuation of the mountains along the eastern side of the Cascade basin, is found to have another coal basin developed on its eastern flank, commencing south of the Panther river. This extends northward and crosses the Red Deer river, while, still farther to the east, past another mountain range, a triangular area of the same coal-bearing rocks occupies a position a few miles to the northward of the one noted above. The two streams, Panther and Red Deer, which here cut transversely across the mountain ranges, give sections of three coal bearing basins having their maximum width on the Panther river.

The most easterly of these basins was prospected several years ago; a seam of coal was discovered and the location applied for. This is locally known as the Costigan seam. A visit of five days to this locality was made by us and a part of the area was examined.

By using the pickets which still remained from a traverse of the stream by Mr. McLatchie, D.L.S., several stations were fixed on the surrounding hills and a series of photographs was taken. A small topographic map has since been constructed to accompany the notes bearing on our examination. This is appended to the present summary of our proceedings for the summer.

Forest fires.

Large fires in British Columbia, which did incalculable damage to the forest wealth of the country, started during the last week of July. After the first week of August, the smoke blotted out all view of distant hills for several days at a time and our work suffered accordingly. An occasional shift of wind to the north cleared the air but the prevailing wind was from the west.

After the first week of September we moved south, to continue the work across the Kananaskis river, but had only one day of fairly clear atmosphere and, finding no change, even after a snow storm, I determined to discontinue the work for the season. We reached Morley September 25 and returned to Ottawa. Since then, a great part of my time has been occupied in preparing maps and diagrams for this report.

GENERAL NOTES ON THE STRUCTURE OF THE CASCADE BASIN.

Cascade coal basin.

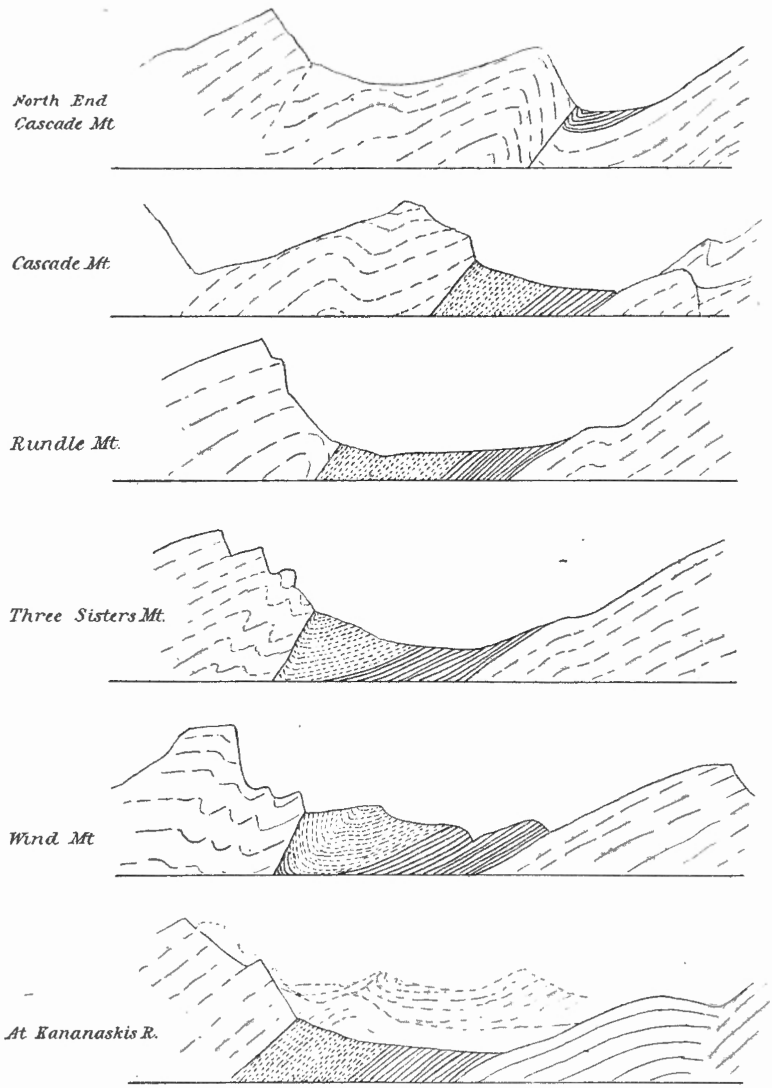
The valley of the Bow river, from the Gap to Anthracite, is eroded along the edges of Cretaceous sandstones and shales. These are dipping to the south-west and are terminated by a long line of fault, which runs about north-west and south-east. On the western side of this fault the limestone beds, which underly the Cretaceous, are thrust upward and now form the mountain ranges in which are situated Wind, Rundle and Cascade mountains. This break is continued south-east across the Kananaskis river. The various beds in the limestone ridge can be traced continuously, and, at the Kananaskis, the relative heights agree very well with those at Cascade mountain, but at the intervening points they are generally at higher elevations. The amount of displacement relative to the eastern side of the break also varies considerably. The total series at one time contained a great thickness of Cretaceous and Tertiary rocks, all softer, and therefore weathering and crushing more easily, than the basal limestone strata. The overthrust of the fault brought the limestone members up against the Cretaceous, in many cases displacing and breaking up the upper part of these softer rocks.

Along this break the limestone sometimes overrides part of the Cretaceous, and at others, abuts fairly against the edges. At the Kananaskis it has been forced over part of the series. Northward on the height-of-land between this river and the Bow, the base of the Cretaceous does not seem to have been overridden, but has sustained the great pressure and the beds, for a short distance, are bent up in trough form. In the limestone, also, the pressure has developed a series of flexures which run through the range in a north and south direction about parallel to those noted last year in the Cretaceous, north of the Three Sisters mountain, and seems to denote a pressure, not at right angles to the line of fault, but rather from the west. A

Pressure folds.

possible explanation, without a resort to secondary pressure, may be deduced from the fact that the fault continues, on a straight line, to the vicinity of Anthracite, and then diverges more to the north until it practically dies out. This point, then, the end of the fault, can be considered as a pivot for the lateral displacement of the beds. If the whole mass to the west is not influenced by this break, a part at least will be, and the direction of pressure and lateral displacement should be, in most cases, along lines at right angles to radii from the pivotal point. The folds, as above mentioned, roughly lie across this direction of pressure. Those in the Cretaceous beds from Anthracite south to the Three Sisters run, probably, more nearly parallel to the line of break, but also show, in some degree, the effect of pressure at an oblique angle to the general strike.

The different conditions of pressure along the break no doubt caused transverse faults, and some of these seem to be indicated at the gap behind Canmore in the Whiteman pass, and between Wind mountain and Three Sisters mountain.



SKETCH SECTIONS ACROSS CASCADE BASIN

A series of sketch sections are here added to show the effect of the thrust on the limestones when abutting against the Cretaceous, as well as the fold in the latter, and also the position of the two series in event of an overthrust. The sketches serve also to illustrate the shifting of the break from the line of one primary fold to another to the east.

Primary folds.

A primary series of folds, which were probably the first effects of the lateral pressure, mark out the general lines along which the breaks occurred. In some cases these folds were not continuous, but, where they end, there is an accompanying one running in the same general direction. In the case illustrated in the sections, a primary fold, along which the break occurred in the lower sections, dies out in the upper, while the break runs from the crown of this to the east, to follow the crown of the next. This deflection and the final end of the break gave rise, as before noted, to the oblique series of folds displayed in the sections at Wind and Three Sisters mountains.

Gap in range at Banff.

The great gap which appears in the range between Rundle and Cascade mountains seems to have been caused by several factors. One of these is no doubt due to the general line of weakness that follows the summit of the line of the primary fold. Then there are many reasons for supposing that there is a fault, or series of faults, running transversely across the general one. This would then leave a large triangular area at the bend of the fault ready, on account, of its broken nature, to be removed. The narrow valley, in which Lake Minnewanka lies, presents every indication of having been eroded along a line of fracture, and disturbance near this line is also seen in the drifts on seams Nos. 1 and 2 at Bankhead. Instead of the drifts following fairly straight lines, the entries are a series of reversed curves for about three hundred feet, after which they straighten out, and lights at the head of the workings, then 1,600 feet distant, could be seen.

Buckling in coal measure.

Other phenomena, resulting from the sliding of the rock in the mountain over the coal bearing beds, are clearly shown in workings on seam No. 3. This seam has apparently acted as a plane along which little resistance to lateral shearing would be presented. The stress has caused a block—that part above No. 3—to move bodily upward along the plane of the beds. Where the strata were firmly held down by the backing of limestone, the beds moved in a solid mass, but, in the beds not under the heavy load, a certain amount of relief was afforded by the sliding measures buckling back on themselves. This formed, along the sliding plane, a series of rolls which made pocketsin which the brecchia from the grin ding action was accumulated—in this case coal from No. 3 seam. In the preliminary work on the crest of the ridge, No. 3 was found with a width of 100 feet of broken coal; below it, as if in continuation, there was only five feet. At the mine below, where a cross-cut was made to the same seam, confirmation of this buckling was found. The tunnel evidently ran below one of these rolls as, after the seam was passed, the rocks of the roof gradually bent backward and, where the work was stopped, the rocks in the roof were nearly horizontal. The foot-wall of the seam was here smoothed, and showed the effect of the grinding. It was also crumpled, as if by the lateral pressure, in small narrow ridges. Another cross-cut to No. 3 proved the seam to be shattered, full of rock fragments and unsuitable to work.

On creek No. 6, some distance to the north, on these same measures, an example of the same kind of buckling is represented in a section on the side walls of the gorge. This caused an apparent expansion in the thickness of the measures in the unloaded portion, and the narrowing down might be looked for toward the foot of the mountain. This seems to have been found in the slope put down on the highest seam near the mine. This slope was started on the dip of the seam at about 45°, but the underlie soon increased and, on account of nearly vertical cross faults, turned downward. At a depth of 200 feet the general dip of the slope was nearly 80° instead of 45° as in the beds of the lower part of the series. This would seem to point to a compression of the beds, were it not already noted that an expansion of the unloaded part was accounted for.

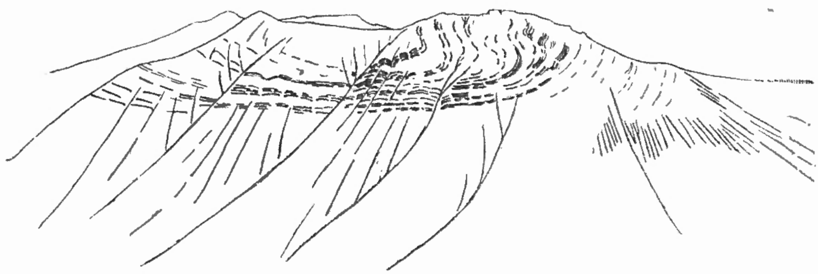
Highest seam.

The rocks of the northern continuation of the Cascade basin extend, practically, around the end of Cascade mountain, so that they occupy the valley between the Palisser and Vermilion ranges. For the most part, this broad area is made up of the rocks of the lower part of the Cretaceous; the sandstones, in which the coal seams are found, form the upper part, only, of the hills in the centre of the valley. North of the Panther river, this broad, shallow basin which is terminated, at each edge on the Panther river section, by an upturn of the beds, is gradually narrowed, and as the Red Deer river is approached, appears as a monocline dipping to the west, abutting or going under the rocks upheaved to form the Vermilion range. The coal bearing rocks, which in the shallow basin appear only on the summits of the hills, here again form a narrow strip along the west side, in very much the same manner as along the face of the Cascade mountain.

Northern part of field.

The division line between the two types of structure is marked by a heavy fold running from the fault line, at the height-of-land between the Red Deer and the Panther rivers, south-eastward to the centre of the valley near the Panther river, and is probably continued farther down the valley. Remnants of this or similar folds are seen on the hills to the south.

The sketch introduced here is outlined from a photograph of the south end of a hill just north of the Panther river. This is about midway between the ranges, but from this point the fold bears to the left, or in a W. N. W. direction.



Sketch of fold in the Cretaceous north of Panther river.

Palliser basin. Another Cretaceous area is found to the east of the Palliser range, and attains its broadest dimensions just south of the Panther river. It is roughly triangular in plan, with a broad base along the east side of the Palliser range, and its apex at the gap through which the south branch of the Panther river crosses the range lying to the east. In the section on the Panther, the underlying rocks which form the eastern range are seen to have several heavy rolls in their beds as they disappear beneath the Cretaceous. These are sharpened up in compressed folds in the Cretaceous above. Unfortunately, most of the coal bearing rocks are here again removed, and the tops of the hills show crushed seams; it is only near the western fault, where some of the beds appear to turn down, that there is any chance of finding workable coal. Several seams were located but we had no opportunity of proerly uncovering them.

The section published with the map of the Costigan coal basin is intended to show the relation of each of these areas to one another or the construction of the ranges. It extends from the Sawback range eastward to the first or outer range of the Rocky mountains, and includes three basins of Cretaceous rocks. To the west of the Sawback a fault has brought up against the highest of the Palæozoic, rocks comparable to the series in the Castle mountain, probably of Cambrian age. Eastward, then to the edge of the Cretaceous, there is a continuous series down to below the Intermediate series which is Devonian

The summit of the Vermilion range is of the Lower Banff limestone and, in the Palliser, the higher points vary between that and the Upper Banff limestone. In the two ranges to the east the Upper Banff forms the main summits.

NOTES ON THE MINES.

The mines at Canmore continue in active operation and the output is expected to increase materially as a new and additional entry is to be made on the Sedlock seam about a mile south-east of the town. This, as noted in last year's Summary, will probably be found to connect round by the south with the seams of the present mine. If this occurs it will give readier access to a large area, the distance of which from the main slope of the mine precludes payable underground haulage. Canmore mine.

As the railway takes the run of the mine, the temptation to be lax in picking up rock and other dirt, on the part of the miners, is very great, and some of the complaints from the engineers are no doubt due to too much dirt being shipped. The majority of the seams are of good quality of coal, but some are dirty, and unless great care is exercised, either by inspection or washing, the good character that this coal has hitherto had may suffer.

The mine at Anthracite has been gutted and the pillars taken out. The operating company having given up their lease, all the machinery has been removed to Canmore. All the available coal in the fold on the south edge of the property in which the mine is situated has been taken out to the boundary of the claim and no arrangements were effected for mining the adjacent land, so that now it will be difficult to reach the latter except by a new entry. The northern part of the property, as far as the Cascade river, still contains many seams, the continuations of those at the north side of the stream, on what is now the C.P.R. mine at Bankhead. Owing to the greater part of the valley to the east of the Cascade river being covered by a thick gravel terrace, prospecting will be difficult. For the present this area will have to be left unworked; the coal on the C.P.R property can be mined much more cheaply since most of the output will be from that part of the measures above the entry.

DEVELOPMENT WORK AT BANKHEAD.

The coal bearing measures lying along the north-east slope of Cascade mountain were prospected for the C.P.R. Company by Mr. J. C. Gwillim, formerly of this Survey. The cuts made by the small streams running from the face of the mountain were utilized for this purpose Bankhead mine.

and many small tunnels run in on the seams so found. For the larger workings, it was however more advantageous to attack the seams from the south end of the slope near the Cascade river where a spur line could be built from the main line. Two prominent seams near the ower part of the measures were traced southward and down the slope to a small plateau above the river. From this point two tunnels were driven on the strike of the seams. The spur from the railroad ends on a lower plane near the stream, some 250 feet below the tunnels. The larger seam was followed downward from the mouth of the tunnel by a slope to near the level of the spur track near the river and a tunnel was started to connect the bottom of the slope with the shipping point. As most of the material lying along the face of the hill is gravel, a great part of the total length, which is about 1,600 feet, will be under the gravel. The tunnel is, therefore, very heavily timbered and the progress in construction is necessarily slow. It has a width of twenty-two feet to accommodate two tracks and is nine feet high, so that it will be made the main entry to the mine.

The slope of the measures approximates 45°, a little steeper than the angle of repose for broken coal; the coal consequently will be filled in chutes running down to the lower level. The chute will be kept nearly full to minimise the impact of the falling coal and thus reduce crushing to a minimum. The mining will then be carried upward and little of the material need be rehandled till drawn out at the lower level. This, although requiring an extra outlay in the construction of the lower entry, will for many years reduce the cost of mining, the supply of coal being above the entry.

Cross entries are to be made to cut all the measures, but it is expected that from No. 1 seam to the highest known, a distance, on the level, of 2,600 feet, will be about the total width of the available measures. The two lower seams now being mined, are but a part of the available coal.

Amount of coal.

The supply which these two seams should furnish, if they maintain their thickness of from seven to nine feet each, can be estimated roughly by considering that, at a mile from the lower entry, the upper outcrop is at least 1,000 feet above and, at two miles, about 1,500 feet above the entry and this latter height is maintained for several miles. In the upper seam, the distance to the surface is generally greatly increased owing to the steep slope of the mountain side and on one of the creeks, four miles from the south entry, coal is found at an elevation of 2,300 feet. These upper seams will probably not be mined as far along their strike as the lower ones, on account of their gradual approach to the fault plane, and a fold, the centre of the original prim-

D. B. P. Photo.

MAIN ENTRY TO BANKHEAD MINE.

ary syncline which occupied the valley at its northern end. This fold seems to run southward and downward into the plane of the fault. This may really not be a part of the primary fold but simply a modification due to the overturning of part of the beds and the overriding of the rest. The effect of this on the outcrop of the coal seams in going north will be to bend them toward the mountain and the fault plane. As the beds are entirely eroded before reaching the first gap in the range, some six and a half miles northward from the entry of the mine, all the seams must eventually end at the fault and the lower ones will naturally be found to extend the farthest. If the seams on which the entries are made be continuous, the lower entry should run about five miles before reaching the fold, when the beds should bend in toward the mountain and mining operations will follow the long easy slope up to the outcrop at the far end.

A rough estimate may be made of the available coal in a length of five miles for the lower seam. The seam may average eight feet in thickness and have a depth of 1,200 feet above the entry or 1,700 feet along the slope. A rough approximation would give more than nine million tons or an output of nearly 500 tons daily for fifty years and, for the two seams, 1,000 tons daily for the same time. The market for semi-anthracite being at present restricted, the product of these two seams should last longer than this estimate. Estimate.

The observations made in the Souris coal field on comparisons of seams whose age of deposition varied slightly, appeared to point to a general tendency of the older beds to be higher in fixed carbon than those above. This is found to also apply to the seams at the Bankhead mine. Another factor to be considered as affecting the present condition of the coal in the seams is that the lower ones are enclosed in thick walls of sandstone and have been gradually giving off their gases through the porous sandstone, while the upper and middle seams are enclosed in thinner sandstones and shale beds and have, therefore, not lost the volatile elements so rapidly. In the seams at the mine the variations in the fixed carbon content are in a fairly regular order following the position of the seams. The lower ones contain from 84 to 85 per cent fixed carbon with from 9 to 16 per cent volatile matter, a semi-anthracite coal, while the upper ones are a coking or blacksmith coal having 78 per cent fixed carbon and 14 per cent volatile. The middle seams will probably be of about the same character as those at Canmore,—a steam coal, the quality which is required for the present style of engine used on the railway. Lower seams harder than upper.

The plant now being installed includes four large shops for storage, car building, blacksmith and machine shops. These are equipped with the latest type of machines. Steam for motive power will be supplied from a battery of boilers designed to use the smallest of the coal produced at the mine. The plant will also include two air compressors, one for drills and the other, of high pressure, for motors. The screening plant now in use and probably the most successful for this brittle coal, is a series of shaking screens which retain the larger sizes at first and eliminate much of the grinding action of the larger pieces against the smaller. Mechanical pickers are to be installed if any of the devices prove satisfactory.

About forty cottages were built during the summer, many of them of very neat appearance. Streets are graded, drains and water pipes laid and a water supply arranged for either domestic use or fire purposes.

THE COSTIGAN COAL BASIN.

Costigan coal basin.

This area is the first inside the first range of the Rocky mountains on the Panther river. It is roughly triangular in shape with a short base extending up the south branch of this stream. The two sides are longer and the apex is north of the Red Deer river. The western edge is along the fault line which brings up the second range, and the eastern edge follows the contact of the lower part of the Cretaceous on the upper part of the Banff shales which, in all this district, maintain practically the same character, namely, reddish shales and dolomites overlying the quartzite at the summit of the Devono-Carboniferous limestones. The Cretaceous here has not been denuded to such great extent as in the adjoining basins but forms an irregular plateau betwen the two limestone ranges.

The fault along the western edge is evidently of the nature of an overthrust, but traces of parts of an overturned fold still remain and tend to confirm the belief that these breaks were formed along the centre and crests of compressed folds. North of the river an example is seen in the face of the range, where, evidently, the upper beds bend down in front of the break through the lower members. The Cretaceous, against which these rocks now rest, show the effect of the west to east pressure and the beds are turned up to form a syncline.

Structure.

The third side or base of the triangular area is bounded by the same beds as on the east, but there is a line of fault through this range at the gap of the Panther river where there is a sharp deflection in the direction of the range. This break is continued westward into the Cretaceous, and then south-westward between the upper beds of the limestones and the Cretaceous. The beds of the latter have been thrust up on the limestones in the movements induced by the eastward pressure, and the contact is changed from a conformable one, along the east side, to a line of broken beds, chiefly coal-bearing sandstones. The shales of the base of the Cretaceous were the weakest members of the series and, therefore, did not withstand the crushing and shearing.

The general structure of the Cretaceous in the form of a syncline is maintained to the fault line at the south-eastern border, but the coal seams, which should here outcrop, are probably very much fractured or, in most part, cut off by the fault.

Most of the upper beds occupying the centres of this trough are sandstones, but a few of a coarser nature become in places a conglomerate. These, so far, do not appear to contain coal seams and, therefore, are for convenience outlined on the map in a light shade of green. Below this division the measures are practically barren for 1500 feet, after which a five foot seam is met, which is the one originally prospected as the Costigan seam. On the eastern outcrop this is practically the only one exposed, except perhaps another on the south branch, where the beds are very much disturbed.

Up the river, near the mountains, the Costigan seam reappears and is seen in the crest of a small anticline which runs across the river. It again outcrops about 650 feet further west and runs up toward the disturbed measures near the fault.

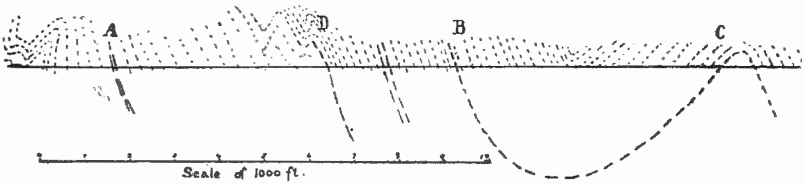
Beneath the seam, at this point, there is a series of seams that appear to be of fairly compact coal.

The appearance of the Costigan seam, where exposed at the eastern edge of the basin in Section 4, is poor. About eight feet will have to be mined to get a total of five feet of coal. The following is the measured section :—

Dip 25° W. 10° N.

Roof, soft friable sandstone, some of which will have to come off. Costigan seam.

ft.	in.	
3	7	sandstone and shale, containing two streaks of coal 3 in. and 5 in. respectively.
1	9	"coal", weathers to black powder.
	8	shale.
2	7½	coal.
8	7½	of which, say, five feet is marketable coal.



Section of measures on river near western boundary.

On the accompanying map, posts placed by Mr. McLatchie are indicated by letters A, B, &c. At C, a point on the west side of the anticline, near the western edge of the field, the Costigan seam dips 70° W. 15° S. The thickness here totals nearly five and a half feet, as indicated in the following section :

ft.	in.	
	5	coal.
1	4	shale and sandstone.
4	11	coal, including two small streaks of shale one and two inches thick.
6	8	

Section at western upturn.

The seam is repeated at *B*, with the addition of a few streaks of coal above it. As the seam is here dipping at a high angle to the east, the following section, measured from the east, will be in descending order, and is illustrated on the accompanying section from *C* to *D*.

Sandstones above Costigan seam :

	ft.	in.	
	1	6	coal.
	6	0	sandstone.
		8	coal.
	2	4	black shale.
	1	0	coal.
	4	0	shale and thin sandstones.
Post B	4	9	coal.
	145	0	shale and sandstone.
	4	0	coal, crushed to powder.
	15	0	sandstone.
	3	9	coal hard and not broken (between walls 5 ft. 4 in.)
	120	0	sandstone.
Post D	3	6	coal fairly hard but fractured.

From *D* to *A* there are several waves in the beds. At *A* there are two seams close together, very much crushed, but these are probably the thickest in the basin and may average six feet each. If the section above be repeated on the eastern outcrop, there is a chance that several of the seams can be mined there, and as the entry would be made near the river at an elevation of about 5,000 feet, the coal in the long strip of the plateau above this entry could be cheaply mined. Very little of the upturned seams at the west would be payable unless their quality justified deep mining. The area, then, that seems of promise is the elevated plateau north of the stream. The southern portion is probably crushed to a considerable extent.

An estimate of the probable amount of coal in the five-foot seam underlying a square mile of the above plateau would be over three million tons, but if all the seams exposed at the western upturn were present, a total of fifteen million tons might be counted on.

The character of the coal, as given in the analyses, indicates generally a steam coal. The samples received by this department some years ago are, owing to lack of surveys, not definitely indicated as to locality. The first analysis quoted below appears to be of coal from beneath the Costigan seam, and is probably indicated in the section from *C* to *D*, 145 feet below *B*. Analyses of coal.

*'Semi-anthracite from foot-hills. First branch of Panther or Little Red Deer river, to east of base of main Rocky mountain range, one mile above confluence with Panther or Little Red Deer river, District of Alberta, North-west Territory. Seam four feet thick and horizontal.'

Collected by Mr. W. B. M. Davidson.

'Structure lamellar, made up of irregularly alternating layers of a grayish-black, somewhat bright and dense, jet black coal of brilliant lustre-compact; brittle; fracture uneven; hard and firm; when suddenly heated decrepitates, but not very considerably.'

"Analysis by fast coking gave :—

Hygroscopic water	1.52
Volatile combustible matter	11.65
Fixed carbon	81.16
Ash	5.67
	100.00
Coke per cent	86.83

* Annual Report, vol vi (1892-93), p. 11 R.

"Ratio of volatile combustible matter to fixed carbon 1 : 6.97. It yields a non-coherent coke. The gases evolved during coking burnt with a yellowish, somewhat luminous, all but smokeless flame. The ash, which is almost pure white does not agglutinate at a bright red heat, but at a most intense red heat becomes fritted."

Dr. Hoffmann has kindly furnished the results of analyses made by Mr. F. G. Wait of coals collected from this locality during the past season. The results are as follows :—

Analysis of coal from the Costigan seam at its outcrop just above the forks of the Panther river. Thickness of seam 4′ 4½″.

Hygroscopic water	1.14
Volatile combustible matter	13.63
Fixed carbon	80.64
Ash	4 59
	100.00
Variety of coal semi-anthracite coke, pulverulent	85.23 per cent

Analysis of coal from outcrop, supposed to be of the same seam, at western edge of basin at post *B*. Thickness of seam 4′ 9″.

Hygroscopic water	0.69
Volatile combustible matter	15.75
Fixed carbon	77.15
Ash	6.41
	100·00
Variety of coal—anthracitic.	
Coke, firm, coherent	83.56 per cent

Analysis of coal from seam 3 ft. 9 in. thick and 164 feet below the seam at *B*.

Hygroscopic water	0.79
Volatile combustible matter	15.66
Fixed carbon	76.05
Ash	7.50
	100·00
Variety of coal—anthracitic.	
Coke feebly coherent	83.55 per cent

Analysis of coal from seam 3 ft. 6 in. thick, and 270 feet below that at *B*, but on north side of river at post *D*.

Hygroscopic water	0.61
Volatile combustible matter	16.49
Fixed carbon	79.56
Ash	3.34
	100.00

Variety of coal—anthracitic.

Coke, firm, coherent.. 82.90 per cent

The seam at A is probably already described in an analysis of specimens brought by Mr. W. B. M. Davidson. The thickness is given as eleven feet.

* Analysis by fast coking of a fair average sample of the foregoing material gave :—

Hygroscopic water	1.87
Volatile combustible matter	13.74
Fixed carbon	79.55
Ash	4.84
	100.00
Coke per cent	84.39

Ratio of volatile combustible matter to fixed carbon 1 : 5·79.

" It yields a firm coherent coke. The gases evolved during coking burnt with a yellow, luminous somewhat smoky flame. Colour of the ash, white, with a faint reddish tinge ; it does not agglutinate at a bright red heat but at a most intense red heat, it became fritted. "

These analyses show that all the seams furnish steam coal of good character and some of them a good coking coal. The two specimens from the eastern part of the field are rather unexpectedly found to have a higher percentage of fixed carbon than those at the west. This must indicate that their proximity to the south-eastern line of overthrust has been close enough to allow of a considerable alteration in the character of the coal, greater in degree than that induced in the bent up part along the western margin.

Northward along the eastern outcrop, away from the faulting, the coal measures have every appearance of little disturbance and they should there contain coal seams of more bituminous character. No specimens are at hand to prove this assertion but it should be borne in mind as a possibility.

* Annual Report, Vol. VI, p. 11 R.

THE GOVERNMENT EXPEDITION TO HUDSON BAY AND NORTHWARD BY THE S. S. 'NEPTUNE' 1903-04.

GEOLOGY AND NATURAL HISTORY.

By Commander A. P. Low, Officer in Charge of the Expedition.

Introduction. In the summer of 1903, Mr. A. P. Low, a member of this staff, was appointed to the command of the Government Expedition to Hudson Bay and Northward; at the same time he received instructions, from this Department, as to the work in connection with the geology and natural history of these far away and little known regions of the Dominion.

The primary object of the expedition being other than scientific, work in that direction was necessarily subordinated; the following report gives the results attained by the scientific staff of the expedition, working under considerable disadvantages as to time, and, owing to the nature of the field of exploration, as to climate and ice.

The Neptune chartered. An itinerary of the voyage of the *Neptune* is printed in the Annual Report of the Department of Marine and Fisheries; only a brief outline, therefore, of the course followed need be given here. The *Neptune*, the largest and most powerful of the Newfoundland sealing-fleet, was chartered for the use of the expedition and arrived in Halifax about the middle of July. The vessel was in the same condition in which she returned from the spring sealing voyage, so that a considerable amount of repair and alteration was necessary to equip her for the winter quarters of a large crew. Provisions and outfit sufficient for two years having been purchased, the ship sailed from Halifax on August 23.

The coast of Labrador was duly reached by passing through the strait of Belle Isle. On the way north, stoppages were made at Dominoe, Nachvak and Port Burwell, where the Archæan rocks were noted in some detail.

Hudson strait. From Port Burwell the voyage was continued across the mouth of Hudson strait. Coasting along the bold shores of Resolution island, a good idea of its geology was obtained, the rocks being all Archæan and crystalline, in which light-coloured granites appeared to prevail. Heavy fogs prevented a further examination of the shores, until the southern side of Cumberland gulf was reached. This shore is very bold and rugged, rising in cliffs from 500 to 1,500 feet above the sea, while, inland, the general elevation of the country probably exceeds 2,500 feet. The coast is deeply indented with deep fiords, and a wide fringe of rocky islands increases the number of channels, so that it is possible to pass, with small boats, from the mouth to the head of the gulf, without touching the open sea. The rocks were examined in a bay about twenty miles east of Blacklead island, where pink medium-grained granite was found interbanded with gray mica and mica hornblende gneisses, evidently cut and altered by the associated granite. At Blacklead island, the gneisses prevailed over the granite-gneiss, which was much coarser in texture. In places, the dark mica-gneiss contained flakes of graphite; hence the name of the island. To the westward of this island, prospecting has been done on some deposits of mica and pyrite but, under the difficult climatic conditions, these proved unprofitable.

Kikkerton islands.

At the Kikkerton islands, on the north side of the gulf, the geology is complicated by the presence of large bands or masses of gabbro, and its schists, formed by pressure; no valuable minerals have as yet been discovered in these bands.

Returning south from Cumberland gulf, landings were made at Cape Haven, the northern point of Cyrus Field bay, and at Frenchman cove at the head of the bay. At the former place the rocks are largely granitic, with some bands of darker micaceous and hornblendic gneisses and schists. One of these bands, on the island forming the harbour, contains many fine cube crystals of pyrite. At Frenchman cove, the rocks are wholly granitic, but there are, in the neighbourhood, other rocks, from which the natives have obtained large lumps of pyrite, and also, perhaps, from their descriptions, some copper-pyrites. The rocks of this eastern portion of Baffin island, appear to carry a considerable amount of mineral, as well as mica and graphite, and will probably repay closer investigation. In visiting this region, after leaving the rounded, strongly-glaciated hills of the Labrador coast, one is struck by the more uneven outline of the hills, and their peak-like summits. Glacial striae are very difficult to detect, and, although there is good evidence that the country was covered during the glacial period, it was probably by a lesser thickness than were the more southern regions of Labrador, and the eroding action of the ice was not nearly so intense as in Labrador.

Crystalline rocks.

The crystalline rocks form the islands separating Frobisher from Cyrus Field bay. Franklin and Montmental islands are about twenty miles apart and lie off the mouth of Cyrus Field bay; they appear to be formed of crystalline rocks and are probably the summits of a long submerged ridge marked by a line of icebergs, which extends from a distance of ten miles beyond the northern island to a like distance south of the other island.

Grinnel glacier.

Returning to Hudson strait, the course was laid westward along its northern shore. This coast is indented by a number of deep bays, where, when the coast is surveyed, good harbours will probably be located. The country rises rapidly inland, so that its summit is upwards of 2,000 feet above sea-level. The surface of the great Grinnel glacier may be seen from the southern waters, extending westward for forty miles and lying just beyond the southern watershed. This glacier is not very active and discharges only a few small icebergs into one of the numerous fiords of the southern shore of Frobisher bay.

The Saddle-back islands were passed so closely that their Archæan character could be observed and we were able to count at least twice the number of islands at present laid down on the chart.

The next stop was made at the western end of Charles island, where the rocks were largely a pink granite-gneiss, associated with bands of light and dark gray, mica-gneiss. An interesting fact in relation to the glaciation is that the striae on the island show that the glacier moved from west to east; this confirms the observations made by Dr. Bell, on other islands of Hudson strait, that the ice poured down from the lands on both side of the strait and then flowed eastward in a great stream to the Atlantic.

Several hundred walrus were seen swimming about or resting on a small island near the north end of the island and a stop of a day was made to hunt these animals, to procure food for the dogs during the coming winter. After a great deal of exciting sport, in the small steam launch, seven of these great animals were captured by first harpooning them and then killing them with rifles Owing to the difficulty in securing them at least twice that number, mortally wounded, were lost.

Erik cove.

From Charles island the *Neptune* proceeded direct to Erik cove, which is situated immediately east of Cape Wolstenholme at the western end of Hudson strait. A stop was here made to fill the water tanks; while this was being done, the hunters killed two white bears, one of which was found asleep in a deep hole it had scooped out of a large snow bank. Erik cove was the starting point of the Geological Survey Exploration of the east coast of Hudson bay in 1898-9, when the geology of the vicinity was fully investigated. A further examination, to the eastward, failed to produce any new facts on the present voyage, the rocks being chiefly rusty, fine-grained, dark mica-schist and gneiss, holding considerable amounts of disseminated pyrite and graphite. These rocks are cut and twisted by a later pink and red granite-gneiss.

From this cove the ship headed northward, across the mouth of Fox channel to the eastern coast of Bell island, or rather of Southampton island, as the supposed Bell island is a portion of the greater island. A landing was made at Seahorse point, where a junction occurs between the older crystalline rocks and the newer, overlying Silurian limestone. This junction is strongly marked on the physical character of the island; the northern portion, underlain by the old crystalline rocks, has all the characteristic features of more southern areas of similar rocks. Low, rounded hills, with a more or less flowing outline, rise in low cliffs from the sea, and the adjoining waters are fairly deep. The country is, of course, barren, nothing but small arctic shrubs being found in the damp hollows or surrounding the myriads of small lakes and ponds which dot the surface. The predominant rock is a granite-gneiss of coarse texture, and varying in colour from a dark to a light red, with a peculiar pearly lustre due to its feldspar. Broken bands of diabase and its alteration product, dark chloritic schists, are contained as bands in the red gneiss. Southampton island.

To the southward, the country of the limestone is very flat, with low shores rising inland in broad, shingle covered terraces, each a few feet higher than the one below. Seaward, the water deepens very slowly and reefs of limestone break the even bottom, so that it is dangerous to approach within three or four miles of the low, monotonous shores. The limestone shingle covers the terraces to a depth of several feet, making the drainage perfect, and rendering the surface so dry that even the hardy arctic plants cannot grow. The result is a very desolate plain rising slowly inland, with everywhere the unrelieved dirty yellow colour of the broken limestone. No fossils were found on this side of the island.

A large quantity of loose ice, in large, heavy cakes, had been passed through on the trip northward, from the neighbourhood of Leyson point, at the entrance to Evans strait. This ice became more plentiful to the northward of Seahorse point, and the attempt to pass through the supposed channel between Bell and Southampton islands was abandoned owing to the loss of time entailed by passage through the ice so late in the season. Loose ice.

While passing through the ice, hundreds of walrus were seen floating about on the smaller cakes, and two of these were added to the supply of dog meat. Turning southward Leyson point was rounded and, the ship heading westward, passed through Evans and Fisher straits, which separate Southampton from Coats island. The low shores of the former were followed to the vicinity of Walrus island, a small knob of crystalline rocks rising through the limestone near the middle of the strait, and not two fairly large islands as marked on the chart.

Winchester inlet.

Land was not again seen until Winchester inlet, in the north-west corner of Hudson bay, was reached. The mainland of the western portion of the bay, from Chesterfield inlet northward to Wager inlet, bears throughout the same physical character. Archæan rocks are universal, and the character of the country corresponds to the low-lying areas of those rocks in more southern regions. Long low hills, rounded and striated by the glacier, lie in broken parallel ridges, with wide shallow valleys between. These valleys are everywhere filled with lakes and ponds, or with swampy ground where hardy shrubs, grasses, mosses and lichens grow fairly luxuriantly and afford good pasture for the large bands of barren-ground caribou that roam about the region. In former times this pasturage supplied food to similar herds of musk-ox that have now disappeared, having been too closely hunted by the natives, so that they have either been exterminated or driven to the more inaccessible country to the westward of the head of Wager inlet.

Description of the shores.

The shores are comparatively low, with no elevations of more than a hundred feet, and the country inland does not rise, on an average, ten feet to the mile. Rocky islands and shoals, in most places, form a wide fringe along the low shores, so that the danger zone for ships extends for five to ten miles from the mainland, often, indeed, to beyond the sight of land.

A band of Eskimos, found at Winchester inlet, gave the information that the American whaling schooner *Era* was already in winter quarters at Cape Fullerton, and that a supply of meat and deerskins for the necessary winter clothing of our crew could be obtained only from the natives of Chesterfield inlet. In consequence of this information the *Neptune* was sent to Fullerton, while the launch started on a trip up Chesterfield inlet, a rather risky undertaking so late in the season.

Eskimo encampments.

Owing to the hurried nature of this trip, little geological work was accomplished beyond confirming the observations of J. B. Tyrrell, who had in 1893 examined the shores of the inlet. Two Eskimo encampments were visited; the lower one was about sixty miles up the inlet, where some half a dozen tents, made of deerskins, were pitched on a barren plain at the head of a large bay on the north shore. The second encampment, of four tents, was situated on the banks of the south channel of Bowell island, near the entrance to Baker lake and ninety miles from the mouth of the inlet. There are large areas of dark green schists and eruptive rocks along this channel, which, owing to lack of time, could not be examined for economic minerals. Smaller areas of similar rocks were seen on the banks lower down the inlet, but the prevailing rock everywhere is a light-coloured granite gneiss.

The large islands and the shores of the mainland about the mouth of the inlet are low and rocky, the rounded hills seldom having an elevation of one hundred feet. The land rises slowly as the inlet is ascended, so that, twenty miles up, the surrounding country has a general elevation of 200 feet, while about Bowell island it may rise 100 feet higher. Dangerous shoals extend far out into the bay from the northern side of the entrance to the inlet. In rounding these shoals with the launch, the low shores of the mainland were lost sight of in the wide detour necessary to pass them. Upwards of 200 skins were purchased from the camps, payment being made in knives, needles, ammunition and tobacco. A large amount of fresh meat was also secured. The caribou were on their way south to the edge of the wooded country, and were killed at their favourite crossing places along the inlet by the natives, who speared them from their kyaks. At the upper encampment the evidence of a great slaughter existed in the large heaps of horns piled around the tents.

Caribou.

On the return trip down the inlet the launch was unfortunately wrecked at Dangerous point, thirty miles above the mouth. The crew were in a dangerous predicament, without fuel or winter clothing, and with only a twelve foot dingy to cover the hundred and fifty miles separating them from the *Neptune*. The ponds were frozen over and the ground covered with snow, so that the greatest dispatch was necessary in order to obtain relief from the ship before winter set in. The Eskimo pilot, the interpreter and a sailor were immediately sent in the dingy to the ship, while the remaining four of the crew made themselves as comfortable as possible with the sails and covers of the launch. Considering the season and weather the dingy made a remarkably quick trip, and on the sixth day after their departure those remaining behind were gladdened by the sight of the *Neptune* steaming up the inlet to their rescue. Bad weather delayed the attempts to raise the launch, and it was a week before it was hoisted on board, so badly damaged as to keep the carpenter busy all winter on repairs.

Wreck of the launch.

While awaiting the arrival of help, the party at Dangerous point made excursions inland, in various directions covered by a radius of ten miles. The country was found to consist of ridges of low hills, with many small lakes in the intervening valleys. The rocks throughout were light and dark red granite-gneisses, without any trace of enclosed areas of other gneiss or schist. Signs of the barren-ground caribou were plentiful, but no sight of the animal itself was obtained. Several Arctic hares were killed in their beautiful white winter coats, and ptarmigan, in large flocks, were continuously crossing the inlet on their way south. Several unsuccessful attempts were made to catch fish through the ice of the lakes.

Return to Fullerton.

No trouble occurred on the return trip from the inlet to Fullerton harbour, which was reached on October 11. Preparations for the winter were immediately undertaken. These included the cutting of a large supply of ice from a freshwater pond on a neighbouring island; the ice was already nearly a foot thick in the pond. The decks were closed in with a rough boarding, and the cracks covered with tar-paper; later, when the ice about the ship was sufficiently thick, a wall of snow, about three feet thick, was carried to the top of the housing and made to completely enclose the ship, keeping out much of the cold and preventing all draughts. The *Era*, similarly prepared for the winter, lay within a hundred yards of the *Neptune*.

Zoology.

While the ice-cutting was in progress, Professor Halkett, who had charge of the zoological work, made large and interesting collections of invertebrates from the waters of the pond. During the winter months, he prepared, for museum purposes, a number of skins and skeletons of the animals killed in the vicinity of the ship. The short days and cold, blustery weather of the winter months prevented all other scientific work, out of doors; work was confined, therefore, to the taking, at intervals of four hours, complete weather observations, which will prove very valuable for comparison with those of the Northwest Territories.

Eskimos.

About one hundred and fifty Eskimos, belonging to two distinct tribes, lived, throughout the winter, in snowhouses built on the ice near the ships. With the assistance of Captain Comer of the *Era*, a considerable amount of information was gathered concerning the numbers, habits, manners, customs and religion of the tribes inhabiting the north-western shores of Hudson bay; while Dr. Borden took many body measurements and studied the diseases of these people. The information thus obtained, supplemented by that derived from other natives of the north, forms the basis of the lengthy article on the Eskimos to be published in the forthcoming report of the Expedition.

Survey.

The spring work was commenced on April 6, when Mr. King started to survey the harbour and its environments, and continued at that work until the ice broke up in July. The survey embraced a great number of soundings of the waters of the harbour and the approach from seaward. These soundings were made through ice averaging six feet in thickness.

Mr Caldwells's work

Mr. Caldwell left the ship on the 11th. with instructions to survey the coast northward to Wager inlet, the shores of which were to be examined thoroughly; after which, if the season and other considerations permitted, he was to continue northward along the coast to Repulse bay making as thorough an examination of the rocks as circumstances would allow. He was accompanied by two natives and his outfit was drawn on a sled by a team of eight dogs. Mr. Caldwell returned to the ship on May 30, having, in the interval, explored the coast to the head of Wager inlet; bad weather and a scarcity of dog food had so greatly delayed him that he found it impossible to continue the exploration to Repulse bay.

Mr. Caldwell reported the country as being very low and flat to within a few miles south of the mouth of Wager inlet, with the characteristics common to all Archæan regions. The coast was left a few miles south of the inlet and a pass between the low hills, followed north-westward, ended on the southern shores of the inlet some miles above its mouth. The strong tides at the mouth of the inlet prevent it from freezing over and, as the rocky hills there rise directly from the water, it is impossible in winter to pass with sleds along the coast. The open water extended more than fifteen miles up the inlet, which, elsewhere, was completely frozen over. The land on the north side is considerably higher than that to the southward and has an average elevation of upwards of 500 feet. As the inlet is ascended, the country becomes higher and rougher so that, at its head, many of the rounded hills rise over a thousand feet, while inland they soon merge into the high mountainous country known to lie between Wager inlet and Repulse bay. No difficulty was experienced in procuring an ample supply of deer and seal meat to feed the men and dogs of the party.

Cape Fullerton

Owing to circumstances in connection with the command of the expedition, Mr. Low was unable to leave the ship until May 3, and then only for a short period. Accompanied by two natives with a dog-team, he made a track survey and a geological examination of the coast between Cape Fullerton and the mouth of Chesterfield inlet, connecting the work of Mr. Caldwell with that of Mr. Tyrrell, so that there is now a continuous line of exploration along the west shore of Hudson bay, from York factory to the head of Wager inlet. On the return journey a trip was made inland from Winchester inlet, to obtain some knowledge of the rocks and country in this part of the interior. The general description of the coast previously given applies to this portion and need not be repeated. From Cape Fullerton, for twenty miles to the westward, the rocks are chiefly fine-grained, dark-coloured, mica and mica-hornblende schists and gneisses, with occasional bands of dark, chloritic schists holding considerable disseminated pyrite, never seen however in quantities sufficient to be profitably mined. On the eastern side of this area these rocks are much contorted by intrusions of pink granite-gneiss. A few miles west of Fullerton they are very regular in strike and have all the appearances of highly altered bedded rocks, at one time probably largely clay-slates with interbanded traps. Within ten miles of the mouth of Winchester inlet this series of rocks is cut off by a great mass of granite-gneiss which occupies the coast to the mouth of Chesterfield inlet and which extends inland beyond the limits of the exploration.

The western coast of Hudson bay has been deeply glaciated; several series of glacial striae marking the rock surfaces show that the centre of glaciation was at first to the westward, so that finally, the direction of ice-flow was nearly north and south.

Southampton island.

Mr. Low returned from this trip on May 13. Arrangements had been made (during the winter) with Captain Comer for the use of two of his whaleboats fully equipped, in which to accompany him to Southampton island, in the early summer. This exploration was made in the latter part of June; Mr. Low, accompanied by Dr. Borden, left the ship on the 15th with a crew of two sailors and six natives, in company with the four boats of the *Era*. The weather was still wintry, with heavy frost every night, while the wide margin of shore ice still remained quite firm and the surface of Roes Welcome was covered with large masses of floating ice. The boats were provided with cotton covers which completely enclosed them and afforded very comfortable sleeping quarters, small oil stoves being used for cooking. A narrow lane of water, between the shore ice and the moving pack, was followed northward to Whale point, where a delay of two days occurred owing to the state of the ice in the Welcome. Observations were taken for latitude and longitude and the rocks in the neighbourhood were carefully examined. About Whale point, series of old, much altered

Whale point.

bedded schists and gneisses are cut by two series of basic eruptives; later, all these were intruded by granite, and finally all were cut by dikes of diabase. Although the conditions on the sea were still wintry, Spring had arrived on the land, where the snow was rapidly melting and the birds were busy nesting; several nests of eggs were found, those of the snowbunting being most common. The crossing from Whale point to Southampton occupied two days and included some exciting times when the change of tide brought the great floes of ice rapidly together and the boats had to be quickly hauled out to escape being crushed. One night was passed on a floating cake in mid-channel, where everybody slept as calmly and securely as on land. The low shores of Southampton were reached some twenty miles to the northward of Whale point and were then followed southward to Cape Kendall. At this point the boats of the *Era* left us to continue to the southern end of the island, while the others turned northward, making a number of landings, and finally reached a point about fifteen miles north of the original landing. From there the Welcome was recrossed, when heavy ice forced the boats again to the northward, so that the mainland was reached a few miles south of the mouth of Wager inlet. This coast was safely followed southward until the *Neptune* was rejoined on July 2.

That part of the Southampton shore examined was very low, with shoal extending several miles from the land. The land rose slowly inland in a series of low ridges of broken limestone separated by wide flats, which were partly covered with ponds and lakes, while the remainder of the surface was swampy and supported a fair growth of grasses and Arctic plants. These flats were the breeding grounds of many species of birds, including the whistling-swan, snow-goose, Hutchins-goose, king eider-duck, long-tailed-duck, blue-crane, golden-plover, red and red-breasted phalaropes, Sabine gull and the Arctic tern. Unfortunately, at the time of the visit, the birds had only commenced nesting, so that eggs of several of the species were not taken, although specimens of the birds in full breeding plumage were obtained. A wide margin of solid ice, varying in width from two five miles, continually intervened between the water and the land. The exploring party were forced to live in the boats at the edge of the solid ice and every trip to the land had to be made over these distances of ice which, now covered with several inches of water and slush, rendered the undertaking both wet and very fatiguing. On the land, the ridges were bare, but much of the intervening country was covered with deep snow, so soft that in wading through it, the party sank to the waist. In consequence of these conditions, under which travelling into the interior became impossible, work was confined to the shore, and to five miles inland. A large collection of fossils was made at the different stopping places but the season was too early for plants. Birds.

Towards the middle of July the daily change in the condition of the ice about the ship was marvellous, and on the 18th, the *Neptune* was able to break her way out of the harbour, after being ice-bound for nine months. Loose ice was encountered for a few miles beyond the Summer change.

harbour, and then, with a jump from winter to summer, appeared the open sea and beautiful soft skies. The Southampton coast was followed, in order to confirm the statement of Captain Comer that it extended only to latitude 63 N. No ice was met with in the western part of Fisher strait, but after passing Walrus island, heavy fields on the north side gradually forced the ship towards Coats island, where, after crossing a wide bay studded with low islands, she passed within two miles of the high land forming Cape Préfontaine, the north-east point of the island. The point is about 400 feet high, and is formed of the crystalline rocks, which run south-west in a ridge across the island, the ridge being from five to ten miles wide, and contrasting strongly with the low limestone country on both sides of it. Heavy fields of ice were met with at the entrance to Evans strait, but, there being considerable open water between them, the ship was able to force a passage through by keeping to the southward. Along the shores of the island of Mansfield open water was found and followed to its northern end. The crossing from Mansfield to Digges was made through open leads with much heavy ice to the southward. Close heavy ice stopped all progress off Digges islands, and the ship remained tightly enclosed in the pack for two days, during which time the westerly current on the south side of Hudson strait drifted her about thirty miles to the eastward, past Erik cove.

Charles island.

A narrow lane of open water close to the mainland was then followed eastward as far as a point opposite the eastern end of Charles island, when the ice again closed about the ship and drifted her to opposite the mouth of Douglas harbour, where open water was found and an uninterrupted voyage made to Port Burwell, which was reached on the 25th.

Disco island.

A week was spent there taking on board the cargo of coals and supplies from the relief ship *Erik;* then the *Neptune* was headed northward for the cruise through the Arctic islands. Heavy fogs prevailed for a few days and, when they lifted, the bold shores of the great island of Disco, lying off the coast of Greenland, were seen about twenty-five miles distant. Keeping well away from the coast the ship continued northward to the Duck islands and was then headed north-west to cross Melville bay to Cape York. This dreaded crossing was made in twenty hours and no ice was encountered.

Cape York.

At Cape York the ship, for the first time, came sufficiently near to the shores to allow of geological observations. The rocks forming the high cliffs from Cape York to Saunders island appeared to be all of Archæan age; granite-gneisses prevailed, and were associated, especially in the southern parts, with large masses of dark, basic rocks. Stress of weather forced the ship to anchor in Parker-Snow bay, where a landing was made to examine the rocks and glaciers about the bay. The rocks were largely a medium-grained, pink granite-gneiss cut by many quartzose dikes of pegmatite.

Saunders island

At Saunders island, there is a change in the rocks forming the large islands and shores of the mainland. The Archæan crystalline gneisses and schists give place to nearly horizontal beds of light pink and buff sandstones, associated with what appeared from the distance to be thick beds of dolomite. Sills and dikes of dark-coloured trap cut these bedded rocks, and there is, throughout, evidence of more or less movement and faulting.

Geology.

This series of rocks has, owing to its sandstones and associated traps, been classed with the Tertiary rocks of Disco, though no search for fossils has been made, nor has it been accorded a close examination. The rocks occupy the coast northward to the vicinity of Etah, a few miles north of Cape Alexander, at the narrows of Smith sound, where they are again replaced by Archæan gneisses. At this northern contact there is undoubted evidence that the bedded series, greatly disturbed by the intrusion of the granite, has been thrown in several places into a nearly vertical position. Close to the contact, the rocks have been changed to either quartzite or crystalline limestone much lighter in colour than any of the beds away from the contact. Everything points to the alteration and disturbance of these bedded rocks by the intrusion of newer granite. Now, this rock must be late Tertiary in age if the bedded rocks belong to that formation, and it has all the appearance of the Archæan granite of Labrador. The bedded sandstones and their associated traps bear a close resemblance to the ancient Animikie rocks of the east side of Hudson bay, where similar contacts with the Archæan granites have been noted, and they are probably of this age.

A smaller area of these bedded rocks occurs on the west side of Smith sound, where it occupies the coast of Ellesmere island, from Cape Isabella for about fifteen miles to the southward, and has a similar northern contact with the Archæan rocks. Lack of time prevented a close examination of these measures on the Greenland coast, while, owing to the heavy ice, they could not be approached along the west side of the sound.

Smith sound.

During the night of the 10th of August, Smith sound was crossed from Littleton islands to Cape Sabine. The heavy arctic ice from the northern part of the sound was only then beginning to pass southward, and the crossing was made between great sheets of ice, some of them miles in extent, and upwards of forty feet in thickness. A landing was effected at Cape Sabine, where a visit was paid to the last headquarters of Peary. The road led over dark red granite with traces of foliation in places. On the return to the ship a large pan of arctic ice drifting southward on the tide gave a startling exhibition of the latent power such a moving mass possesses. Surging towards the land, one corner came in contact with a rocky islet about twenty feet high, over which the ice, itself forty feet in thickness, pushed without retarding the progress of the pan.

An accident.

On the way across Herschell bay from Cape Sabine to Cape Herschell, the ship struck a submerged pinnacle of rock; luckily, she was under full steam and bumped over without stopping. Considerable damage was done to the keel, stem and stern posts, but as the ship did not make a great amount of water, little attention was given to the leak until the return to Halifax, when the damage was found to be quite extensive. The rocks at Cape Herschell were, like those of Cape Sabine, red granite gneisses.

An attempt was made to follow the shores of Ellemere island to the southward, and was successful for a distance of thirty miles to the southward of Cape Isabella, when thick weather and much ice forced the ship to the south-east away from the land.

Ellesmere island.

The shores of Ellesmere island rise abruptly to an ice-capped tableland, with an elevation of upwards of 2,500 feet. The coast is deeply indented by many bays, whose surfaces were still fast frozen. Only the outer prominent points were free of snow, while up the bays an occasional rocky piece projected from the deep mantle of snow. All the valleys were filled with great glaciers that discharged numerous large icebergs into the ice-covered waters of the bays. Not a tenth of the fore-coast was free of snow, while the country to the rear was covered by a heavy ice cap. This condition is in marked contrast to that of the Greenland coast, on the opposite side of Smith sound, where the shores are free of ice and snow and the outer hills bare. This difference of climate is due to the Arctic current flowing south along the western side of the strait and to the prevailing easterly winds, which give clear weather on the Greenland side while the opposite shore is buried in fog.

The next land seen was some small islands, lying off the eastern point of Philpots island, near the entrance to Lancaster sound. Occasional glimpses through the fog showed low rugged shores of Archæan rocks. During the following night, as the ship pursued a western course along the north side of the sound, the land was seen at intervals, with high rugged peaks of crystalline rock rising above the snows of the outer lands, with numerous discharging glaciers in the valleys, flowing down from the interior ice cap.

On the west side of Croker bay the character of the country changes with a change of the rocks. The rugged hills of Archæan rocks give place to cliffs of nearly horizontal beds of light buff limestone, which rest upon the rounded bosses of the gneiss. At Coming creek, one of the many long narrow bays that indent the western part of the south coast of North Devon, these bosses of gneiss rise from 50 to 200 feet above the water and are capped by steep cliffs of limestone that rise abruptly to a height of 1,500 feet and then in gradual steps 500 feet higher, at which altitude they are masked by the ice cap of the interior. Croker bay.

Fossils of Silurian age are found only in the lower beds of the limestone. A few small glaciers discharge from the ice-cap in the vicinity of Coming creek, but only for a few miles to the westward, after which the ice-cap retreats and no glaciers are seen. The underlying gneisses gradually disappear beneath the water as the coast is followed westward, leaving only the limestone in the cliffs. These cliffs, minutely sculptured by the streams, appear to have been long exposed to the atmosphere, and thus resemble, on a grand scale, the cut banks of a stream flowing through a clay country. An excellent survey was made of this southern shore to Beachey island, at the south-west end of North Devon.

The ship anchored in Erebus harbour and a landing was effected at the historical Beachey island, where the gallant but unfortunate Franklin, with the crews of the *Erebus* and *Terror*, passed their last winter in harbour; thence they travelled westward in search of the North-west passage, only to perish on the coast of King William island, or, perhaps, in an endeavour to reach succour, further south. Here, also, the headquarters of the search expeditions from the eastward were established for a number of years; the place, indeed, is redolent of the memory of gallant men enduring great hardships in the effort to rescue unfortunate comrades. Erebus harbour.

On the shore lay two large boats badly damaged by ice. On a low terrace immediately behind was the frame of a large storehouse containing many casks of provisions, partly broken and spoiled. Scattered about were hundreds of tins which had held a patent preserved meat, and which had been opened, found to be rotten and condemned by the Franklin party. Broken casks, hoops and staves, with hundreds of leather boot-soles, were strewn everywhere. On the next terrace, a few yards behind the house, is the wooden cenotaph erected by the relief expeditions to the memory of the Franklin expedition, while, lying alongside, was the large marble slab sent as a token of respect to the gallant dead by American citizens, and left there by McClintock on his last voyage. On the plain, a few hundred yards away, four lonely graves and four small crosses mark the last resting place of two of Franklin's crew and two belonging to the relief expeditions.

Attached to the cenotaph was a sealed tin box, which was found to contain a record of the Norwegian Magnetic Pole Expedition, in the sloop *Gjoa.* It had been left in August, 1903, and stated that all were well on board and were bound down Peel sound. This record has been sent to the Norwegian government.

Beachey island.

A fine collection of fossils from the limestone of Beachey island was obtained, as also a collection of the few plants growing there. Looking north up Wellington sound and westward through Barrow strait, no ice could be seen from Beachey island. It was to all a matter for regret that our instructions limited the cruise westward to this place, and that the damaged state of the ship and the lack of an adequate supply of provisions forbade the attempt to make the North-west passage—an attempt which, with so powerful a ship and in so favourable a season, would, in spite of previous failure, have probably been successful.

North Somerset island.

From Beachey island, a crossing was made to North Somerset island, on the south side of Lancaster sound, and a stop was made at Port Leopold, a fine harbour on the east side of the island, a few miles down Prince Regent inlet. The character of the island is very similar to that of the western part of North Devon already described. The limestone cliffs are not quite so high and the bays are wider and appear not to run so deeply into the land as those of the opposite coast. There is no continuous ice-cap, and consequently no glaciers, and the climate appears to be much milder than that of North Devon.

Port Leopold.

On the low point which forms the harbour of Port Leopold, the boiler, keel and lower timbers of a large steam launch were found close to the land-wash: this launch was brought out from England, some sixty years ago, by one of the Franklin relief expeditions. A number of cases of biscuit and butter, for the Norwegian Magnetic Pole Expedition, had been left, a few days before the arrival of the *Neptune*, by the Scotch whaler *Windward*, and were piled against the boiler, with the Danish flag flying over them.

Numerous traces of an ancient Eskimo encampment were found on the point, and places were seen where the whalers had built fires to try out blubber.

Shortly after leaving Port Leopold a thick fog completely hid the land, which was not again sighted until the ship was off the north-western end of Bylot island. The physical character of the island showed that the limestones had again given place to the rugged hills of Archæan rocks. The island rises in broken ridges with dark rocky peaks surmounting the many great glaciers of the valleys, which flow down from a continuous ice-cap, situated from five to ten miles inland and rising fully 3,000 feet above the sea. The northern and eastern coasts of the island were followed to the mouth of Ponds inlet, the next great sound to the south of Lancaster sound and the gathering place of the Scotch whalers towards the end of July. Bylot island.

At an Eskimo encampment, just inside the mouth of the inlet on its north side, a pilot was engaged to take the ship to the whalers, some thirty miles up the inlet. On the way a second smaller encampment was seen on the same side and about five miles above the first.

From the pilot it was learned that the native population of Ponds inlet consisted of thirty-five families, or one hundred and forty-four persons in all. Another small band lives to the westward, on the shores of Admiralty inlet. Members of both bands occasionally visit the northern part of Hudson bay, and, at other times, go to North Somerset, and even to North Devon, where there is excellent hunting for barren-ground caribou and musk-ox on the western part of the island, while bears and walrus are plentiful on the ice of the adjacent Wellington channel. During the summer, more than half the population journey inland to the south-west to hunt deer for the necessary clothing, the remaining able-bodied men being engaged in the whale boats. Ponds inlet.

Bylot island is everywhere high and rough. The continuous ice-cap seen from the coast does not extend much over ten miles inland, after which the land is mostly bare of snow in the summer. The interior of Baffin island is much lower, and there are great grass-covered plains where the caribou roam about in huge bands.

The *Diana* and *Eclipse*, Scotch whaling steamers, were found at anchor close under a high plain of drift on the south side of the inlet, Whaling.

and the *Neptune* dropped anchor alongside. The five ships engaged in the Baffin bay fishery had up to that date caught nine whales. Arctic salmon being reported very plentiful in a small river close to the anchorage, a short net was borrowed and two boats were sent on a fishing excursion. They returned in about an hour with fully a thousand fine fish varying in weight from three to ten pounds, the catch aggregating at least 5,000 pounds.

Topography.

A trip inland into the plain proved that the first terrace rose 200 feet above the sea, and stretched backward to the south and west in an uneven plain, deeply cut by small streams. An abundance of arctic plants gave evidence of a marked improvement of the climate in comparison with that of the lands bordering on Lancaster sound. The high gneissic hills to the eastward were flanked by terraces of drift, or rather of stratified sands, clays and gravel, which rose to a height of 500 feet above the present level of the sea. The presence of fragments of lignite in the bed of the Salmon river points to the age of these surface deposits being older than the glacial period. They are probably Tertiary, and have been undisturbed by the action of the glacier, which in this region does not appear to have been very active. Similar particles of lignite in similar association have been found at Cape Hay and at Durban island, both on the east coast of Baffin island, and there may be extensive deposits of this mineral. Owing to their distance inside the arctic circle and the uncertainty of the navigation of the northern seas, it is doubtful if these deposits of lignite will ever be of much value, but the presence of these deposits of ancient surface material may be important, if alluvial gold be found in Baffin island. In such a case, the ancient gravels, undisturbed by the later action of the glacier, would probably contain rich concentrations of placer gold in the old valleys of the streams. Of course, gold has not as yet been discovered in the rocks of this region and these remarks are only intended to draw attention to the possibility of extensive placer deposits should the precious metal be found in the rocks of that great area. Captain Adams reported having found copper ore loose in the drift, a few miles inland, from Clyde river,

Erik harbour.

Erik harbour, in a long narrow bay on the south side of the mouth of Ponds inlet, was the next place visited. The *Balaena* and *Albert*, of the Scotch whaling fleet, were found at anchor in the harbour, and the *Albert* had wintered here. Erik harbour is about five miles long and about a mile wide, the anchorage being at its head, close to the front of a glacier, which fills two-thirds of the valley. The south corner of the harbour is free of ice for about 300 yards where a small stream discharges from a southern valley. The glacier flows down a wide north-west valley with rocky walls that extend outward to within half a mile of the sea. The division between the glacier and the southern valley is continued to the sea by a sharp ridge of boulder clay.

This ridge is about two hundred feet high at the termination of the rock wall of the valley and gradually declines to fifty feet at the water's edge. The glacier is about a hundred feet thick along its front, where it discharges a few small icebergs into the bay, but its motion is so slow and the bergs are so small that no danger is incurred by the ships anchored close to its front. The glacier once filled the bay to its mouth, and the deposits of fresh boulder clay, on the rocky walls of the valley, show that its thickness then was sufficient to raise its surface four hundred feet above the present water level. The glacier has, at present, two lines of medial moraines upon its surface while much clay exists in patches on and in the ice. Glaciation.

A few miles to the westward of the harbour, several small glaciers descend short steep valleys, and break off before they reach the sea, so that they present low cliffs of ice. The strange part is that these glaciers rest upon thick deposits of stratified drift which are quite undisturbed by the glaciers passing over them.

This part of the coast is characterized by steep rugged cliffs of Archæan rocks, rising into sharp peaks, only slightly rounded, if at all, by the glacial action. The rocks about the harbour are chiefly a pink mica granite-gneiss but, in the boulders of the glacier, all the different gneisses and schists common to the sonthern Archæan areas were found.

The intention to follow the west shore of Baffin island soutward to Cumberland gulf, was prevented by the fogs and great fields of ice through which the ship had to force a way almost to the Greenland coast, and then back again, reaching the western shore a few miles north of Cumberland gulf. In marked contrast to the conditions prevailing at the same time in the previous year, the gulf was found full of heavy arctic ice and several days were spent going to and returning from Blacklead island. This heavy ice was finally left at Cape Haven and the ship again reached Port Burwell on September 4, where the supplies, left before going north, were taken on board again for conveyance to Fullerton. Cumberland gulf.

During the absence of the *Neptune* in the north, Mr. Caldwell had remained at Port Burwell, with instructions to explore as much as Ungava bay.

possible of the irregular eastern shore of Ungava bay and to make examinations inland. He reached a place about half way to the mouth of George river. Travel in the interior proved very difficult, owing to the high hills separated by deep valleys filled with long narrow lakes. The rocks are all Archæan; granite-gneisses predominate, with a large amount of basic irruptives, such as gabbro and anorthosite. A considerable quantity of impure graphite was found and a deposit of impure iron ore, the value of which has not yet been determined by analysis.

Cape Wolstenholme.

On the return voyage through Hudson strait, a survey was made of the southern coast from Douglas harbour to Cape Wolstenholme, so that only a short distance between George river and the end of Mr. Caldwell's work remains unsurveyed on that side of the strait. The rocks along the western half of this coast appeared to be mostly red gneisses, with frequent areas of dark basic rocks. For several miles to the eastward of Cape Wolstenholme the characteristic rusty gneisses of that place largely occupy the face of the high cliffs on the shore. Two excellent harbours were discovered, one opposite the western end of Charles island, the other about halfway from that place to Cape Wolstenholme.

Salisbury island.

On the completion of this work, the ship headed northward and an examination of the north side of Salisbury island was made. Good harbours, where a ship might lie in safety if the water does not prove too deep for anchorage, were seen at the north-east and north-west ends of the island, in deep bays protected by islands. This side of the island is very bold, rising in steep cliffs directly from the water to a rough tableland with an elevation of 500 feet and upwards. The water along the islands is very deep, none of our numerous soundings touching bottom at 220 fathoms, the length of our sounding line. These are the deepest soundings in Hudson strait and Hudson bay. The tides are very strong around the island and evidence of the easterly current in the northern part of the strait was afforded by the stranded icebergs, two at the east end and one in the bay at the west end. As there are no glaciers discharging into the waters of Hudson bay, these bergs must have come from Davis strait. The rocks of the islands are all Archæan.

Return to Fullerton.

Bad weather and the danger, in the crippled condition of the ship, of meeting ice, forced a return south around Salisbury and Nottingham islands. The southern edge of the Fox channel ice, encountered a few miles beyond the western end of Salisbury, completely blocked the entrance to Evans strait; the usual passage, therefore, south of Coats island, was followed into Hudson bay, and Fullerton was safely reached on the 16th. The Scotch whaler *Active*, having on board the bone of two whales taken in Repulse bay, was met a few miles from Fullerton. Captain Murray gave information concerning the mica mine operated by the firm owning the *Active*. It is situated at Lake harbour, on the south shore of Baffin island, a few miles to the eastward of Big island. Nine whites and a number of natives are employed at the mine during the summer, the whites returning home in the ship. The output for the year is thirteen tons of mica.

Homeward bound.

Several days were spent at Fullerton and then the *Neptune* headed eastward for Port Burwell; the passage south of Coats was again taken, and the ice was found to be some miles more to the southward and westward of its previous position. Burwell was reached on October 1, and, within an hour of our anchoring, the *Arctic* arrived to relieve the *Neptune*. The return to Halifax was safely accomplished and the voyage ended on October 12, having lasted almost fourteen months.

Thanks are due to the gentlemen who formed the scientific staff of the expedition for their unfailing attention to the duties assigned to them and for cheerful assistance rendered by them at all times. Prof. Andrew Halkett made large zoological collections, including the skins and skeletons of mammals and birds, birds' eggs, fishes, marine invertebrates and insects. Dr. Borden, in addition to his surgical duties, made careful measurements of the natives, and enquired closely into their diseases; he also attended to the botanical collection and assisted with the weather observations. Mr. C. Frank King had full charge of the topographical work and has added materially to the accuracy of the charts of these northern waters. Mr. Caldwell made a number of valuable surveys and geological examinations, and assisted in many other ways. Mr. Ross kindly volunteered to assist Prof. Halkett, and proved of great help to him.

Summary of scientific results.

The following summary of the scientific results of the expedition shows, in a tabulated form, the importance of having trained scientific men on such expeditions, where, for a very small extra expenditure, a great amount of valuable information may be collected, without in the least interfering with the main purpose of the expedition.

SUMMARY OF WORK ACCOMPLISHED BY THE OFFICERS AND SCIENTIFIC STAFF ON BOARD THE S.S. NEPTUNE, 1903-4.

The *Neptune*, from Halifax until her return to that port, steamed 10,000 miles. Of this 9,100 was in open water, and 900 miles through heavy ice. The distance steamed through ice is at least twice that of the course shown, owing to the number of turns and twists required to work through the ice. In consequence the actual ice-mileage should be given as 1,800 miles, and the total 10,900 miles. This is probably the greatest ice-mileage ever made in one season by any ship.

SURVEYS.

Surveys.

	Miles.
Log and compass surveys of coast line, checked by astronomical observations, previously unsurveyed, or roughly sketched in by sailing vessels.	1,175
Numerous astronomical observations, for the position of Fullerton, and accurate chain and micrometer surveys of the harbour and environments of Fullerton.	91
433 soundings, taken through six feet of ice, in the harbour and approach to Fullerton.	
During the time that the *Neptune* was at winter quarters at Fullerton, the western coast of Hudson bay was geologically examined from the head of Chesterfield inlet to the head of Wager inlet, and track surveys were made of that distance................	610
While the *Neptune* was fast in winter quarters, a boat trip was made to Southampton island and a track survey and geological examination were made of part of its western shore......................	70
During the absence of the *Neptune* to the northward, a boat survey of the east side of Ungava bay resulted in the geological examination of..............	95
Total mileage of surveys..............	2,041

GEOLOGICAL AND NATURAL HISTORY WORK.

Geological and Natural History work.

In addition to the work mentioned above, geological examinations were made at every place touched at by the *Neptune*, and a considerable amount of information was obtained concerning the rocks and glaciers of the north.

Large collections of rocks and fossils were made.

A close study of the manners and customs of the Eskimos was made during the winter. Measurements of typical Eskimos were taken, together with a good series of photographs of these people and their habitations. The diseases of the natives were studied and reported upon. A census was made of all the natives of Baffin island and southern side of Hudson strait and the western side of Hudson bay.

A large collection of the northern birds was obtained, together with a very fine collection of the eggs of many rare birds, often accompanied by the nests.

A number of skins and skeletons of northern animals, including a group of six musk oxen, were prepared for museum purposes.

Several fishes of the northern seas and fresh waters were obtained and specimens preserved in formaline.

The use of the dredge secured important collections of marine invertebrates while those of the ponds were taken in nets.

A fine collection of arctic plants was made at the several places visited, and a number of interesting insect specimens was secured at the same time.

A great amount of information concerning the habits and distribution of the important animals, including the whales and seals, was obtained at all places visited.

METEOROLOGICAL OBSERVATIONS.

Meteorological observations.

Weather observations, including readings of thermometers, barometers, rain and wind guages, were taken daily throughout the voyage. During the winter months observations were taken at intervals of four hours.

ICE OBSERVATIONS.

Ice observations.

While in the ice, continuous notes were kept of the character, thickness, extent and kind of ice met with. These observations are particularly important in regard to the future commercial navigation of Hudson bay and strait.

In connection with this question, all the information possible was collected concerning the tides and currents of these waters, and also of the ice laden currents of Baffin bay and Davis strait.

COUNTRY AROUND THE HEADWATERS OF THE SEVERN RIVER.

By Charles Camsell.

Introductory.

Notification of my appointment to the staff of the Geological Survey reached me in Edmonton, together with instructions to proceed to Winnipeg, where I was to prepare for my field work. I left Edmonton on June 1 and reached Winnipeg on the 3rd where I remained until the 10th awaiting further instructions and purchasing some necessary supplies. A letter of instructions reached me there, directing me to proceed to Dinorwic, and from there to make a survey of a route to Cat lake, defining and mapping the eastern boundary of an area of so-called Huronian rocks, whose western edge was examined by Mr. Dowling in 1893. On completing this work I was to go north from Cat lake across the height-of-land dividing the Albany from Severn river waters, and make a survey and examination of the rocks on the hitherto unexplored branch of the Severn river called the Lake or Cedar river, descending this as far as Severn lake to connect with a survey of the western branch made by Mr. A. P. Low in 1886.

The party, consisting of five men, was made up at Dinorwic; of these Mr. Greenshields and Mr. Dawes gave me valuable assistance during the summer, the latter in making independant trips to the east or west of the main route, and the former also in making independant trips as well as in the micrometer surveys.

Itinerary.

Outfit, provisions and two canoes were obtained from the Hudson's Bay Company at Dinorwic. The party left here on June 17 and travelled as far as Lac Seul in company with Mr. McInnes, who there turned north-east to the Albany river. At Lac Seul I hired an Indian guide to take us as far as Cat lake by the Wenasaga river route, a river which enters Lac Seul about two miles east of its western extremity. This route had been explored by Mr. Fawcett, D.L.S., some years ago, and in 1902 Dr. Wilson and Mr. Johnston of this department also made a micrometer and compass survey as far as Cat lake, from which point they returned following the Cat river to Lake St. Joseph and thence out to Dinorwic by the Hudson's Bay Co's usual route.

We reached Cat lake on July 15 only to find the place deserted by all except two Indians. It was necessary that the services of another guide should be obtained here to take us across the height-of-land and down the Lake or Cedar river, as our Lac Seul Indian had never been beyond Cat lake. A party of Crane Indians was expected from the north in a few days, so, in the intervening time, I made a micrometer survey of the shores of Cat lake, not knowing at the time that I was duplicating the work of Dr. Wilson and Mr. Johnston.

Mr. Williams' journey.

This work, on account of the stormy and unsettled state of the weather, occupied us until the 28th, and on our return to the Hudsons' Bay post I found Mr. Williams of Osnaburgh house. He had come straight across to Cat lake by a route hitherto travelled only by Indians. I obtained a copy of Mr. Williams' notes and some sketches of the largest lakes; but he had no means of estimating his distances. The journey took him five days and he reckoned the distance to be somewhat over 100 miles. Shorty after leaving Lake St. Joseph he got on to the waters of the Attawapiskat system, and on these he travelled by river and lake to within a few miles of Cat lake. A rough sketch of the route has been prepared and incorporated in the accompanying map of the Cat lake district. Williams lake, which is drained by the Sand river and whose waters pass through Vermilion lake and river to the Attawapiskat, is the largest lake on the route, and is said by Indian report to be two days travel from one end to the other, or almost as large as Lake St. Joseph. Mr. Williams describes the geology to comprise the usual Archæan granites and gneisses with only one band of the darker basic rocks crossing the Vermilion river above Vermilion lake.

On July 29, the party left Cat lake, after, with much difficulty, obtaining the services of a young Crane Indian who was to act as guide down the Lake or Cedar river to Severn lake. Through a difficulty of interpreting my wishes correctly a misunderstanding arose, and he got the impression that we only wished to go as far as Pakhoan or Little Cedar lake, which is only about half way down the river to Severn lake. From Pakhoan or Little Cedar lake he refused to accompany us farther, and left for his own camp, while we had to find our way down the river alone.

The northernmost point reached.

On August 14, we reached our farthest north, a point fourteen miles below the junction of the Lake or Cedar river with the middle branch of the Severn, which the Indians call the Jackfish river. From here we were unfortunately compelled to return owing to a scarcity of provisions and our ignorance as to how far we were from Severn lake. I afterwards learned that another day's travel would have brought us to the lake and completed the survey.

In returning, short side trips were made up the middle and other branches of the Severn river, and Cat lake was reached on Aug. 30. The following week was spent in making a trip forty miles to the northwest-ward to a lake (Wigwasikak lake) which is said to be the headwaters of the central branch of the Severn river. Southward from Cat lake the route followed took us west from Wapikik, or what Mr. Fawcett calls Pine Channel lake, through a series of lakes and portages to the Shabumeni lake, defining the north-eastern boundary of the large Huronian area before mentioned; and from Shabumeni lake I followed Mr. Dowling's route of 1893 down through Woman lake and Trout lake river to Lac Seul, which we reached on Sept. 24.

On arriving at Dinorwic I found it necessary to go to Winnipeg to pay off my men and settle accounts, after which I proceeded to Ottawa, reaching here on October 10.

TOPOGRAPHY.

Area covered. The area covered by the summer's exploratory work is roughly enclosed by a parallelogram, the east and west angles of which are placed at Cat lake and Wigwasikak lake, the headwaters of the central branch of the Severn; and the north and south angles at Severn lake and the western end of Lac Seul. It occupies a part of the great uplifted peneplain of the Archæan protaxis, and is similar in character to that so frequently described by other geologists in its more thoroughly explored sections. The general relief is even lower than is usually found in other parts of the Archæan, and the maximum relief seldom exceeds 100 feet above the level of the water. There are a few exceptions, the most notable of which occur on the Severn river watershed, where some isolated hills attain a height of 130 feet. These are usually granitic eruptive masses, which sometimes have very precipitous slopes and are very noticeable features in the topography. Residual monadnocks of this description occur at Cat lake, Cedar (Kishikas) lake and at the mouth of the middle branch of the Severn river; while a range of hills, probably of similar origin, borders the western shore of Windigo lake about twelve miles to the east of Cedar river. The highest hill in the whole area is situated about three miles west of Greenshields lake. It rises 300 feet above the level of the water and is composed seemingly entirely of boulders and drift material. Similar hills and ridges of morainic material occur in the neighbourhood of the large one, also on the height-of-land between the Severn and Albany rivers, and in the country a few miles north of Cat lake. These hills form excellent land-marks and can be seen from a distance of several miles rising above the surrounding country. From the top of any one of them a good view is obtained, and everywhere we see the same gently undulating surface and even skyline typical of the Archæan area.

Lakes. Lakes are more numerous on and south of the Severn river divide than on the area north of it. These all occupy more or less shallow rock basins eroded out by the action of the continental ice-sheet, their long axes usually lying parallel to the direction of the glacial striæ. Their shores are deeply indented and beaches are rare, a few sand beaches occurring only on Cat lake and Whitestone lake.

Streams. The streams occupy only shallow valleys, and rapids and falls are common. In the distance between Greenshields lake and the mouth of the middle branch (Jackfish river) the slope of the land is much more pronounced, and here the river has cut itself a fairly defined valley twenty-five or thirty feet in depth. A corresponding slope was noticed by Mr. A. P. Low on the western branch of the Severn river which he descended in 1886. There is no very decided fall in any one place, except a long steep slope marked by a series of shallow rapids, the majority of which can be run.

ARCHÆAN GEOLOGY.

Archæan rocks.

As has been already stated, the whole area is occupied by rocks of Archæan age, principally granites and gneisses, with a few bands of the darker basic rocks. The largest area of the so-called Huronian rocks lies to the south and west of Cat lake, and has been examined in different parts of its south and west borders by other members of this department. Mr. Dowling defined its western boundary and Dr. Wilson crossed it by the Wenasaga river route. It was crossed this year in two directions, one by the same course as Dr. Wilson, and the other by a route from Wapikik lake to Shabumeni lake. By the latter route, the north-western extension of the area was traced to a distance of twenty-five miles east of Shabumeni lake. The northern boundary of the area crosses Shabumeni lake about three miles north of its outlet, striking in a general direction north-easterly. The contact with the granitic rocks was not seen anywhere except at a point just east of Kay-gat lake, so that the boundary is only sketched in approximately, by following the strike of the rocks. On Shabumeni lake the strike is about 50°, on Birch lake from 105° to 120°, on Kay-gat lake 75°, and on the contact a couple of miles east of Kay-gat lake 145°. The eastern boundary of this area appears to be very irregular, running out into several long narrow tongues. As reported by Dr. Wilson, the Wenasaga river flows through the area south-westerly for about twenty miles, and going up the river beyond this, the Huronian belt is replaced by very coarsely crystalline granites and some gneisses. Two narrow tongues, however, of basic rocks intervene before reaching Gull lake. One of these occurs on the Sesikinaga river and is perhaps a quarter of a mile wide. The other is crossed on the height-of-land between Cat river and the Wenasaga. The latter tongue is undoubtedly a continuation of the main body, for it was traced westward for a distance of five miles from the height-of-land portage. The other band may or may not be an altogether isolated area, but nothing resembling it in composition was noticed on the main area. The south-eastern corner of the main area extends very much farther eastward than any other part and it is probable that a much larger

Wenasaga river.

Valley of Slate lake.

and longer tongue projects out from here. The valley of Slate lake, which has been formed by the erosion of the soft calc schists, which make up this portion of the belt, can be traced eastward for six or seven miles beyond the lake, at which point it bends slightly to the southward, running approximately in the direction of Goose lake. Dr. Wilson also examined an area of Huronian rocks north of the east end of Lac Seul; but it yet remains to be proved whether this area is continuous with the one on Slate lake. This I intended doing on my way back from Cat lake; but was unfortunately prevented by the impossibility of getting any guide to take us through that country.

Cedar river.

North of Cat lake and on Cedar river there is an almost unbroken continuation of the granites and gneisses, with a predominance of the red granite variety. In a few places basic inclusions in the gneisses might indicate that larger bodies of the same rock would be found in the near neighbourhood; and the following places might be mentioned where such conditions occur:—on the lake at the head of Cedar river; on the lower end of Cedar (Kishikas lake); on Cedar river at the mouth of the Francis river.

A very narrow band of hornblendic rock crosses Cedar river a few miles above the junction of the Windigo river; while a much wider band is met with just below the mouth of this river. Here Cedar river takes a sharp bend to the west and flows in this direction for ten or twelve miles. The cause of the deflection is its entrance into this band of softer rocks, which it follows until it strikes against a steep bluff of eruptive rocks at the south-west angle and is again deflected into its original course. The southern boundary of this belt follows closely the course of the river in its western trend; but its northern contact with the granite is covered by a layer of drift, and could not be accurately placed. Its width is perhaps two miles, and the strike slightly north of east. The central branch of the Severn river joins Cedar river in this belt of Huronian, and occupies a shallow valley in the wide depression caused by the excavation of these soft hornblendic rocks. Few outcrops of this belt occur, for the drift covering becomes much thicker in the lower parts of Cedar river. Dawes falls, just below the junction of the two streams, where the river has a drop of twelve feet, is caused by a band of hard siliceous hornblende-schist striking diagonally across the river and dipping down stream at an angle of 45 degrees.

The large area of these basic rocks south of the height-of-land has been referred by Mr. Dowling to the Keewatin series, and the two narrow bands which are seen on Cedar river, through their lithological similarity to the large area, may also be referred to the Keewatin.

Samples of the different varieties of rocks occuring in the several Huronian belts were taken, and thin sections are being made of those whose mineralogical composition could not be readily determined in the hand specimen. The Severn river specimens are all hornblendic rocks varying from a massive amphibolite to a siliceous hornblende-schist. The latter is closely associated with a coarsely crystalline rock composed essentially of hornblende and quartz, and no doubt the one is simply a phase of the other.

Rocks on Wenasaga river.

The rocks on the Wenasaga river have been referred to by Dr. Wilson in the Summary for 1902; but one occurrence, which appears on the Sesikinaga river, and which he consequently did not visit, shows an interesting contact. A narrow band of pyroxenite, showing considerable metamorphism, and alteration on the surface to serpentine, is separated by a band of granite from a hornblende schist having alternate layers of quartz and hornblende in very thin laminæ. Closely associated with these exposures, and at no great distance from them to the east, is an outcrop of what Dr. Barlow has identified as a quartz-mica diorite. All of these strike about N. 60 E. and are separated from each other by narrow bands of later intrusive granite.

The greatest variety of specimens was taken from Birch lake and the Shabumeni river, along the northern boundary of the large belt. Near the contact with the granitic gneisses the rock is a mica-schist which changes shortly to spotted chloritic and hornblendic schist. West of these, along the route, the following rocks are found: slate, conglomerate, quartzite and an altered quartz porphyry, massive fine-grained diorites, amphibolite and hornblende schist. Certain portions of the quartzite are highly impregnated with iron sulphide. The diorites are cut by numerous veins of quartz ranging in width from a few inches up to eight feet, and highly mineralized.

GLACIAL GEOLOGY.

Glacial geology.

The whole area exposed shows a predominance of the action of glacial erosion over that of deposition. In the central portion about the height-of-land, drift material covers a very small proportion of the surface, while bare rock exposures are common. These are always smooth and frequently still retain the glacial markings. The general outline of the lakes conforms to the direction of the striæ, which at Cat lake is about N. 70 E., and they usually occupy shallow rock basins. A few of the lakes on and about the height-of-land occupy basins formed by an unequal distribution of morainic material. Cat lake itself is an example of the erosive force exerted by the moving ice. Its long axis lies N. 70 E., while several long narrow bays cutting into the western shore have the same general trend. Many of the islands are composed of drift material, and conform to the direction of the striæ. They are long and narrow with rounded tops and gently sloping sides composed largely of boulders and having the appearance of drumlins or sowbacks. Whatever drift there is, is made of material carried presumably but a short distance, boulders of granite and gneiss; but I also noticed some erratics of a hard bluish limestone, which could only have been brought from the Palæozoic area bordering Hudson bay. A large number of bearings of the glacial striæ on Cat lake were taken. The average gives a reading of N. 70 E. On Birch lake, two sets occur on the same exposure, one giving 55° and the other 65°. The latter, however, is the more constant. On Cedar river few striæ occur; those near the head water conform in a general way to those on Cat lake. One reading near the mouth of Windigo river shows a great divergence to all the others, being N. 12 E., and the indications are that the movement was apparently towards the north instead of away from it. This is an isolated case, and no other striæ occur anywhere near it to check it. All the evidence, however, of the movement of the ice north of the height-of-land agrees with the results obtained by other explorers in this region, that the ice movement was southward instead of northward.

Lower down Cedar river the covering of drift becomes thicker. Sedimentary clays form cut banks fifteen feet high on the river just above the south-west angle.

Moraines and sand plains.

Moraines and sand plains are numerous on the height-of-land, also in the neighbourhood of Pakhoan or Little Cedar lake. Some of the former have been mentioned before as forming some of the principal typographic features. Two long parallel north-east and south-west ridges, rising to a height of 120 feet, are crossed in making the portages over the height-of-land. But the most important glacial hill occurs near Greenshields lake, and is 300 feet above the level of the water. It lies east and west with prominent peaks at either end, each higher than the centre of the ridge. From peak to peak is about half a mile, and beyond this the ridge slopes gently away to the level of the plain. The east and west sides are exceedingly steep, the slope being determined entirely by the angle at which the material of which it is composed will rest. It is composed entirely of boulders and gravel.

A number of lower ridges and hills of the same material are irregularily scattered around the larger one.

Several moraines have been laid across the valley of Cedar river, and some of these deflect the course of the river, while others are cut through and form shallow rapids. About ten miles below the junction of the middle branch of the Severn a moraine, lying at right angles to the course of the stream, had dammed up the waters and formed a lake nearly three miles long and a mile wide, which, on the cutting down of the dam, has been transformed only recently into a huge meadow.

TIMBER, SOIL, ETC.

Spruce, poplar, banksian pine and birch are found everywhere over the whole district. White and red pine were only noted in the southern part of Lac Seul. One solitary white pine tree occurs on Slate lake, and this appears to be the northern limit of the tree in this district. Ash trees were observed here also for the last time on our way north. The white cedar is a rare tree; but it occurs on the east end of Slate lake, on Sesikinaga lake, on Cedar (Kishikas) lake, and also on Greenshields lake. On the shores of the last a few rusty looking trees are growing, and this is their northern limit. Mr. Williams, in his traverse across from Osnaburgh to Cat lake, reports seeing ash trees for the last time on the east shore of Elbow lake. Timber.

Large areas have been burnt along the route of the Wenasaga river, notably at Wenasaga lake, ten or twelve years ago, and at Big Portage lake, about five years ago: also on Gull lake. North of Cat lake, we enter, at the lower end of Cedar (Kishikas) lake, an area that has been burnt probably eight or nine years ago, and this extends to a few miles below the mouth of the Francis river, or a distance of over thirty-five miles. Eastward it extends at least to Windigo lake, ten or twelve miles to the right of the river, and westward as far as could be seen from the tops of the highest hills. This is generally being reforested with a second growth of banksian pine and poplar.

In very few places, either on the north or the south sides of the height-of-land, do the spruce and tamarack attain such a size as to make them economically important to the lumbering industry. On the shores and islands of Birch lake the best timber occurs; that on the branches of the Severn river is generally small.

Beyond the Hudson bay post at Lac Seul no farming of any kind is done. At Cat lake, some years ago, potatoes and other hardy vege- Farming.

tables were grown with indifferent success, but this has now been discontinued. Being so near the height-of-land they are liable to frosts at any time during the summer. When we were there a sharp frost occurred on the night of July 31, and also on August 6. The Crane Indian chief, who has built himself a house at Windigo lake, every year raises a small crop of potatoes, which he first obtained from Trout lake posts. A great part of the country is either too rocky or swampy for agricultural purposes, and nothing will ever be grown on it, but there are portions, particularly in the large belt of Huronian rocks, and in some parts of the valley of Cedar river, where the land is dry and the rocks are covered with a clayey soil that is good enough to raise some of the hardier vegetables. The region around the mouth of the Anamabine river is such a country, as also the clay belt below the mouth of the Windigo river. As a rule, however, the dry land only occupies a fringe along the water courses, while the country back of this is largely muskeg or rocky.

Game and fish.

Moose and caribou are fairly plentiful in the Shabumeni and Birch lake section; and bears were frequently seen on the lower parts of Cedar river. White fish, pike and pickerel were caught with a net in all the larger lakes; but no trout were got anywhere. Sturgeon ascend Cedar river as far up at least as the mouth of the Windigo river, and in several places the natives have gone to a great deal of trouble in building weirs across the river to catch them.

Much delay was caused in our work by the inclemency of the weather, and the disadvantage of travelling through parts of the country without a guide. The season was very wet and cold, frosts occurring in every month. Snow fell first on September 10 and again on the 19.

Flow of the streams.

The discharges of all the larger streams were taken, and the fact established that what was considered to be the main branch of the Severn river is really not so large as the Cedar river branch. The discharge of these two streams was taken near the end of August, when the water was at its lowest stage. Cedar river was found to give 735 cubic feet per second, and the middle branch 503 cubic feet. At the junction, the middle branch is wider and deeper than the eastern branch, and it would appear to carry much more water; but there is a great difference in the relative velocities.

NOTE.—All bearings in this report are magnetic.

THE UPPER PARTS OF THE WINISK AND ATTAWAPISKAT RIVERS.

By Mr. William McInnes.

Region explored.

In accordance with official instructions the season of 1904 was spent in an exploration of a part of the District of Keewatin lying to the north east of Lake St. Joseph. The Winisk river, from Weibikwei lake to the sea, was surveyed last season, and the present summer's work was designed to supplement that of last year by an exploration of the upper stretches of the Winisk, and of the Attawapiskat to the south of it.

The ordinary canoe route was followed from Dinorwic, on the Canadian Pacific Railway, to lake St. Joseph, at the lower end of which the season's work was begun. This point had been fixed geographically by Thomas Fawcett, D.T.S., by a line run in 1886, and the micrometer survey was accordingly started there.

Route followed.

An Indian canoe route leading northward to the headwaters of the Attawapiskat river promised to afford the most ready access into the interior, and this was followed. A Rochon micrometer telescope and a surveyor's compass were used for the survey, the northing being checked by latitude. From the extreme north-easterly bay of the lake a portage was followed leading to the smaller Annimwosh (dog-hole) lake, which discharges south-westerly into the next westerly bay of Lake St. Joseph. Ascending the inlet in a north-westerly direction, the larger Annimwosh lake was reached by a short portage. These lakes are shoal and studded with small islands and projecting boulders. The water is very dark in colour, showing the influence of drainage from large areas of muskeg: the temperature, early in July, was 58° Fahr. Green forest of eighty years' growth surrounds the lakes.

Forest growth

Black spruce and tamarack are sparingly scattered over the muskeg areas: poplar, white birch, spruce and banksian pine clothe the ridges. The trees are not of large size, averaging from ten to twelve inches in diameter at the stump.

Rocks.

Biotite gneisses, generally fine in texture and well foliated, striking north-east, occur in low, rounded ledges all around the lakes. Continuing up stream, Kasageminnis (island) lake, the next in the chain, has the same general characteristics. A few miles of river connect this lake with the Wichig (fisher) lakes, the larger of which is six miles long. With the exception of a narrow belt of hornblende schist just south of the Wichig lakes, representing probably the diminishing end of a Keewatin belt, the gneisses before noted occur throughout. Green forest continues as before and in favourable situations, such as flats extending back from bays, the trees are tall, free from branches and have diameters of from thirteen to fifteen inches at the stump.

Keewatin belt

Two portages aggregating a mile in length lead across the height-of land to Wimbobika (hollow-rock) and Kapkichegima lakes, lying nearly at the source of the south-west branch of the Attawapiskat river. They are long narrow bodies of water extending north-easterly, in troughs parallel to the foliation of the underlying gneisses, for four and thirteen miles respectively. Between the two a low ridge of Keewatin rocks is exposed, made up principally of feldspathic and chloritic schists. By way of Minominatikoka (rice-stalk) brook, entering Kapkichegima from the north, near its eastern end, there is an Indian canoe route to the head of the middle branch of the Attawapiskat and to Cat lake.

Kawinogans river.

The water of these lakes was clearer and of higher temperature, 64° Fahr.; indicating a less swampy drainage area. The outlet of the lake, a stream about a chain in width, called by the Indians the Kawinogans (no doré) river keeps a general easterly and north-easterly course, with a fairly swift current and frequent rapids, for twenty-five miles to Kagabadesdawaga, a long narrow lake extending north-easterly for nineteen miles. Occasional exposures of chloritic and feldspathic schists occur along the banks of the river; evidently a continuation of the belt of Keewatin rocks already noted. At the head of the lake a few ledges of hornblende granite gneiss occur, succeeded along the shore by biotite gneisses. The lake is underlain by deposits of a stiff blue clay, probably a boulder clay, covered by stratified beds, ten to thirty feet in thickness, of calcareous, siliceous clay and very fine siliceous sand. A rolling plateau of sand extends back from the lake to hills of unstratified drift rising two hundred feet above its level.

The Odoskwinnigemog (elbow) river, probably the longest branch of the Attawapiskat, flows into the lake a little more than half way down its northern shore.

This river comes from the north-west, heading about ten miles from the north-east end of Cat lake.

Kanuchuan river.

The united streams form the Kanuchuan (long rapid) river, which continues in an easterly direction to Kakagiwizida (crow's foot) lake, a shallow body of water ten miles in length and a mile in width. The same rolling sandy plain surrounds the lake, falling in parts into extensive tracts of muskeg. On the south side of the lake, beyond an area of muskeg, the land gradually rises to about a hundred feet, where occasional glaciated surfaces of gneiss protrude from the drift covering. This sandy flat gradually rises southward for five or six miles, then it sharply rises to a ridge of gravel and boulders 300 feet above the lake level. Everywhere, excepting on the muskeg areas, there is an open forest of banksian pine of small size. Still keeping an easterly direction, with a stiff current and frequent rapids, at twenty-nine miles the river flows into Ozhiski (mud) lake, the largest body of water along its course. The lake is twenty-one miles long and a little over two miles in width at the broadest part. The biotite gneisses, which show in frequent exposures along the shores, occur in shelving ledges lying nearly flat or gently undulating. Fires have destroyed much of the old forest around the lake and along the river, the ages of the trees on different areas varying from twelve to over a hundred years. Occasional trees, growing in favourable locations, reach diameters of eighteen inches, but the general average is small. From the northern side of the lake, about three-quarters of the way down, the main river flows out by three channels that unite a few miles below and continue to Attawapiskat lake. In order to tie the micrometer survey to the work of last year, a route to Fort Hope, leaving the extreme eastern end of Ozhiski lake by a half mile portage, was followed to Eabamet lake, where connection was made with the earlier survey.

Forest.

Pineimuta river.

The bulk of the provisions was *cached* at the forking of the routes, and picked up again after a few days, when the river was again followed. After leaving Ozhiski lake the river flows northwards with swift current and heavy rapids for fifteen miles to a sharp bend easterly, receiving at the elbow the waters of the Pineimuta (partridge's crop) river flowing in from the west. This is the north branch of the Attawapiskat. For the first few miles it is broad and smooth, flowing between banks of clay and sand. A fall of considerable height then occurs, above which the Obikwatawanga river, draining a large lake known as the Totogan (quaking bog), joins it from the south-west. After an extremely circuitous course it heads to the south of the upper branches of the Winisk river. The united rivers form the main Attawapiskat river, which keeps a general easterly direction for twenty miles to Lansdowne lake, with Kabanea (many points) lake on its course. A number of rapids occur along this part of the river, but they are all easily run with loaded canoes.

Clay and sand. This whole region, including the country about Ozhiski lake, is characterized by thick deposits of clay and sand, the latter with thin, lenticular layers of limestone holding approximately 57 per cent of calcium carbonate. Two specimens of the clays were examined by Dr. Hoffmann, one from this area and one from further up the Kanuchuan. They differ only in their lime content, and are described as clays, containing a large quantity of siliceous grit, slightly ferruginous, feebly plastic, readily fusible, containing from 27 per cent to 30 per cent of calcium carbonate. Though of no use as clay, these deposits should form a good soil for agricultural purposes.

Winisk river. Weibikwei lake, on the Winisk river, was reached from Lansdowne lake in four days The river from this point to the sea was surveyed last year, and this summer the exploration was continued up stream. The ascent of the river was comparatively slow, owing to the constant recurrence of very long irregular lake expansions with stretches of quick water between.

The zigzag course of the river has been determined by the occurrence of a succession of glacial drift ridges lying parallel to the course of the striæ. The river occupies the narrow valleys between these ridges in the form of long finger-like bays with short connecting channels where the river breaks through at low points. Ten miles up, the northern channel flows off into the Winisk river below Weibikwei lake, the whole distance made up of long finger-like bays running N. 30° E. and S. 30° W., with intervening short stretches of rapids. Ten miles more of swift water and rapids are then succeeded by twenty miles of most irregular lake expansion, with the same long parallel arms, often separated by quite narrow ridges of drift.

Wapikopa lake. Wapikopa (high-and-low trees) lake, thirteen miles long, with a long bay stretching to the north for eighteen miles, occurs above another stretch of swift water. A tributary from the north known as the Wapikopa river comes into the head of the northerly bay. Ten miles of rapids and strong current intervene between this lake and Nibinamik (spring-beaver) lake, a body of water of similar character, its shape defined by the ridges of glacial drift that bound it.

Nibinamik lake. Above Nibinamik lake the river, coming from the west, is for some distance broad and deep, with a quiet current and only occasional ripples. A section across it at one of these points gave a width of 280 feet and a depth varying from one foot to twenty feet, with an average current of about two miles an hour.

The only rocks exposed along the river are biotite gneisses, lying in broad, low undulations, but much disturbed by later intrusions of coarse, pegmatite-like rock of similar composition. Gneisses.

The forest growth is much the same as that already referred to along the Attawapiskat. Though too small for timber, excepting in limited areas, the spruces would apparently make an excellent pulp wood.

From the south end of Nibinamik lake an old Indian winter trail was taken, leading southwards by a remarkably straight course to the Attawapiskat river above Lansdowne lake. The route led through a series of comparatively small lakes lying near the head waters of small rivers draining into the Winisk and Attawapiskat rivers. The journey is one of about eighty miles, and includes thirty-one portages aggregating ten miles in length. The areas of muskeg are many and extensive, most of the portages crossing tracts of swamp. Winter route.

With the exception of a small area of Keewatin rocks, biotite gneisses are exposed at intervals the whole way across. The route joins the Attawapiskat by a small tributary coming in on the north side eight miles above Lansdowne lake.

The region explored may be said, in a broad way, to consist of an elevated plain 800 to 1,200 feet above sea level, reduced by a long period of denudation to the gently undulating surface so generally characteristic of the great northern Archæan area. General description.

Deposits of drift material apparently of glacial origin are very extensively distributed over the whole region, and form the most striking feature in its relief. They occur both as unmodified deposits and as redistributed material that has been laid down under water.

The region of the upper Attawapiskat valley and that lying between it and the Albany river are characterized by many east and west ridges of drift, rising steeply to sharp edges and composed of gravel and boulders. Along the sides of the ridges great depressions, like inverted cones, 300 feet across at the top and 100 feet or more in depth, are common. These deposits seem to be such as might be laid down during the retreat of a glacier. Evidences of the passage of such a glacier are everywhere apparent. Its direction, as indicated by the glaciated rock surfaces, was S. 30° W. to S. 40° W. over nearly the whole area, though in the valley of the Attawapiskat, and along the Albany, striæ were found running west or up the river valley. The frequent occurrence in the drift of pieces of fossiliferous Silurian limestone, Glacial striæ.

similar to that occurring along the west shore of Hudson bay, would seem to indicate that the gathering ground of the glacier lay beyond the shore of the bay.

Geology.

Archæan rocks only were found over the whole district explored. Biotite gneisses, varying but slightly in composition and always well foliated, are the prevailing rocks. They occur generally in broad, low undulations, but are much disturbed by intruded masses of coarse white granite or pegmatite.

Two belts of Keewatin, made up for the most part of massive diorite and diabase and chloritic and feldspathic schists, were noted, one occupying the valley of the Kawinogans river for a distance of about twenty-five miles, and the other, an irregularly shaped area lying immediately south of Nibinamik lake on the Winisk river.

Forests.

The forest growth over the district generally is not large, though on limited areas the spruces reach dimensions fitting them for sawing. At Fort Hope fairly clear nine-inch lumber was being sawn from trees cut near the shores of Eabamet lake. One tree was felled that gave a log over two feet thick at the butt and 100 feet long. The greater part of the forest is about eighty years old, though in places trees reaching 140 years were found. These old trees were on low-lying areas, that had escaped where the higher and dryer parts were burned, and were not generally large. Their growth-rings showed a rapid increase in size for the first fifteen years and afterwards an extremely slow growth. The large sandy tracts are now, for the most part, covered with an open growth of banksian pine, a tree of small commercial value. When the day comes in Canada for reforesting, these districts might be replanted with pines commercially valuable. Over large areas the spruces would, apparently, if more accessible, be available for wood pulp.

Black birch.

Specimens of a black birch that was noted last year in this district were brought home and handed to Professor John Macoun, botanist of this department, who submitted them to Dr. C. S. Sargent for determination. Dr. Sargent has named this birch *Betula fontinalis*, Sargent, a species formerly confounded with *B. occidentalis*, Nutt. The range of this tree in the sub-arctic region is not yet known.

Specimens of this birch were found last year as far north as lat. 53° 35′ south of Weibikwei lake. This summer occasional trees were noted on the upper branches of the Attawapiskat river and in about the same latitude, between that river and the Winisk.

The depredations of the Larch saw-fly upon the tamaracks along the Winisk river were noted in last year's report. Since that time the ground covered by this insect has been extensive, and some idea of the damage they have done may be given. Last season all trees along the Winisk river, from a point near the mouth to a point within a few miles of the Weibikwei lake, were stripped; south of that area they were untouched. During the present spring and early summer their ravages extended southward to the Albany river and westwards for sixty miles up the Winisk river and to about midway between Eabamet lake and Lake St. Joseph, on the Albany, an area of about 14,000 square miles. Larch saw-fly.

The principal food fishes of the district are the sturgeon, doré or pike-perch, whitefish, pike and sucker, all of which occur plentifully and furnish the principal means of subsistence of the Indians. Fishes.

The ruffed and Canada grouse and various kinds of wild ducks are the principal game birds, and are fairly plentiful. Game birds.

Moose were noted along the Attawapiskat river, but were not so plentiful as further south. Caribou range over the whole district, and black bears are numerous. The smaller fur-bearing animals, including the otter, beaver, fox, pine-marten, fisher, mink and muskrat, are still fairly abundant. The skin of a raccoon trapped on the Attawapiskat river was brought into the post at Fort Hope by an Indian woman. The ordinary northerly range of this animal is south of Lake Superior, and so rare a visitor is it in this northern latitude that none of the Indians coming to the post knew what it was. Animals.

At Fort Hope post, garden vegetables maturing prior to August 31 and those unaffected by a few degrees of frost did well, but the potato plants were all killed on that date, the tubers being generally small and unripe. At Osnaburgh post much the same conditions prevailed, though the potatoes, which were being harvested on the last days of September, were mature enough, and, on a small tract of newly broken land, of good size and quality, an Indian, who cultivated a small patch of land near the head of the north branch of the Attawapiskat, claimed, when seen in September, that he had a good crop of potatoes. Horticulture.

Observations of the temperature on the upper branches of the Attawapiskat and Winisk rivers between July 5 and September 13 gave averages of Fahr. 47·5°, 61·6° and 58° at 6 a.m., noon and 6 p.m. respectively. The first frost noted was on the morning of August 28, and on the nights of the 30th and 31st the cold was sufficient to form Temperature.

ice on small pools and to kill all tender vegetation Owing to the exceptionally wet season the average temperatures given above are probably a little lower than those of the normal season.

Inhabitants

The only inhabitants are roaming bands of Indians, belonging partly to the Salteux branch of the Ojibway tribe and partly to the Plain Crees of the west shore of Hudson bay. They live entirely by fishing and hunting, obtaining their powder, shot and other necessaries that the country does not supply by trading furs at the posts of the Hudson's Bay Company. The only known attempt at agriculture was that made by an Indian on the Attawapiskat river, who had planted a few potatoes obtained at Fort Hope post.

A small collection of land and fresh-water shells was made and Dr. J. F. Whiteaves furnishes the following list of species identified :—

List of Land and Fresh-water Shells from the district of Keewatin, collected by Mr. Wm. McInnes in 1904.*

By Dr. J. F. Whiteaves.

A.—Land Shells.

Vertigo ovata, Say.

Land shells.

Minnitaki river, English river and Lac Seul, several specimens; Kawinogans river, Attawapiska, three specimens; Rib lake, Albany river, four specimens; Wapikopa lake, Winisk river, one specimen.

Conulus fulvus (Muller).

Lake St. Joseph, three specimens; Kawinogans river, ten specimens; Rib lake, Albany river, ten specimens; Minnitaki river fifteen specimens.

Zonitoides arboreus (Say).

Lac Seul, two specimens; Kawinogans river, five specimens; Rib lake, Albany river, eight specimens; Mistassin lake, one specimen; Winisk river, two specimens; Wapikopa lake, Winisk river, three specimens; Nibinamik river, Winisk river, two specimens.

Vitrea hammonis ? (Ström).

Rib lake, Albany river, one specimen.

* The *Vertigo* and most of the critical species of *Sphærium* and *Pisidium* in thi list have been kindly determined by Dr. V. Sterki.

Pyramidula striatella (Anthony).

Lac Seul, four specimens; Lake St. Joseph, six specimens; Kawinogans river, several specimens; Rib lake, Albany river, four small specimens; Mistassin lake, four specimens; Winisk river, one specimen; Wapikopa lake, Winisk river, several specimens; Kibinamik lake, Winisk river, three specimens.

Succinea vermeta, Say.

Lac Seul, five specimens; Minnitaki lake, seven specimens; Kawinogans lake, Attawapiskat river, four specimens; and Rib lake, Albany river, one specimen; Winisk river, one specimen; Wapikopa lake, Winisk river, one specimen; and Nibinamik lake, Winisk river, two specimens.

Succinea retusa? Lea.

Succinea ovalis, Gould, non Say.

Winisk river, two specimens; Wapikopa lake, Winisk river, one specimen.

B.—Fresh-water Shells.

PELECYPODA.

Fresh-water shells.

Lampsilis luteolus (Lamarck).

Kawinogans river, one specimen.

Anodonta marginata? (Say).

Anodonta fragilis, Lamarck.

Attawapiskat river, two specimens; Pusabiwan river, Attawapiskat river, one specimen.

Anodonta Kennicotti? Lea. Var.

Lake St. Joseph, two specimens; Attawapiskat river, two specimens; Kawinogans river, Attawapiskat river, one specimen.

Sphærium simile (Say).

Ozhiski lake, Attawapiskat river, three specimens; Wijig river, Attawapiskat river, thirteen specimens; Pusabiwan river, Attawapiskat river, several specimens; and Mijigamog lake, Attawapiskat river, one specimen.

Sphærium Walkeri, Sterki.

Attawapiskat river, fifteen specimens.

Sphærium emarginatum, Prime.

Attawapiskat river, one specimen. Dr. Sterki thinks that *S. emarginatum* may not be specifically distinct from *S. stamineum*, Conrad.

Sphærium stamineum (Conrad).

Kawinogans river, seven specimens.

Sphærium——— ?

Root river, two perfect specimens and one odd valve.

Sphærium (Musculium) securis, Prime.

Kawinogans river, one specimen.

Sphærium (Musculium) partumeium (Say).

Kawinogans river, two odd valves.

Pisidium compressum, Prime.

Pisidium altile, Anthony.

Ozhiski lake, Attawapiskat river, one immature specimen; Winisk river, six specimens; Kawinogans river, ten specimens.

Pisidium fallax, Sterki, var. *errans*, Sterki.

Ozhiski lake, two specimens.

Pisidium variabile, Prime.

Kawinogans river, two specimens.

Pisidium affine, Sterki.

Kawinogans river, 'two valves, small and probably not full grown' (Sterki).

Pisidium Sargenti, Sterki.

Kawinogans river, two separate valves.

Pisidium——— ? (near *P. abditum*).

Ozhiski lake, two specimens.

Pisidium scutellatum, Sterki.

Ozhiski lake, four specimens of a small form of this species; Kawinogans river, six similar specimens.

Pisidium splendidulum, Sterki.

Ozhiski lake, two specimens.

Pisidium, sp. nov. ?

Ozhiski lake, two specimens.

GASTEROPODA.

Valvata tricarinata, Say.

Lake St. Joseph, one specimen; Kawinogans river, twelve specimens at one locality and six at another; Ozhiski lake, one specimen; Wapikopa lake, Winisk river, three specimens.

Valvata sincera, Say.

Kawinogans river, four specimens of a remarkable, small and partially uncoiled variety of this species; Attawapiskat river, two small specimens.

Amnicola limosa, Say. Var.

Lake St. Joseph, seven specimens; Kawinogans river, at three localities, several specimens; and Ozhiski lake, one specimen.

Limnœa megasoma, Say.

Island in Lake St. Joseph, four adult living specimens.

Limnœa stagnalis appressa.

Lake St. Joseph, four specimens; Kawinogans river, two specimens; Weibikwei lake, Winisk river, two specimens; Ozhiski lake, two specimens; Wapikopa lake, Winisk river, five specimens.

Limnœa catascopium, Say.

Mistassin lake, Attawapiskat river, nine specimens; Kawinogans river, thirteen specimens; Attawapiskat river, three specimens; Winisk river, at two localities, several specimens; Ozhiski lake, a few specimens from three different localities.

Limnœa galbana (Haldeman) Dall.

Kawinogans lake, Attawapiskat river, three small specimens; Kanuchuan river, Attawapiskat river, eighteen specimens; Ozhiski lake, four small specimens; Attawapiskat river, one small specimen; Wapikopa lake, Winisk river, one specimen.

Planorbis trivolvis, Say.

Ozhiski lake, two specimens; Machawaian lake, Attawapiskat river, two specimens; Wapikopa lake, Winisk river, nine specimens.

Planorbis corpulentus, Say.

Minnitaki lake, one specimen; Lac Seul, three specimens at one locality and one at another; Root river, two specimens; Sioux Outlook, English river, seven young specimens.

Planorbis bicarinatus, Say.

Lake St. Joseph, four specimens; Kawinogans river, one specimen.

Planorbis campanulatus, Say.

Lac Seul, three specimens; Kawinogans river, nine specimens; Elbow river, Attawapiskat river, seven specimens; Lake St. Joseph, four specimens; Winisk river, one specimen.

Planorbis albus, Muller.

Planorbis hirsutus, Gould.

Lake St. Joseph, three dead shells. Kawinogans river, two specimens from one locality and three from another; Attawapiskat river, two small specimens; Wapikopa lake, Winisk river, nine specimens.

Segmentina armigera, Say.

Kawinogans river, one specimen.

Physa heterostropha, Say.

Lac Seul, five specimens; Lake St. Joseph, two specimens. Ozhiski lake, three specimens; Machiwaian lake, Attawapiskat river, one specimen; Wapikopa lake, Winisk river, five specimens.

The Little Current and Drowning Rivers, Branches of the Albany, East of Lake Nipigon.

By Mr. W. J. Wilson.

Introduction.

The work of the past summer was a continuation of that done last year. In 1903, time did not permit of the exploration of the region drained by the headwaters of the Little Current and Drowning rivers and their branches. Being informed that the Indians who hunt on the headwaters of these rivers trade at Long Lake House, and that guides could be easily obtained at that post, I left Ottawa, May 31, accompanied by Mr. W. H. Collins, B.A., of Toronto, as assistant, with instructions to examine the sources of the above-named rivers and to make a survey of the Pagwachuan river.

Itinerary.

On June 15, we reached McKay lake, where we began a compass and micrometer survey, which we carried across the height-of-land to Pagwachuan lake; and thence north-east down the Pagwachuan river to its junction with the Kenogami, a distance of nearly 150 miles. We then went up the Kenogami river to Long lake reaching the Hudson's Bay Company's post, July 15. Here we secured a guide and supplies for six weeks and ascended the Devilfish river, following the route surveyed by Dr. Bell in 1870, to Wawong lake. From this lake we followed a series of portages and small lakes into Eskagenaga* lake, thence eastward to Wababimiga lake which drains into the Drowning river. From this lake four portages and three small ponds form a route to the main branch of the Drowning river. We descended this river, connecting our survey with that made by Mr. O'Sullivan last year. Returning, we ascended the river to its source in a long lake, from

* Previously mapped as Oskanaga.

which the canoe-route continues eastward, by a number of portages, small lakes and streams, and reaches the Kenogami river five miles below the mouth of the Devilfish river. Distance surveyed 225 miles.

We then went to Long Lake House for supplies but could get neither guides nor canoemen, so that we were compelled to undertake our third trip with the two canoemen whom we brought with us from Timiskaming. With two canoes and supplies for five weeks we again ascended the Devilfish river and followed the ordinary canoe-route to the portage to Wawong lake. The Kawashkagama river, which we followed from Fleming lake, was surveyed to this point by Dr. Bell in 1870, and by W. S. Davidson in 1900, to Howard fall, twenty-seven miles further down. Below this the river was unknown. From information gathered at the Hudson's Bay Company's post it seemed probable that this river is the upward extension of the Little Current which was explored and mapped last year, and this proved to be correct. We followed it to O'Sullivan lake and for twenty-five miles below, connecting with the micrometer survey of 1903.

The distance surveyed on this trip was 123 miles, making a total for the summer of nearly 500 miles by compass and micrometer, besides a short track-survey down the Wababimiga river. We returned by Long lake and Pic river, reaching Heron Bay, October 7, and Ottawa the following day. Distance surveyed.

PAGWACHUAN LAKE AND RIVER.

In passing from McKay lake to Pagwachuan there are six small lakes or ponds and five portages. The longest portage is 193 chains and the five have a total length of a little over four miles. The soil is sandy and no rock exposures were seen. The height-of-land is between the fourth and fifth lakes and is fifty-five feet above McKay lake and 150 feet above Pagwachuan. The latter is about 900 feet above sea level, and is eleven miles long, varying from two miles to half a mile in width; occasional low hills, from 75 to 100 feet, rise from the shores, and a thick growth of small spruce, poplar, fir, canoe-birch, tamarack and cedar is found everywhere round the lake. McKay lake to Pagwachuan.

The rocks along the western shores of the lake are a coarse granite-gneiss, amphibolite, biotite-schist and pegmatite. The schists strike N. 70° E. vertical; biotite-schist, with masses of pegmatite, is the prevailing rock along the narrow eastern part. The river leaves the lake at the extreme eastern end. There are two short portages in the first four miles and two lake expansions, from the lower of which the canoe-route leaves the river and follows a lake on the north side of the river for four miles; in the next five miles come two portages separated by a small lake. The guide said that the part of the river thus avoided is blocked with driftwood and that about a mile below the point where we turned off there is a fall of 150 feet. The river is fifty feet wide, with slow current, where it connects with the portage at the east end.

Pagwachuan river.

For twenty-six miles below this portage the river runs almost due east and is from one to two chains wide with numerous rapids, but only two short portages. The low clay banks are densely wooded, for the most part with large spruce, poplar and cedar. The country, back from the river, is sometimes undulating, but no high hills were seen. The soil along the river where the drainage is good is of excellent quality. Rock exposures in this stretch were few; biotite-schist, granite-gneiss, and granitite were noted. The schist strikes N. 60° E. and is nearly vertical. Many gneissic boulders lie in the bed of the river. They are mostly angular and do not seem to have been transported far.

G.T.P.R. trial line.

The river then turns north and flows in that direction for thirty miles. The Grand Trunk Pacific Railway trial-line, 1904, crosses about four miles north of the bend. The country here is rolling, with low, rocky and sandy hills covered with second-growth banksian pine and poplar fifteen years old. The rock, where the line crosses, is a mica-diorite-gneiss with bands of quartzite. The river at this point is 537 feet above sea level. Two miles farther down there are a fall and portage with a drop of eighteen feet. The fall is caused by a band of hornblende-granite-gneiss striking east and west; just below the fall the rock is a fine-grained, reddish-weathering granite-gneiss.

Continuing north, the river becomes broader with numerous shallow rapids. The banks in places are high, showing twenty to forty feet of clay, sand or gravel, usually containing striated boulders in the lower part, with more or less distinct stratification above. Exposures of hornblende-granite-gneiss, diorite-gneiss, and mica-diorite-gneiss are common. These frequently contain epidote and quartz either in narrow veins or lenticular masses several inches wide. In one place the rock contains large irregular crystals of red orthoclase, which gives it a mottled appearance on the weathered surface.

Exposures on the river banks.

For the last thirty-five miles the river runs north-east. It is from four to six chains wide, and is very shallow, with a swift current and many rapids. The banks are low, seldom rising above fifteen feet, and the whole country, as far as can be seen from the river, is flat. The last exposure of Laurentian rock is thirty-two miles from the mouth. It is a reddish hornblende granite-gneiss, well foliated, dipping N. 30° W. <85°.

Dolomite.

For twenty-three miles, following the bends of the river, no rock is seen in place. Then there is an exposure of a drab dolomite containing fragments of shells. From this point to the mouth of the river, a distance of nine miles, there are outcrops of the flat-lying dolomitic rock. There are ochreous-weathering bands succeeded by others, of a cream colour, filled with small cavities, and soft earthy layers of an olive colour. I made a small collection of fossils from these rocks, chiefly corals, which Dr. J. F. Whiteaves identifies as belonging to the Silurian system, and probably comparable to the Guelph group.

ESKAGENAGA, WABABIMIGA AND NESTABON LAKES.

Wawong lake.

The country adjoining the route *via* the Devilfish river to Wawong lake was described by Dr. R. Bell in 1870*

Wawong lake is two and a half miles long. The shore-line is very irregular, numerous sand and gravel ridges extending into the lake, forming deep bays. In two places a portage of only ten to twenty feet across a low neck of sand was required to pass from one bay to the other. The lake is surrounded by a rolling, sandy country covered, for the most part, by banksian pine and poplar. The water, as the Indian name implies, is very clear and of a bluish green colour. From Wawong lake the canoe route runs north-east through four small ponds and five short portages to Eskagenaga lake, a distance of two miles. The country along this route is similar to that round Wawong lake. There are no rock exposures, but there are some areas of good soil well wooded.

Eskagenaga lake.

Eskagenaga lake is over twelve miles long and averages about three miles in width. There are seven deep bays, and the whole shore line is irregular. It is studded with islands, some of considerable size, especially in the eastern part. Two or three small streams enter the lake; the outlet, which flows into the Little Current river, is from the north-east arm. Several soundings were taken, showing a maximum depth of fifty-six feet. Depths of between forty and fifty feet were common near the middle of the lake. A portage leads from the north-west bay into O'Sullivan lake. The surrounding land is generally low,

* Report of Progress., Geol. Surv. of Can., 1870-71, p. 341.

but on the south an occasional hill rises 200 or 300 feet above the level of the water. Except in a few small areas, the forest growth is all small, being about thirty years old.

Rock exposures are common all round the lake. In many places, especially along the north shore, abrupt gneissic walls rise from the water. In going east along the south shore, from the portage by which we entered, the first rock seen is a compact gray granite-gneiss, containing basic bands and quartz veins. This is the prevailing rock for some miles, after which a mica-diorite-gneiss striking N. 55° E. is common to the east end of the lake. Near the outlet a beautiful reddish granitite-gneiss occurs in several places. Hornblende granite-gneiss, much contorted in some exposures and cut by dikes of diabase, quartz and pegmatite, are found along the north shore.

Wababimiga lake.

From Eskagenaga lake the canoe-route runs east for thirteen miles to Wababimiga lake, passing through five lakes and over six portages. The two largest lakes are each five miles long but less than a mile wide for most of their length. One portage is a mile and a quarter long: two others are half a mile. The land is generally level, swampy, and covered with a small growth of spruce and tamarack with occasional patches of banksian pine. Near Wababimiga lake there are some areas of spruce and poplar growing on good soil.

Wababimiga lake is six and a half miles long and one to two miles wide and has a depth of forty-two feet. The land round the lake is low and rolling and generally covered with a small second-growth of canoe-birch, poplar and spruce. The stream draining this lake was followed to its junction with the Drowning river near the point where Mr. O'Sullivan completed his survey for last year. It is a clear, shallow river running over a gravelly bottom and can with difficulty be navigated by light canoes.

Drowning river.

The route eastward from Wababimiga lake follows a deep bay to the south-east and then a small brook flowing into it for a mile and a half, when another series of four small lakes and five portages leads to the Drowning river, a distance of seven miles. The first portage on the west is over burnt ground with scattered banksian pine thirty years old. The other portages are mostly through Sphagnum swamps, with old growth of spruce and tamarack. We continued the survey down the Drowning river to connect with Mr. O'Sullivan's survey of last year. The river is about two chains wide and forms an easy canoe-route, as the portages are all short and most of the rapids can be run with empty or partly loaded canoes. The country is low an level. Spruce is the principal tree along this stretch. Many of the trees are large enough for saw-logs while the majority would make good pulp-wood. They grow close together and are straight and tall, reaching a height of sixty feet or more and carrying their size well up.

Returning to the point where we first reached the Drowning river, we continued the survey for thirty-one miles to the south end of Nestabon lake, which seems to be the source of the river. In this distance there are five short portages to pass light rapids; also three lake-like expansions. Nestabon lake is ten miles long and is divided into two equal parts by a narrows. Its width is from a mile to a mile and a half and the greatest depth found was seventy-eight feet. The Indians assert that some parts of this lake never freeze. The surrounding land is generally low and flat, except on the west side of the lower part, where there are hills 150 feet high.

Nestabon lake.

From the Drowning river there are two routes to the Kenogami. One of these leaves the former river about two miles above the portage from Wababimiga lake, and the other begins at the east side of the upper half of Nestabon lake. We took the latter route, a distance of twenty-four miles. There are four portages, aggregating four and a half miles, connecting small lakes and streams. Kawakanika, a beautiful lake on this route, near the Kenogami river, is, owing to the abundance of its fish, much frequented by Indians during the summer. The forest along the upper part of the Drowning river is a large second-growth, probably fifty years old. In this district there is a rather large area which was burnt in 1901, and second-growth prevails around Nestabon lake. In passing eastward from the lake the two long portages are through swampy ground on which are growing spruce and tamarack averaging eight to ten inches in diameter. On the eastern end there are dry, sandy knolls covered with banksian pine alternating with the spruce swamps. These portages lead to a shallow lake from which a r.ver flows to Kawakanika lake. The land traversed by these is low and moss-covered; the forest is of the usual kind. Half a mile north of Kawakanika lake the two above mentioned canoe routes meet. The forest growth on the two last portages, and surrounding the lakes, is larger, and the land improves in quality as the Kenogami river is approached.

Kawakanika lake.

Rock exposures are of frequent occurrence along the route from Eskagenaga lake to the Kenogami river. Gray, finely foliated granite-gneiss, gabbro and hornblende granitite-gneiss are seen on the lakes and portages to Wababimiga lake. The gneiss strikes N. 80° W. On Wababimiga lake the same gneiss is seen in two places striking N. 80

E., and on the river there are several exposures of the same rock. A fall of thirty-six feet on this river is caused by a band of dark gray gneiss dipping S. 28° W. $<80^{\circ}$. Between Wababimiga lake and the Drowning river, granitite-gneiss and mica-diorite-gneiss, striking N. 45° E., were noted. On the Drowning river and Nestabon lake gray, granitite-gneiss is the common rock. The strike varies from N. 40° E, to N. 75 E.. The foliation in much of this rock seems to be vertical, but in one exposure the dip was distinct and was S. 50° E. $<45^{\circ}$, and on a small island in Nestabon lake, it was N. $<30^{\circ}$. These gneisses are mixed with bands of amphibolite, mica-diorite-gneiss and basalt dikes. One of these last, forty feet wide, cuts the gneiss on the west shore of Nestabon lake. Reddish granitite and granitite-gneiss are the chief rocks seen on Kawakanika lake and during the remainder of the route to the Kenogami river.

THE KAWASHKAGAMA RIVER.

Kawashkagama river.

The Kawashkagama river is the outlet of a number of lakes lying twenty-five or thirty miles north-west of Long lake. From its source to Kawashkagama lake it flows in a north-east direction. Then it runs almost due west for twenty-nine miles, when it turns to the north-east again and flows in that direction for thirty-two miles till it enters O'Sullivan lake. These distances are taken from the micrometer survey and follow the bends of the river. Below the portage to Wawong lake the river is from one and a half to two chains broad and mostly deep, with slow current. Between the portage and Rupert fall, a distance of eleven miles, there are only two rapids, and these may be run with loaded canoes, although there is a good portage at each. At Rupert fall there is a drop of fifteen feet and a portage of six chains on the right bank. Below this fall the river is about two chains wide, and continues crooked for twenty-one miles, where there is another portage to pass a log jam. Four and a half miles farther down is Howard fall, where the river cuts through a ridge of greenstone, making a cañon-like gorge from ten to fifteen feet wide for a distance of fourteen chains. This gorge is cut into the schists to a depth of twenty feet in places, and the water descends in steps and slides varying from one to five feet. The portage is on an island, and is seventeen chains long.

Abamisagi lake.

From this fall to Abamisagi lake, a distance of eleven and a half miles, the river is from two to three chains wide, with a slow current. There are three rapids, two of which require short portages. The river enters Abamisagi lake near the east angle and the outlet is only half a mile distant. It turns round, as the name of the lake implies, and runs eight miles south-east into O'Sullivan lake. In this distance the river is broad and deep and there are three rather bad rapids which cannot be run with loaded canoes. Abamisagi lake is about eight miles long and two and a half broad with regular shores and few islands.

O'Sullivan lake.

O'Sullivan lake, the western part of which was mapped in 1903, measures seventeen miles from the north end to the extreme east, and has a breadth of from one to four miles. It has many deep bays and, as the Indian name Sesekenaga signifies, is full of islands. Its shores are comparatively low, but in places, especially in the north-east, the rocks rise abruptly from the water to a height of forty feet. On the south-west the land slopes gradually back from the lake to a height of from 100 to 200 feet, and, at a distance of four miles, there is a prominent hill which rises considerably higher. This hill can be seen both from Eskagenaga and Abamisagi lakes.

Timber.

Above Rupert fall the forest is small second-growth about thirty years old. Below this fall, there are large areas of old growth with poplar and spruce two feet in diameter. Farther down, much of the forest is second-growth of sixty or seventy years. Black-ash groves were noted on the river near Abamisagi and O'Sullivan lakes. These trees are eight to ten inches in diameter and twenty feet high. Most of the forest round O'Sullivan lake is small second-growth. There are some areas of good agricultural land along this river, though much of it is low and swampy.

Rupert fall.

Granite-gneiss and mica-diorite-gneiss striking N. 40° E. appear in occasional outcrops for five miles below the portage to Wawong lake. The next rock seen in descending the river is just above Rupert fall where a pyritous, schistose greenstone outcrops, dipping S. 40° E. < 70°. The contact between the gneiss and schist was not seen, as the country is drift-covered and several miles separate the two nearest exposures on the river. Rupert fall is over ledges of the dark green schists considerably broken and irregular. There are frequent outcrops of a similar rock below the fall and as far down as the north end of O'Sullivan lake, but in places it is of a lighter green, and in others more finely laminated. Pyrite, in small grains, is present in most exposures, and there is an abundance of quartz in dikes and irregular lenticular masses, in one of which ilmenite in small quantities was found. On the south shore of Abamisagi lake, gray granite is the only rock seen. It is rather fine-grained but contains broad pegmatite dikes. On the first portage below this lake there is a small knob of granite-gneiss and

Rock exposures.

between the second and third rapids there are exposures of a finely foliated micaceous schist dipping S. 60° E. <75°. The main body of the rock on O'Sullivan lake is of the same character as that described on the river. In going south, from the mouth of the river, along the west shore, there is a massive diorite which, in places, shows a gradation from fine-grained to coarsely crystalline. Farther east, in the deep bay, a gray quartz-diorite and epidote-granite are mixed with the schists. On a small island three miles south-eastward from the mouth of the river, there is a band of sericite schist eight feet wide, striking N. 78° E. and vertical. Adjacent to this is a band, one wide foot, of ochreous powder containing masses of bluish quartz mixed with the sericite schist. The surrounding rock on this island is finely schistose and of a dark gray colour. All three of the hand-specimens brought from these bands effervesce somewhat freely when touched with dilute hydrochloric acid. A similar band of sericite schist occurs on another island about a mile and a half farther north. There is an isolated exposure of pegmatite-gneiss on the west shore of the long north-east arm of the lake, but below this, on the opposite side, there are good outcrops of well-foliated schists. For some miles below the lake, following the Little Current river, which drains it, very fine mica-schists are common. From here onward—as far as we continued the survey—they are intimately mixed with granite and granite-gneiss. From observations made in 1903 it is known that the same rocks extend down the river till they are covered by those of the Cambro-Silurian system.

Iron reported

These mica-schists and gneisses are probably of the same age as the Grenville series, while the greenstones farther south belong to the Huronian age and in part correspond with what has been called Keewatin in the Lake of the Woods region. It has been reported that iron in small quantities has been found to the east of the Little Current river below O'Sullivan lake, and it is not improbable that careful prospecting in different parts of the Huronian area may reveal this and other minerals of economic importance.

Throughout the country examined, especially along the banks of rivers, there are areas of good clay soil, but on going away from the streams the drainage is poor, and spruce swamps are usually met with. These swamps, however, are not continuous, as there are low elevations, sometimes sandy, at short intervals.

Spruce.

Spruce of a size sufficiently large to make saw-logs is found along the streams and around the lakes wherever old forest growth exists, but, unfortunately, large tracts have been burned within the last fifty years and on these the trees are too small to be of commercial value. Spruce large enough for pulpwood grows abundantly along the streams and often in the drier swamps. The growth of this tree seems to be much slower here than in more southern latitudes, and consequently the wood is firmer and more compact, consisting mostly of woody fibre, and therefore particularly well adapted for making pulp. In one tree, five and a half inches in diameter, I counted 135 rings, indicating that the tree is that number of years old.

Fish of various species are common in the lakes and rivers and form one of the chief sources of food for the Indians; speckled-trout abound in most of the rivers examined, especially in the Kawashkagama, Little Current, Wababimiga and Drowning. In the last named, fish, from one to four and a half or five pounds, were caught with both a fly and bait. Fish.

The larger animals seem to be rather scarce. Only two moose and as many caribou were seen during the summer and their tracks were by no means common. The Indians report that the smaller fur-bearing animals are fairly abundant.

Mr. W. H. Collins B.A., who accompanied me during the summer, performed his duties satisfactorily and assisted materially in carrying on the work.

Messrs. Joseph Miller of Heron Bay and Peter Godchère, Hudson's Bay Company's manager at Long Lake House, rendered me valuable assistance in securing canoemen and in various other ways.

Survey of the South and West Coast of James Bay.

By Mr. Owen O'Sullivan.

In accordance with instructions to survey and explore the west coast of James bay, I left Missinaibi with my assistant Mr. W. Spreadborough on June 13th with two canoes and arrived at Moose Factory on June 27th. Introduction

In 1898 Mr. Henry O'Sullivan made an accurate survey of the south shore of James bay as far west as Point Comfort, which, in a straight line, is forty miles north-east of the mouth of Moose river. West of Point Comfort, the shore line had been sketched in from track surveys whose absolute accuracy cannot be guaranteed, as it is impossible to follow close to the shore in canoes or boats, owing to the shallowness of the water. Surveys.

I hired a small sail-boat at Moose Factory to take us across to Point Comfort, but a strong north wind drove us to East point. I therefore sent the boat back to Moose Factory and started a micrometer survey from this point northward to Point Comfort.

Mesakonan point.

After completing this work, we returned to East point and continued the survey to Moose Factory and northward to Cape Henrietta Maria. We walked along most of the coast to enable us to follow the high-water line, which was the best marked, but often we had to use the canoes on account of the difficult walking through mud and salt marshes. From Point Comfort to Mesakonan point, a distance of six miles, the shore rises from four to twenty feet above high tide, and shoals are seen up to three-quarters of a mile out. Well-rounded gneiss, granite and argillaceous arkose boulders, averaging three feet in diameter, are piled ten feet above high tide at nearly all the points, and short sandy beaches surround the heads of the small bays. The land rises gently and is well-wooded with black spruce, tamarack and banksian pine of from five to nine inches in diameter.

Gull bay.

Gull bay extends from Mesakonan southward to Gull point, a distance of seven miles. This bay, which is about four miles across, is very shallow, the tide running out for three miles. A swamp, called Cabbage Willows, extends eastward from the head of this bay across to Rupert bay ; there is a trail through it, some ten miles in length, which forms part of the winter route between Moose factory and Rupert house.

East point.

Between Gull point and East point, a distance of seven miles to the south-west, the coast is low with mud-flats and boulders. Opposite East point, at about three quarters of a mile from high-water line, is a reef of boulders which runs south for two miles and is then succeeded by sand and gravel bars as far as the Little Missisikabie river, a distance of six miles. This part can only be navigated with canoes at high tide. From the mouth of the Little Missisikabie to Nattabiska, twenty-seven miles, the shore is very flat and the distance between low and high water mark runs all the way from three to six miles. Hannah bay, at low tide, is simply a mud-flat, with the exception of the Harricanaw river channel. From Nattabiska, which is considered the north-west limit of Hannah bay, to Moose Factory, the distance is thirty miles.

Moose river.

The mouth of the Moose river it divided into three different channels : the centre one, passing south of Middleboro island, is reported to be the deepest, but last year the Revillon Bros. found a deep channel from the "inner Ship hole," running north of Middleboro island, to within a few feet of the mainland on the north bank of the river opposite Moose island. Here they have established a trading post in opposition to the Hudson's Bay Co.

We have only to take into consideration the enormous flow of the Moose during spring freshets, when the ice, occupying 150 miles of a comparatively level, broad river, is suddenly disengaged, carried down with irresistible force and stranded for miles along the coast, to appreciate the fact that the delta at the mouth of this river is subject to remarkable annual changes.

From the mouth of the Moose river northward, the shore continues low with mud-flats and boulders as far as two miles beyond Pisquanish, which is thirty-one miles from Moose Factory. Then long reefs of boulders, sand and gravel bars extend seaward as far as Nomansland, sixty miles from Moose Factory. In this last stretch there are some points of land, made up of gravel and sand, that have an elevation of twenty feet above high tide. At Half Way point and Cockispenny one may land with canoes at any time. Nomansland.

Between Nomansland and the Albany river four small rivers enter the bay; the largest, named Kinoje, has a flow of about 8,000 cubic feet per minute. This river has not cut out any channel in the mud and can be reached with canoes at high tide only. Kinoje river.

The tide between Nomansland and the Albany river runs out three miles. The Albany is the largest river entering James bay on the west coast. It has several channels at its mouth, the deepest passing north of the island on which Fort Albany is situated. Fort Albany is ninety six miles from Moose Factory. Albany river.

North of the Albany river the coast is very flat and the walking bad; we were compelled to use the canoes as far as Ekwan point, which is eighty five miles north of Fort Albany. In this stretch, in which the difference between high and low tide is sometimes five miles, we could see nothing but mud, strewn with boulders. Between the Albany and the Ekwan, two large rivers enter the bay. The Kapiskau in Lat. 52° 45′ was surveyed by W. J Wilson in 1902, and, thirteen miles north of it, the Lowasky, a branch of the Attawapiskat, debouches. This river was surveyed by Dr. Bell in 1886. The Attawapiskat enters the bay through five separate channels; the third, north of Lowasky, is the deepest, and on it, six miles from the mouth, the Hudson's Bay Company has an outpost. There is also a Roman Catholic chapel. Ekwan point.

Ekwan river.

North of the Attawapiskat, the water continues shoal to the mouth of the Ekwan river and some distance beyond. Shoals are seen three and four miles from high-water line all along. The Ekwan is 180 milles from Moose Factory and was surveyed by D. B. Dowling in 1901. Ekwan point, six miles north of the Ekwan river, is composed of coarse sand and gravel and has an elevation of fifteen feet above high tide. The water at this point is comparatively deep and there is only a distance of sixty feet between the high and low tide marks. Ordinary tides rise about seven feet.

Raft river.

From Ekwan point to Raft river the distance is twenty nine miles ; the coast continues low with mud-flats. Raft river had an approximate value of 10,000 cubic feet per minute when we crossed it, August 9. The water was then very low. It is navigable for canoes for about ninety miles to its source in two small lakes.

Lakitoosaki river.

Forty five miles north of the Raft river, the Opinnagau enters the bay, and ten miles north is the mouth of the Lakitoosaki. These rivers have about the same volume, 20,000 cubic feet per minute, and are navigable for canoes for some considerable distance. The coast from the Raft to the Lakitoosaki becomes more sandy with fewer boulders, but the tide still runs out from one to two miles from high-water mark.

Big Owl river.

Sixteen miles north of the Lakitoosaki, the Big Owl river enters the bay ; it is two chains wide at low tide and had an average depth of three feet at the time we crossed it (Aug. 16). This river can be ascended with canoes for a short distance only.

Smaller streams.

Eight small streams enter the bay between Ekwan river and the Big Owl river. These streams become wider and shallower at their mouths, and their channels through the mud-flats that appear at low water are so wide that we had to drag our canoes, drawing only fourteen inches, up one of the channels for two miles in order to reach the shore.

Termination of survey.

The most easterly point of Cape Henrietta Maria is eighteen miles northward from the mouth of the Big Owl river and 300 miles from Moose Factory, following the sinuosities of the coast. This part of the coast is flanked by sand and gravel bars, some having an elevation of twenty feet above the tide mark, the water being deep right up to the shore. We terminated the survey at the east point of Cape Henrietta Maria in latitude 54° 51′ 30″ and we planted a post recording my name and the date, August 18. North-west from this point the shore is extremely flat and, when the tide was out, we could see nothing but mud-flats strewn with numerous large boulders.

Inland from high water mark we generally found a strip of low dry mud, in places a mile wide, and covered with grass, with occasional sand and gravel bars. To the rear of this, a fringe of alders and juniper-bushes, of from ten to sixty chains wide, reaches the spruce swamps and muskeg areas which, I believe, is the character of the ground overlying the Devonian and Silurian formations extending for 150 miles west of the James bay coast.

In latitude 54° the spruce woods recede from the shore in a north-westerly direction and the coast continues north to the mouth of the Opinnegau river, then north-east to Cape Henrietta Maria. The country lying between the northern limit of trees and the cape is a barren, dry and gravel plain with sandy knolls and fresh-water ponds.

Only two exposures of rock *in situ* occur on the west coast of James bay, one at High Rock point, latitude 51° 23′ which reaches one foot above high tide, and the other, at Pisquanish, is seen at low tide; both are fossiliferous Devonian limestone lying horizontally. Rock exposures.

There is little doubt that the coast of James bay is rising slowly. Among the facts noted the following may be mentioned. In several places, well-defined elevated beaches are distinctly traceable for several hundred feet back from the present high-tide mark. In some places the old cedar driftwood is discernable fully ten feet above the level of present high tide mark, and still above and beyond these appear other ranges of sand debris traceable through the densest part of the forest bordering the bay.

Game was very plentiful; black ducks by the thousand breed in the southern part of Hannah bay, and the pintail and teal in even greater number, breed north of the Albany. A few ptarmigan were shot near Cape Henrietta Maria and, on our return, a large number of geese were also shot. Game.

Speckled trout and whitefish, averaging three pounds in weight, are caught in nets at the mouths of all the rivers. Fish.

At Ekwan point, while having lunch, I counted over one hundred porpoises passing close to the shore. Seals were often seen, and numerous skeletons of walruses and seals were lying on the beach north of the Albany.

Whales were not seen during the expedition, probably owing to the shallowness of the water all along the western coast of James bay; but in 1898, as assistant with my father, we surveyed the east coast from Rupert House to east Main Fort. There the water is deep and the bay is studded with many islands between which whales and porpoises were often seen playing.

The weather was most favourable. During the whole time, from June until September, we accomplished the work with two eighteen-foot canoes and did not lose more than three or four days on account of bad weather.

Gardening is carried on suc essfully at Moose and Albany. We never had better potatoes than those from Albany. At Moose, cabbages, radishes, lettuce, pumpkins, cucumbers, carrots, turn'ps &c., grew luxuriantly.

Birds.

My assistant, Mr. W. Spreadborough, made a large collection of plants during the season and prepared a list of the birds seen. The list of birds, with notes on their breeding habits, will be published in my complete report. Prof. Macoun has made the following summary report on the plants, and the full list will be included in "The Flora of the Hudson Bay" soon to be published by this Department.

Plants.

"Mr. Spreadborough's collection of plants, numbering 278 species, includes all that were known to occur in the region examined, and many species not before recorded from that district. Though there appear to be none new to science, several species are of great interest or rarity. The more noteworthy of these are *Linum Lewisii* var. *stenophyllum* a white-flowered species of flax only known before from one locality, near Fort Severn; *Potentilla Egedii* which had until recently been confounded with *P. Anserina; Pyrethrum bipinnatum*, rediscovered on the coast of Hudson bay a few years ago; *Arnica foliosa*, a long way out of its usual range; *Gentiana Macounii*, known before in that region only from poor specimens collected at Rupert House, together with many species of willows, grasses and carices of rare occurrence.

"The flora as far north as Albany is in great part made up of species characteristic of the sub-arctic forest region, but from Raft river to Cape Henrietta Maria there is a considerable admixture of species more arctic in their character. No truly arctic species were collected, however. The collection is so complete that little, if anything, more remains to be done botanically along the coast between Moose Factory and Cape Henrietta Maria."

My thanks are due to the Hudson's Bay Co.'s officers whom I met in the course of my expedition, and I may mention in particular Mr. George McKenzie, Chief Officer in charge of the district.

I also wish to thank Rev. Mr. Holland and Mrs. Holland of Moose Factory, Mr. and Mrs. Christie of New Brunswick Post and the Rev. Fathers of the Albany Mission for pleasant hospitality.

Geology of the Country Around Bruce Mines.

By Messrs. E. D. Ingall and Théo. Denis.

During the summer, Messrs. E. D. Ingall and Théo. Denis were engaged in continuing the detailed geological investigation in the Bruce Mines district of Algoma, which they had commenced in 1902. Introductory.

Mr. Ingall left for the field on 22nd of July and proceeded to Desbarats, where work was commenced. Mr. Denis left for the field on Aug. 5th. and joined Mr. Ingall at Desbarats, and together they continued the work until the end of October.

Mr. Geo. S. Scott of Toronto University, a student in practical science, was attached to the party, and was of great assistance by reason of his energy and the keen interest he took in the work.

Considerable delay resulted from unfavourable weather, especially towards the end of the season, when the heavy rains made the lower lying lands very difficult to traverse.

In tracing out the various sedimentary and intrusive formations, the roads and coast line of the lakes, islands etc. having been surveyed, the intermediate areas were examined by means of lines paced along compass bearings through the bush. It was found that when corrected by tying on to fixed points at either end, this method was rapid and gave sufficiently correct results. Surveys.

The road surveys were made with prismatic compass and micrometer, whilst the plane table and micrometer were used for the larger scale detailed work around the mines and for some parts of the coast line.

When starting this work in 1902, the topographical surveys had been completed and a preliminary geological examination had been made over an area comprising some 400 square miles.

As a result of that season's work, it became evident that to trace out the distribution of the intrusives and other members of the formation so as to make even a reasonably accurate, detailed map would take several seasons. It was decided, therefore, to select and complete a smaller area which, whilst affording facilities for the examination, should at the same be typical of the geological conditions surrounding the economic mineral deposits of the district.

In this way a final map was made of a rectangle covering some seventy square miles, which included the Bruce and Wellington group of mines within its eastern extremity, and extended in a general W.N.W, direction for twelve miles in length by about six miles in width as far west as Killaly point, on the coast, and as the western end of Desbarats lake, inland.

Huronian series.

The area above outlined is underlain by rocks of the Huronian series as originally studied and described by Logan and Murray in the early days of the Geological Survey. The results of their work are to be found embodied in several reports and in a map on a scale of eight miles to the inch included in the atlas accompanying the "Geology of Canada, 1863." For the Huronian rocks, the succession given by Murray, is, in descending order, as follows:—

	Estimated Thickness.
l.—White quartzite chert and limestone	2,100
k.—Yellow chert and limestone	400
i.—White quartzite	2,970
h.—Red jasper conglomerate	2,150
g.—Red quartzite	2,300
f.—Upper slate conglomerate	3,000
e.—Limestone	300
d.—Lower slate conglomerate	1,280
c.—White quartzite	1,000
b.—Green chloritic schist	2,000
a.—Gray quartzite	500
Total	18,000

The above series is represented as lying on the Laurentian and as overlain by the Lower Silurian division of the Palæozoic.

In the areas of which the re-mapping has been completed by Messrs. Ingall and Denis, are found only those beds from (c) to (i) inclusive in the above column. As a result of the work done, the succession as thus worked out by Murray was confirmed, although it was found necessary to make considerable changes in the geological boundaries, delimiting the areas covered by the different sub-divisions.

Basic intrusives.

In addition to these sedimentaries, however, a number of extensive areas of basic intrusives form very prominent features in this district. As they have apparently considerable influence on the economic deposits of the formation, their delimitation becomes of great importance.

Although Murray noted their existence, he seems to have assumed that they were practically all surface outflows, nor did he, apparently, attempt to follow them out or study their relationships, etc., in detail. In view, therefore, of the economic importance of these intrusives, it became necessary to undertake the tedious work of exploring for and of delimiting the areas occupied by them, studying also their relationships to the other rocks of the formation.

A number of extensive areas exist, which, until closer determination is made microscopically, may be called, generically, diabase. All those so far examined are uralitic.

The most extensive and important area of intrusive rocks is undoubtedly that within which are included the copper ore veins worked in the Bruce and Wellington mines.

By reference to the accompanying sketch plan it will be seen that this is roughly represented by a belt having an average width of about a mile and a half, and extending from a point about a mile and a half west of Bruce mines village, in a general easterly direction, continuously for about four and a half miles, where it passes off the sheet. Its outcropping is seen to gradually narrow down in passing eastward, for, whereas the width measured northerly from McKay island is nearly two miles, it narrows down, toward the eastern limit of the plan, to one mile, and about a mile still further east, the width exposed is but half a mile. Limit of intrusives.

In its westward extension, this zone seems to terminate abruptly against the limestone belt as the latter swings round the curve of the anticlinal fold in the sedimentary series, and appears on the shore.

Although there appears to be, in this instance, a general conformity with the stratified rocks, the intruded material seems not to be absolutely confined to one horizon, but to have broken through into the upper beds at several places. The question thus remains open as to whether the intrusion extends in a more or less vertical attitude downwards through all the beds or whether, on the other hand, it constitutes a sheet of basic rock intruded between the sedimentary strata.

In the decided diabasic characteristics of the rocks, as far as present microscopic determinations go, and in the observed jointing resembling bedding, is found evidence in favour of the latter view.

On the other hand, the general appearance in the field, especially in regard to some of the other occurrences of similar diabase areas, leaves a strong impression that they represent masses often elongated in long dike-like forms intruded, almost vertically, through the generally flat-lying sedimentary series.

Limestone.

At one point along the northern boundary of the Bruce mines diabase area, an intrusive contact with the limestone is shown, and at a point about five hundred feet N. W. from No. 2 shaft of the Wellington mine, a ridge of limestone, showing a distinct strike about S. S. W. and a flat dip westward, is crossed, almost at right angles, by the diabase about a hundred feet to the south. The actual contact is however covered by soil. On the south side of this area, on the southern shore of Jacks island, is some further evidence of a similar nature. Here, at the water's edge, a salmon-coloured quartzite, apparently in the usual flat-lying attitude, abuts against the diabase mass of the island; higher up, in a little bluff, small splinters of the same occur as inclusions.

Southerly limit of diabase.

Although, as above mentioned, the diabase intrusives and the limestone band abut at several places, low ground as a rule intervenes between the adjacent outcrops of the two rocks. Considerable exposures of the lower conglomerate are exhibited, as shown east of the Rock lake railway line, and also near the middle location road which runs north from the Portlock and Bruce Mines road at a point about a mile west of the latter place. On this evidence, the low ground alluded to has been assumed to be underlain by these same rocks. There is some slight evidence also of a similar arrangement of material where the limestone band skirts the shore of Lake Huron west of Bruce Mines harbour.

The southerly limit of the diabase area is marked by a range of high bluffs extending in an easterly direction from the bottom of Hay bay, for a distance of a mile or more and between this and the first rock outcroppings to the south. The latter are of a pale pink to white quartzite which would represent the lowest member in Murray's succession appearing in this district. The distance of about half a mile between the two rocks is occupied entirely by a wild hay meadow and swamp, so that the actual line of delimitation between the two can only be surmised.

Passing westward along the shore, no other extensive development of the intrusives is found until the Portlock area is reached. This exposure, as will be seen from the sketch map, has been traced in a general east and west direction for a distance of some three and a half miles. The exposure has, for most of its length, a dike-like form and shows an average width of about a quarter of a mile. It outcrops on the line of the Canadian Pacific railway at a point about two miles east of Portlock station, and crossing the Portlock river near its mouth, continues westward parallelling the shore of the lake for a further distance of a mile and a half, ending at its western extremity in a bulbous termination. At about three quarters of a mile south-easterly from Desbarats village, the most northerly exposures are in the bluffs skirting the low flat of the valley of the Desbarats river, leaving the question open as to whether there is any connection between this area and the ridge of diabase commencing on the other side of the valley at the north end of the village. Similarly, at the end of this range, there is a break in the continuity of the exposures, due to intervening low ground, so that the connection between this range and that to the north of the Canadian Pacific rail way is more or less problematical.

Diabase intrusives.

In the north-west corner of the map sheet are large areas of the diabase intrusives. On the western side of Desbarats lake there is a large development of igneous rocks extending towards the north-west, beyond the railway, and bounded on the east by a narrow fringe of red quartzite which forms the western shore of the lake and passes towards the north into the jasper conglomerate.

This area of diabase is very irregular in outline. It consists of a central mass about ninety chains east and west by sixty to seventy chains north and south, from which radiate several arms or tongues. Two of the widest of these, having a south-easterly trend, were traced for two and three miles respectively, and proved to be very irregular in shape and outline.

The more easterly of these two tongues crosses the outlet of Desbarats lake, just above the dam built on lot 26 of the sub-division of Desbarats location, and extends to beyond the eastern boundary of the location. It disappears under the covering of drift of the valley of Portlock river, but it is quite possible that it extends further, as the quartzite formation, on which is situated the Cameron mine on the east side of the river, is cut by dikes of diabase, the same rock outcropping north of the shaft. This belt may further be connected with another large area of diabase which is situated on the south of Caribou lake, occupying a large part of the northern half of the Hinks mining location, and which is described later.

From an examination of a thin section from a dike in the vicinity of the Cameron mine, Dr. G. A. Young describes the rock as being "a much decomposed, fine-grained diabase with quartz which is probably secondary." From a thin section cut from another specimen, Mr. Denis describes it as a "medium-grained rock very much altered, but with visible diabasic structure." On each side of the belt, the rock is red quartzite, studded with an occasional pebble of jasper.

The other, or western tongue, which was traced out, follows a direction roughly parallel to the railway, and disappears near the northern part of the town site of Desbarats, under the alluvial covering of the Desbarats river valley; the belt crosses the Bruce and Sault Ste. Marie road about thirty-five chains east of the railway crossing.

Uralitic diabase.

A preliminary examination of this rock as a whole points to it being a uralitic diabase. Dr. G. A. Young, who examined a thin section from the main part of the area, describes it as "composed of abundant plagioclase laths (containing grains of calcite and epidote and penetrated by chlorite) idiomorphic towards a pale greenish, secondary-like hornblende. The rock has a diabasic structure, and the secondary hornblende is of the kind seen in the other sections, which contained augite."

There are probably other arms of various widths radiating from the central mass of igneous rock, and it is likely that the narrow belt on which are situated the workings known as the Richardson mine, on the east shore of Desbarats lake, is connected with it.

Igneous rocks.

Another development of igneous rocks occupies the greater part of the northern portion of the Hinks location and extends into the Keating location. It appears to measure over 150 chains east and west. On the south, the greenstone disappears in the low ground which lies between the railway and the road opened along concession VI of the Hinks location subdivision. The northern limit falls outside the boundary of the sheet of the area examined. The igneous rocks area probably extends north of Caribou lake, and the ridge on which are situated the workings on the Williams property (shaft said to be forty feet deep on quartz stringers containing copper) on the south half of lot 12, Con. II., Plummer township, is probably a part of it. The time available was too limited to allow of the definition of this development of diabase beyond the boundary assigned for mapping, and no thin section of the rock has yet been examined. As before mentioned, on account of intervening low ground, it cannot be positively proved that this area connects with the Portlock range of diabase, but it is regarded as probable, and is accordingly so designated in the sketch plan. The diabase areas above described do not, of course, constitute the only exhibitions of igneous intrusions in this area; smaller dikes are of common occurrence, cutting the sedimentaries throughout this whole district.

THE SEDIMENTARY SERIES.

Sedimentary series.

The lowest member of the above series appearing on the map sheet, is that designated (c.) in the column given on a previous page. It consists of a white or very pale pink quartzite frequently containing thin layers of small pebbles of white translucent quartz or dark gray-brown jasper, the former decidedly preponderating.

Of the rocks designated "lower slate conglomerate" (d) there is but a slight development in this district, their place being mostly occupied by the Bruce Mines diabase intrusion. In fact, for this vicinity, the term "slate conglomerate" seems to be rather a misnomer, as, whilst the beds carry pebbles as elsewhere, they often present a quartzitic appearance. East of the road from the village to the station of Bruce Mines, a pale pink quartzite shows along the north side of the lower Thessalon road. This contains layers of boulders and pebbles, and is overlain by a thin layer of very dark-coloured quartzite in which the pebbles are numerous. This is specially noticeable immediately east of the Station road and, with a flat dip, the quartzite passes under the limestone belt that outcrops a short distance to the north of it.

Limestone belt.

The limestone belt (e) is apt to be variable in composition and at places charged with argillaceous, siliceous and other impurities. On exposed surfaces the more impure bands are accentuated by the process of weathering, and the strike, as well as the folds and twists, etc., in the beds, are thus made plain.

By reference to the sketch map, it will be seen that the next two members of the series occupy the greater part of the area mapped.

Upper slate conglomerate.

The "Upper slate conglomerate" (f) constitutes the coast line for over five miles easterly from Portlock harbour; it forms most of the smaller islands and rocks between this point and Killaly point, as well as the northern shore of Campement d'Ours island, all of Portlock island and the eastern portion of Dawson island.

Slaty rocks and a general slaty appearance are the marked features of this horizon, although quartzitic developments are by no means uncommon. No particular slaty cleavage is present. The pebbles, which are a characteristic feature, are very unevenly distributed, and are as apt to be scattered through the rock as to lie in definite layers. On some of the islands, however, and at other places, solid beds of pebbles are seen, whilst over large areas, only the slaty rock is to be found practically free from these inclusions. In both the upper and lower conglomerates the pebbles vary much in size, ranging from those a foot or over in diameter down to the size of small marbles. They are of varying composition, but all are apparently derived from the underlying formation. The materials most frequently represented in the pebbles are granitite, gneiss, quartzite and jasper.

Red quartzite.

The next higher horizon consisting of the red quartzite (g) covers also a large part of the area mapped. It comprises a series of quartzite beds of various shades of red. It constitutes the coast rocks from the Portlock river, westerly, to the limits of the map ; a few of the islands close to the shore are also of this rock. Pebbly portions are not unfrequent, but do not form a prominent feature.

Jasper conglomerate.

Towards the most westerly portion of the area studied, still higher beds of the series are encountered. These probably represent the red jasper conglomerate (h) of Murray. The main distinction between these quartzitic rocks and those last mentioned, is to be found in the much greater profusion of the pebbles of quartz and jasper of red and other tints. The finer quartzitic ground mass of the rock being white, also serves to distinguish it, although the distinction between the various siliceous members of the series rests rather on such general features as the colours and proportion of pebbles than on anything else, and no sharp delimiting lines can be expected.

The general attitude of the sedimentaries is as represented on Murray's map, viz. that of a flat anticlinal whose easterly and westerly axis pitches towards the west. This structure is made plain from the swing of the outcropping of the limestone bed near Bruce Mines and, in passing westerly, the upper beds seem to follow in average conformity to this trend. Locally, there are of course variations from the average strike and dip and many secondary folds. Nowhere are the angles of dip very steep, the higher measuring from 30° to 40°, whilst over large areas, the dip would possibly average about 15° or under. In fact, along the coast and throughout the islands westerly from Portlock harbour, the beds seem to lie in a series of gentle undulations, so that islets and reefs of turtle-back shape are common.

Economic minerals.

The minerals of economic interest in the district are the sulphuret ores of copper* and the hematite ores of iron.

* For results of recent assays of these ores see Appendix at end of report.

Geological Survey of Canada

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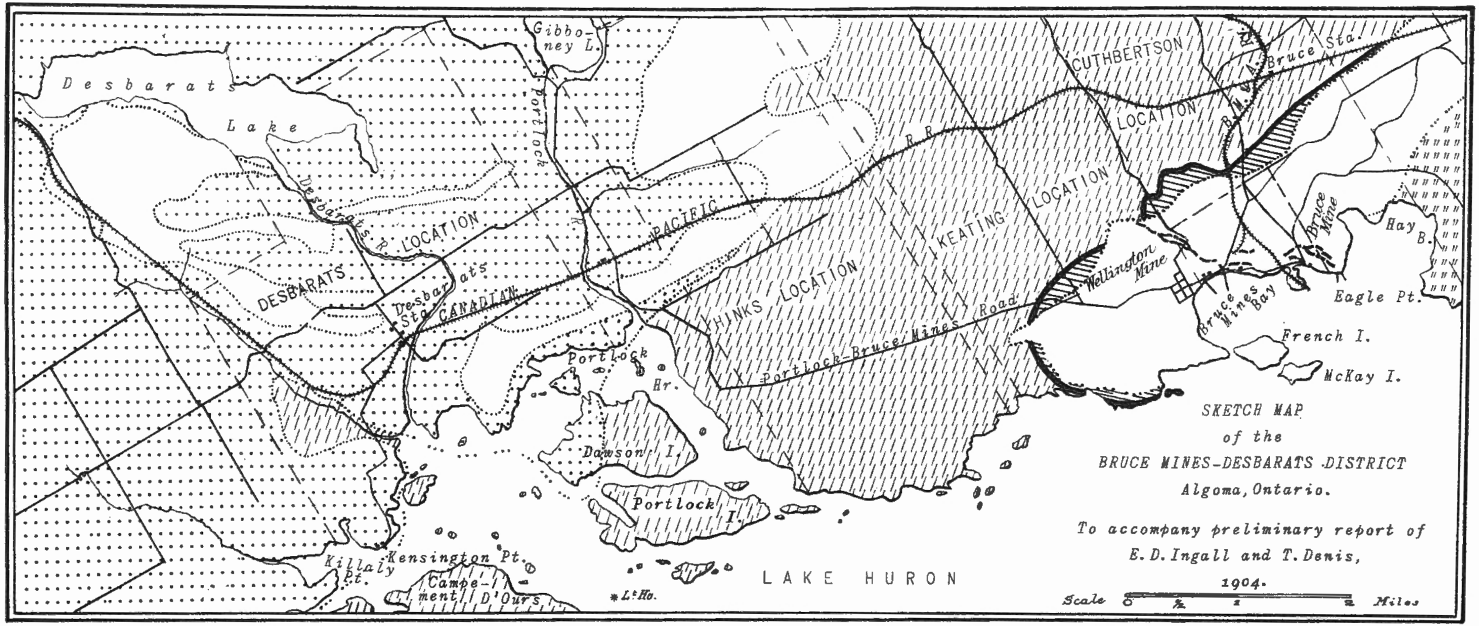
1905



To accompany Part A, Vol. XVI

No. 898

Within the area of this sheet, development work has been done on veins of the former ores at the Bruce and Wellington groups of mines and at the Cameron and the Richardson. Copper.

At a few places within the same area, a small amount of development work has been done on aggregations of ochreous and hematite ores such as are frequently found to occur near the contact of the diabase inclusions and the sedimentaries, chiefly occupying shattered portions of the latter. No deposits of economic importance have, however, yet been proved.

For the past two years, all the mines in the district have been practically idle, although shipments continue to be made to Sudbury from the old waste piles at Bruce mines.

The veins worked in this group of mines consist of fissures. They carry the copper in the form of different sulphides, chiefly chalcopyrite, in a gangue of quartz. At places the gangue is partly dolomitic, but the former mineral is very largely predominant, as evidenced by the material of the waste piles around the workings. Near their outcrops the veins are said to have carried a higher percentage of copper than below, owing to the presence of bornite and other rich sulphides of the metal. The presence of these minerals is probably due, as would elsewhere appear, to secondary enrichment.

Wellington and Huron Copper Bay mines.

A preliminary examination of the lower levels of the Wellington and Huron Copper Bay workings showed chalcopyrite with some pyrite disseminated through a gangue of white quartz. In the Wellington and Huron Copper Bay mines, the veins have been worked out to great widths, excavations often being twenty-five to thirty feet wide. Of course there are many places where the veins narrowed down sometimes to not more than four feet in thickness, but ten feet might be accepted as an average of the thickness all the way through. At the old Bruce mine, the veins are seen to be narrower and, in the main workings, possibly would not average more than five feet.

The total length attained in the Bruce workings would measure about 2,000 feet, whilst the combined length of the Wellington and Huron Copper Bay mines would measure nearly 2,500 feet. The workings of the Bruce attained depths of 250 to over 300 feet and at the Wellington the average of the depth attained in the workings would be about the same, although Bray's shaft was put down to about 1,060 feet. The area of the veins stoped out, as shown on the old plans, would measure approximately as follows, viz.: At the Bruce mine about 225,000 square feet, which, assuming a depth of 300 feet for the mine, would represent a length of, say, 750 feet of vein excavated. At the Wellington, a total measurement is shown of about 600,000 square feet, which would represent an assumed average depth of 300 feet, an equivalent in length of 2,000 feet. In both cases, it must be borne in mind that in these dimensions the two mines represent workings on two main veins close together and parallel to each other. In the Wellington mines, the veins were known as the New Lode and Fire Lode. They parallel each other for about 1,300 feet but join together to form a single vein at the east and western ends of the workings.

Bruce workings, west.

The westerly part of the Bruce workings is situated on the main lode and its branches for about 1,300 feet, whilst east of this, for about 600 feet, the chief excavations are on two veins known as the Trial and Dodge. A good deal of prospecting work was done on the minor veins and branches in the vicinity of these two chief mines, and also on veins which outcrop in the 4,000 feet of distance intervening between the Bruce and Wellington workings, but much more development will have to be done before the question as to the practical continuity of the series of fissures and their profitable nature can be settled. An excavation called Taylor's shaft, from which it was said some test drifts were run, was sunk at a spot about midway between the two mines, but no details are available as to the results attained.

West Canada Copper Co.

The particulars given above refer to the work done, during the first period of the history of these mines, by the West Canada Copper Company and its predecessors. This period ended with the cessation of work in 1876. When this company was working at its strongest, it employed as many as 380 men, and for the period of years from 1858 to 1875, produced about 37,378 long tons of concentrates, having a total content of nearly 7,500 long tons of copper, valued at over $2,000,000. The average price received for the copper during that whole period of eight years would thus be somewhat over seventeen cents per pound. Since 1858, however, the price of this metal has fallen considerably. In that year the company obtained an average of twenty-one cents per pound for its copper, whereas the figures for 1875 show an average value of less than sixteen cents per pound. When the present company bought the mines, a few years ago, some further work was done, of which, however, we have as yet no complete data. At present nothing is being done other than to keep the plant and workings in order. In connection with the operations of the present company, the mines have been fully re-equipped with modern machinery for mining and ore dressing, the mill having a capacity of 400 tons per day. There were current rumours last year that the mines had been acquired by the International Nickel Co., but these seem to have been without foundation. As it is intended to give full particulars of this important group of mines in the complete report to follow later, nothing further need be stated here.

Causes of failure.

The final failure of the first attempt to work these mines seems to have been due to a variety of causes, many of which have ceased to be operative with the progress of opening up of the district, and it becomes a question whether successful work can not again be carried on with careful management and the improved plant and methods available.

Cameron mine.

About two and a half miles north-east from Desbarats station on the Canadian Pacific railway (Algoma branch) is the mine known as the Cameron or Stobie. At this place a fissure vein is seen cutting a ridge of red quartzite. On this vein a shaft has been sunk some 150 feet in depth, from which, at the 100 feet level, have been run drifts east and west totalling in length about 150 feet. To the east of the shaft the vein does not outcrop, but west, for a distance of 150 feet, it has been stripped; from that point it runs under the deep soil of the adjacent farming land of the valley. On the rocky ridges opposite the mine, 1,700 feet further west, small surface workings have also shown the existence of ore. These are roughly on the strike of the Cameron mine vein, but whether they are to be taken as representing its actual extension is doubtful. The outcroppings near the shaft show a composite vein of about four feet in width, the ore being chalcopyrite in a gangue of white quartz. Some specimens show, plainly, surface change of the chalcopyrite to bornite. The vein in the workings shows a dip of 75° to the south and a width at places of about twelve feet, made up of subordinate branches with 'horses' of quartzite.

Richardson mine.

The workings known as the Richardson mine are situated about two miles and a half north of Desbarats village near the south-east end of Desbarats lake. These consist of a small prospecting shaft and a number of shallow pits and trenches extending over a distance of about three-quarters of a mile along the strike of a series of greenstone dikes which cut the jasper conglomerate of the sedimentary series. The evidence of the intrusive nature of the greenstone is here very marked, long narrow strips and lenses of the jasper conglomerate being included in the igneous mass. Some of the mining work done here is altogether in the greenstone, as in the case of the before-mentioned shaft. Here, as so frequently observable elsewhere in the district, the rock is much decomposed: the resulting ochreous material has stained it, giving a very ferruginous appearance, whilst in the jointing etc., it has at times consolidated to form fairly good hematite ore."

On Corundum in Ontario and on Surveys near Lake Temagami.

By Dr. A. E. Barlow.

Introduction.

Dr. A. E. Barlow was engaged during the winter of 1903-4 in compiling a report on 'The Nickel and Copper Deposits of Sudbury, Ontario.' The finished manuscript was sent to the King's Printer on July 4. At the time of writing, a few copies of the complete report have been received, and it is confidently expected that the whole edition will be ready for distribution in a very short time.

Occurrences of corundum.

In this work, it has been the author's aim not only to embody the results of his own personal examinations and investigations, but also to bring together all the valuable and reliable information necessary for a true understanding and appreciation of the origin, geological association, extent and economic development of these immense ore bodies. This information is comprised in a volume containing 236 pages of text, illustrated by twenty-nine plates and five maps. Considerable progress was made in an investigation regarding the origin and composition of corundum, the basis of study consisting of specimens of this mineral and associated rocks from the now world-famous deposits of Central Ontario. Descriptions of occurrences of corundum elsewhere throughout the world have been closely consulted for purposes of comparison, attention being especially directed to the corundum deposits of India, Russia and the United States. These three countries possess areas of corundiferous rocks capable of economic development, although, so far as is known at present, none of these deposits are likely to become serious rivals of the Canadian mines. A report on 'The Occurrence of Corundum in Canada' is in progress and, as in the case of the report on nickel and copper, special care has been devoted to the economics of this mineral. This report awaits the completion of certain necessary chemical analyses (undertaken by Mr. M. F. Connor of this department) which are being conducted on material illustrative, not only of the different varieties of corundum, but also of the several somewhat peculiar and unusual types of rocks with which this mineral is invariably associated.

Robillard mountain.

Occurrences of corundum in Canana are now known to be confined to a series of eruptive rocks frequently presenting a well-marked foliation in very close accordance, as a general rule, with that of the surrounding granites and diorites (Laurentian gneisses). Outcrops of these rocks on Robillard mountain at Craigmont are regarded as belonging to an intrusive complex, the products during crystallization of a highly alkaline and aluminous magma. The resultant rock-types present several varieties of nepheline-syenite and a red feldspar rock which is the prevailing corundum-syenite or syenite-pegmatite. Most of the syenite-pegmatite is altogether free from quartz, though occasional exposures contain a very small proportion, thus showing a distinct approach to ordinary granite-pegmatite. Although all of these rocks are regarded as the product of one distinct period of plutonic activity, they are themselves somewhat different in age. Thus, the nepheline-syenite is older than the ordinary red or corundum-syenite, the syenite-pegmatite following, while certain quartz-pegmatites closed the period of volcanism. In age, these rocks doubtless belong to the Archæan, although they are intrusive into ordinary granite and diorite gneisses usually classified as Laurentian, as well as into the crystalline limestones and sedimentary gneisses of the Grenville series. Indeed, the calcite, which was at one time thought to be an original constituent, is now known to be derived from the crystalline limestone whose association with the nepheline-syenites is so general.

Character of corundum-bearing rocks

The corundiferous rocks are of syenitic or gabbroic type and appearance, the feldspathic constituent varying from microperthite, through albite, oligoclase and andesine to bytownite. Scapolite and nepheline often accompany or replace the prevailing feldspars.

Scapolite rock.

The dark greenish bands or portions of the ordinary red corundum syenite at Craigmont are made up almost entirely of scapolite, with a much smaller quantity of titaniferous magnetite and occasional individuals of corundum. These rocks are, as a rule, very poor in coloured or ferro-magnesian constituents, which may be either biotite or hornblende, or both. The prevailing absence or scarcity of quartz or free silica is especially noteworthy, although, in the corundum-syenite-pegmatite from Craigmont, quartz has very occasionally been noticed in the same hand-specimens with crystals of corundum. The rarer or accessory minerals include calcite, muscovite, apatite, garnet, magnetite (always titaniferous), sodalite, zircon, gahnite or zinc-spinel, graphite, molybdenite, chrysoberyl, pyrite, chalcopyrite, pyrrhotite, galena, eucolite and eudialite.

Corundum in nepheline-syenites.

The frequent occurrence, and, at times the abundance, of corundum in the nepheline-syenites of Ontario are, so far as is known, unique, for, although similar rocks occur as differentiated forms of the corundum-syenites in India and Russia, no corundum has yet been found immediately associated with them. It is confidently expected, however, by those who have studied the Canadian occurrences, that more careful prospecting and examination will result in the finding of corundum in the nepheline-syenites of both countries. In this connection, it is worthy of remark that at Craigmont small crystals of corundum, amounting to perhaps half per cent of the whole rock mass, have been found in a rock composed of about 63 per cent of nepheline and 30 per cent of plagioclase (an acid oligoclase). The remaining 6·5 per cent is made up of muscovite, calcite, biotite and titaniferous magnetite. Another closely related form, occurring at the same locality, with 4·5 per cent of corundum, contains 70 per cent of oligoclase, 12 per cent of nepheline, 10 per cent of muscovite, other minor constituents being calcite, biotite and titaniferous magnetite.

Origin of corundum.

The simplicity and, at the same time, completeness of the Canadian occurrences of corundum, combined with the fresh and unaltered character of the associated minerals, at once removed all doubt as to the pyrogenetic origin of this mineral, showing clearly its development as a primary constituent from a highly aluminous silicate magma, as one of the first products of its crystallization. The chemical analyses so far completed give remarkable emphasis to the fact that these natural occurrences conform very closely to the law formulated by Morozewicz from his observations of the behaviour of the cooling of magmas artificially produced. This law, in brief, recites that 'the development of corundum in any pure alumino-silicate magma is dependent on the ratio of the alumina to the sum of the other bases. With the knowledge of this fact, therefore, we can predict with the utmost confidence the saturation point for alumina for any such magma. Corundum, consequently, although an accidental or accessory mineral in these syenitic and gabbroic rocks is, nevertheless, frequently so abundant as to characterize the containing rock. For example, the specimen of the ordinary red corundum-syenite-pegmatite, chosen for analysis as representative of this rock occurring at Craigmont, contained 34·14 per cent, and the corundum-bearing rock from Dungannon township showed the presence of 13·46 per cent of this mineral. The results of concentrating operations on a large scale at the Craigmont mill, covering a period of two years, showed a saving 10·6 per cent of corundum.

Percentage of corundum.

Increasing use of corundum.

The increasing demand for corundum is due, not only to the improved methods of cleaning corundum, but also to the wider application of the material thus obtained. Its manifest superiority as an abrasive to the ordinary impure products sold as emery is being generally recognized. The decrease in price which is sure to come in the near future will drive emery and the other cheaper abrasives out of the market. It is confidently believed that the Canadian occurrences stand unrivalled, not only in regard to the great area covered by the corundum-bearing rocks, but also in regard to the comparative richness of the individual deposits as well as in the pure and unaltered character of the material secured.

It is particularly worthy of note that Canada is now the largest producer of corundum in the world, and the future of this comparatively new Canadian industry is very bright indeed, provided undue competition and over production can be avoided.

Production of corundum.

The various grades of crystal corundum hitherto produced have obtained an enviable reputation for purity and uniformity not only in this country but throughout the world. An idea of the rapid growth of the industry may be gathered from the fact that in 1900, the first year of its establishment, only three tons of concentrates were produced, valued at $300, while in 1903, the total output amounted to 1,119 tons valued at $87,600, of which 849 tons was grain-corundum, the remainder being rough-cobbed ore.

On May 1, 1904, Dr. G. A. Young, a graduate of McGill and Yale universities, was appointed as assistant petrographer to succeed Mr. O. E. Leroy, who had resigned this position to become geologist to the Imperial Chinese Mines Prospecting Administration.

From June 6 to 10, Dr. Barlow was visiting the mines and smelters in the vicinity of Sudbury for the purpose of securing additional information in regard to the nickel and copper industry. Many photographs were obtained illustrative for the most part of the modern smelting appliances recently installed by the Canadian Copper Company at Copper Cliff.

Work near lake Tamagami.

Dr. Barlow's intructions for the summer's work called for a continuance of the detailed geological exploration of the area in the vicinity of the Northeast Arm of lake Temagami, but, owing to his official engagements elsewhere, he was unable to give that large share of his time and attention to field work in this area as was at first contemplated. This work, which was begun in the summer of 1903*, was intended to trace with more accuracy and in greater detail than before, the geological associations of the jaspilite iron ranges occurring between the Northeast Arm and the Ko-Ko-Ko lake. Acting under instruc-

* Summ. Rep. Geol. Surv. 1903, pp. 120-133.

tions received from Dr. Barlow, Dr. Young, whose report is appended, left Ottawa for the Temagami district to examine the country lying to the east and south-east of Lake Temagami. He was assisted by Messrs. W. Herridge, of Ottawa, and M. E. Wilson, of Paris, Ontario, and speaks in terms of commendation of the performance of their duties. A few days were spent (July 26 to 31) by Dr. Barlow in company with Dr. Young and Professor W. G. Miller, provincial geologist, in a special examination of certain portions of the iron formation.

American mining congress.

The hon. the Minister of the Interior having decided that Canada should be represented at the annual meeting of the American Mining Congress to be held at Portland, Oregon, from August 22 to 27, Dr. Eugene Häanel, Superintendent of Mines, and Dr. Barlow were selected by him as the official delegates. In company with Dr. Häanel, Dr. Barlow left Ottawa for Portland on August 15. A report concurred in by both representatives has already been presented to the Minister of the Interior; it contains all such information on mining or geological matters presented or discussed by the delegates at this session of the Congress that may either directly or indirectly affect Canadian interests..

While in the West, the opportunity was embraced of examining some of the more salient features in connection with the geological associations of the Rossland ore deposits for purposes of comparison with those of Sudbury. During the few days that were allotted (Sept. 1 to 7) to this district, short visits were paid to the smelters at Grand Forks and Nelson.

Dr. Barlow returned from the West on Sept. 14, and left for Temagami on Sept. 18, where a month was spent in securing the necessary geological and topographical details in the area between the North and Northeast arms of Lake Temagami. The Ko-Ko-Ko jaspilite or iron formation was outlined with great care.

Surveys.

A re-survey was made of Ko-Ko-Ko lake which has been plotted on a scale of 40 chains to an inch, while similar surveys were made of a large number of smaller lakes, including Business, Charlie, Pine View and other lakes to the east of Ko-Ko-Ko lake. These will enable the geological boundaries to be shown in much greater detail than on the geological map previously issued.

ON SURVEYS BETWEEN RABBIT AND TEMAGAMI LAKES.

By Dr. G. A. Young.

Commencing at Long lake, on the line of the Timiskaming and Northern Ontario Railway, geological boundaries were traced within, and surveys made of, the area bounded by Lake Temagami and its Northeast Arm, the portage route to White Bear lake, White Bear lake itself, Rabbit lake and the southern boundary of map-sheet No. 138, or about latitude 46° 55′ N. Field work was continued until October 29, when the weather became very unsettled.

The country included within the above area is comparatively level, though abrupt ridges, seldom rising above three hundred feet, are characteristic of those sections, underlain by a formation of slate and conglomerate. Elsewhere, as a rule, the hills and ridges are much lower and rounded. The area is densely wooded and contains a large number of lakes, most of which drain into Temagami or Rabbit lake.

Geological succession.

The geological succession is similar to that of the area to the north of the Northeast Arm, but jaspery-iron-ore bands do not occur. The oldest series of rocks consists chiefly of schists, which, in one area, are mainly chloritic and sericitic, while, in a second area, hornblende and mica schists predominate. These schists are penetrated by masses of granite of at least two varieties, one of which is also cut by a body of syenite. The schists and intrusive masses of granite and syenite are, in places, unconformably overlain by a heavy conglomerate, which almost invariably grades up into a slate, and the latter, in one instance, is conformably overlain by a bed of quartzite. The beds of slate and conglomerate, as a whole, occur horizontally, and are frequently capped by sills of diabase. The diabase is also found resting on the schists and granites. Diabase dikes intersect the schists, the granites and the overlying conglomerate and slate formation; their relation to the sheets of diabase was not observed.

Areas of schists.

The schists form two large areas in which they, or the rocks from which they presumably are derived, are alone present, while in two other areas schists are present with what are probably more highly metamorphosed forms and with intermingled masses of granite. Schistose rocks occupy nearly the whole of the point between the Northeast Arm and Muddy Water bay on Lake Temagami, and continue in a band of varying width to the head of the Northeast Arm, where they extend southward nearly to the head of South Tetapaga river. This band, seldom above one-half mile in width, is bounded on the south-east by an intrusive granite, while on the east and north-east it passes under the overlying conglomerate. The boundary between the schists and the granite is not a definite one; on the contrary, as the granite is approached, masses of it, usually of a finer-grained variety, are found within the schists, the granite body appearing as a batholite underlying the schists. The rocks of this area are mainly gray to dark green or greenish black, dense sericite and chlorite schists, frequently having a very pronounced slate-like parting, and they appear to have been formed from the shearing of quartz porphyries and more basic eruptives, which, at times, still preserve much of their original character. These schists frequently contain disseminated sulphides, which, along certain lines or bands, are sufficiently abundant to cause the rock to become rusty from weathering.

A second area of schistose rocks stretches from Long lake westward to Lizard lake. The southern boundary of these rocks is formed mainly by an intrusive granite, while on the other sides, as a rule, the schists are overlain by tho conglomerate and slate formation or by sheets of diabase. Within this second area the rocks are usually very dark in colour and are mainly fine-grained mica and hornblende schists with masses of fine-grained to dense diabase-like rocks. The schists are frequently banded, and the strike near the contact is commonly parallel with the direction of the usually sharp line of contact of the intrusive granites.

The remaining two areas of schistose rocks are situated, one along the north side of Wa-sac-si-na-gama lake, and the other in the area between that lake and Ingall lake. Both of these areas are difficult to define, consisting, as they do, of intermingled masses and bands of dark hornblende and mica schists surrounded or penetrated by granite. Coarser-grained gneissoid hornblendic rocks are common within these areas and appear to represent highly metamorphosed forms of the schists or basic modifications of the granite, perhaps due to the absorption of the schists.

Granite varieties.

Two varieties of granite are found, which will be referred to as the gray and pink types. The gray type is by far the more abundant and occurs in two main areas; one of these is found on both sides of the northern extension of Wa-sac-si-na-gama, and reaches further north across the South Tetapaga river; the other is found about Ingall lake, extends north to Lizard lake, eastward to Rabbit lake, and southward to the southern limits of the section. This granite is commonly of a grayish colour, coarse-grained, and, as a rule, is rather rich in coloured bisilicates. The feldspars are usually conspicuously large and tabular, and when hornblende is the chief coloured constituent, the latter mineral is often present in large prismatic individuals. Frequently, however, biotite is the principal coloured bisilicate; at other times it may be present with hornblende in about equal proportions. In the eastern area, the mineral constituents are sometimes seen to be rudely parallel, and, proceeding southward, towards the borders of the district, this tendency to parallelism becomes more prominent, the granite appearing to pass into a gneissic type. The granite of the eastern area is less uniform than the western representative, contains masses, more basic in composition, and is much cut by pegmatite dikes. At one point along the south shores of Wilson lake occurs the second type of granite, the pink variety. It is of medium grain and rather poor in coloured constituents; it underlies the conglomerate. A similar granite is also found on the shores of Lizard lake cutting the gray variety.

Hornblende-syenite.

On both sides of the eastern arm of Wa-sac-si-na-gama and on the north side of Brophy lake occur areas of pink hornblende-syenite. These areas and several others to the south of Brophy lake are separated from one another by a flow of diabase, but it appears that they are all part of one mass, undoubtedly intrusive into the gray type of granite. This syenite is of medium to coarse grain and is composed principally of broad tabular feldspar individuals. On the south side of Brophy lake, the syenite appears to grade into a fine-grained red granite, poor in coloured constituents.

Slate and conglomerate.

Three main areas of the slate and conglomerate formation are present, besides small isolated areas, sometimes measured in yards, at other times a quarter of a mile in diameter. One large area of these rocks occurs between Wa-sac-si-na-gama and Muddy Water bay and extends southward to Cross lake and Cross bay. Another large area extends from Ingall lake up to Lizard lake, while a third stretches from the head of the Northeast Arm to the southern end of Rabbit lake; this latter area is, however, separated into two portions by a sheet of diabase in the neighbourhood of Twin lake. The conglomerate, which is always found wherever the base of the formation is exposed, consists of a dark fine-grained base holding pebbles and boulders of granites, gneisses, schists, etc. The number of different kinds of rocks forming these pebbles and boulders is very large, and sometimes varieties are found which cannot with certainty be correlated with any of the types occurring within the district. But in general, a distinct preponderance of boulders or pebbles of the adjacent underlying rocks is found. On some glaciated exposures the granite appears to hold masses and strings of the conglomerate, but the presence within the conglomerate of rounded pebbles composed of what, macroscopically, seems to be the same granite, and the entire absence of metamorphism in the conglomerate, and of endomorphism in the granite, negatives this conclusion.

Wherever any considerable section of these sedimentary rocks is found, the conglomerate passes upwards into a slate by the gradual decrease in amount and size of the pebbles and boulders. Over large areas, however, the upper beds cannot be said to be true slates, since pebbles are of very common occurrence. The slates are dark coloured like the conglomerate, and like it, too, often lack distinct evidence of the original bedding planes. The formation, as a whole, occurs in a horizontal position, but the strike and dip are constantly varying. Sometimes the beds are sharply folded or plicated, but more generally they lie in low domes. At one locality, on Lizard lake, these small dome-like folds have preserved a small area of quartzite, an upper formation very common to the north.

Diabase.

Areas of diabase occur throughout the district, and it appears tolerably certain that all of these are parts of a once continuous sill. The rock is often very coarse-grained, becoming finer as the contact is approached and always dense at the immediate junction. The diabase is frequently found capping the slate, and the line of contact is seen to follow the folds of the slate formation. At one locality a sheet-like area of diabase passes gradually into a dike-like mass dipping under the granite; the diabase is also found dipping on all sides under hills of granite and syenite.

THE GEOLOGY OF A DISTRICT FROM LAKE TIMISKAMING NORTHWARD.

By Dr. Wm. A. Parks.

Introduction.

Pursuant to arrangements made with the director, I left Toronto on June 1, 1904, with instructions to examine as closely as possible the geological conditions of occurrence and general extent of the deposits of ores of silver, nickel and cobalt discovered along the right of way of the Timiskaming and Northern Ontario railway. As these deposits are situated within five miles of the village of Haileybury on Lake Timiskaming, the most convenient means of access, prior to the completion of the railway, was via Mattawa by rail to Timiskaming and steamer to Haileybury.

The second day of June was spent in Mattawa in securing men and supplies, and on the following day I was joined by Mr. H. L. Kerr, B.A., who had been appointed my assistant for the summer. The party immediately proceeded to Haileybury, and on June 6 we were enabled to begin work at the mines. About two weeks were spent here in work which will be described below, after which our headquarters were moved to Tomstown, on the Blanche river, and the rest of the summer was devoted to the exploration of the country from that centre. The cause for this alteration of the plans for the summer lay in the fact that the Bureau of Mines of Ontario had already despatched Professor Miller, the provincial geologist, to carry on the same investigations which I had been instructed to undertake. Realizing the lack of economy in duplicating the work, it was proposed to divide the field between Professor Miller and myself; the director was pleased to acquiesce in this arrangement and, in consequence, directed me to examine the country northward to the height-of-land, paying particular attention to the extent of the silver-bearing series, but not neglecting the features usually dealt with in a general geological report.

Surveys.

It was in pursuance of this arrangement that the party was moved to Tomstown. On June 22 a micrometer survey of the Blanche was begun from the above village and carried to the height-of-land. The route followed on this expedition was up what is known as the east or Abitibi branch of the Blanche or White river, to Windigo lake, and thence by a series of small lakes to Lake Present and beyond to Beaver House lake. Besides the lakes of this chain, several others, lying in the vicinity of the interprovincial boundary, were surveyed.

The north branch of the Blanche flows out of Beaver House lake; by means of this stream, which was surveyed as far as the boundary of the township of Catharine, we were enabled to return to Tomstown without retracing our steps.

Division of the work.

The territory between the north branch and the Montreal river consists chiefly of surveyed lands; on this account I decided, as no micrometer work would be necessary, to divide the party, and directed Mr. Kerr to examine the country accessible from the north branch while I proceeded up the south branch and investigated the country towards the Montreal river. Mr. Kerr succeeded in extending his trip to Lake Kenogami, while I was successful in the object of my expedition to the westward. We met at Tomstown on August 7.

The country immediately east of the lower part of the Blanche is entirely inaccessible by canoe; to gain a general knowledge of the rocks of this area an overland expedition was conducted eastward from Tomstown to the Quebec boundary and southward along the line to Lake Timiskaming.

Having determined that the general trend of the silver-bearing rocks is towards the north and east, I deemed it advisable to pass up the old Abitibi route via Quinze lake and examine the exposures near the height-of-land. For this purpose we left North Timiskaming on August 13 and spent two weeks in the vicinity of Opazatica and Island lakes. During this time the country immediately accessible was examined and track surveys were made on some unrecorded or ill-mapped lakes. After the completion of this work, on August 27, the voyageurs were paid off and the camp equipment was packed and sent to Ottawa. One day was spent on a trip to the Wright silver mine, after which Dr. Kerr and myself went to New Liskeard, and examined all the roads converging at that point. In order to see the progress of work on the mines during the summer, a few days were spent in the camps at Long or Cobalt lake, after which we proceeded directly to Toronto, where we arrived on September 11, having been absent on the expedition 102 days.

Cobalt (Long) lake.

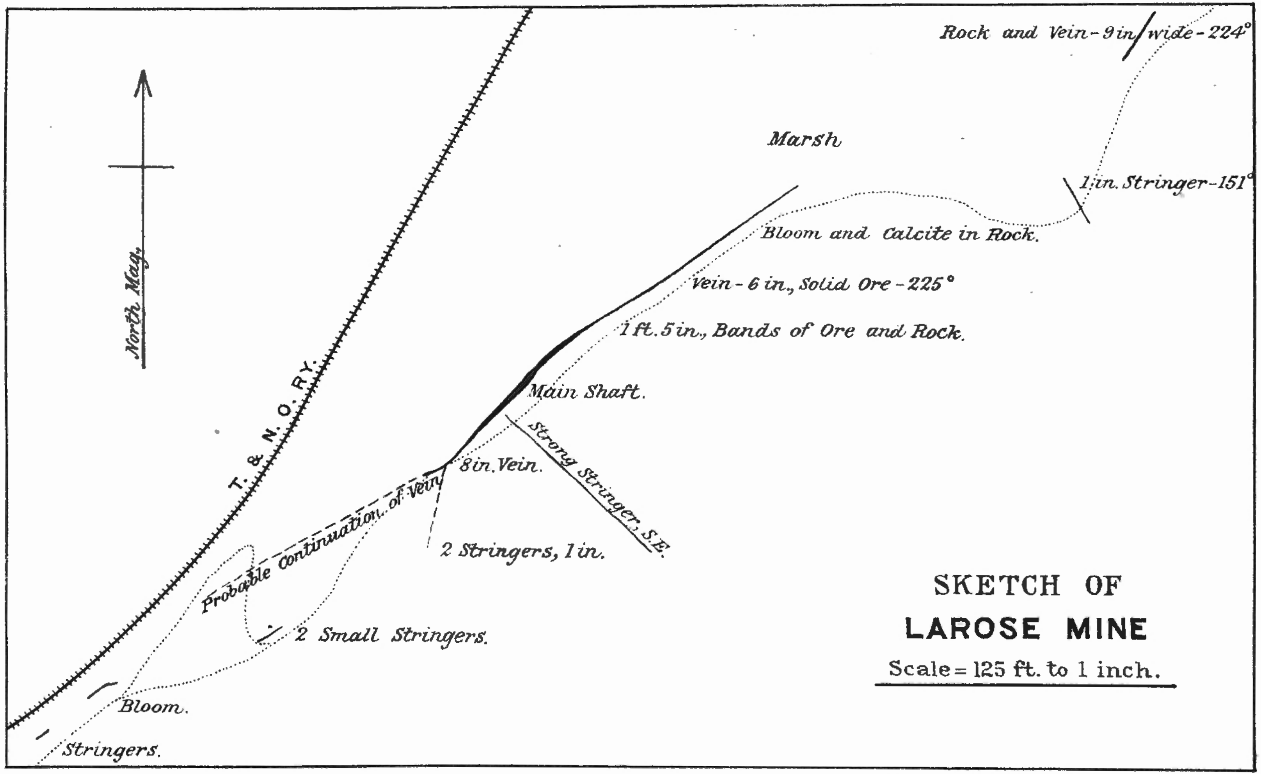
The main deposits hitherto discovered are situated in lots 4, 5 and 6 in both the fifth and sixth concessions of the township of Coleman. This area is intersected by the line of the new railway at a distance of about five miles to the south and west of the village of Haileybury.

The more important deposits are situated within easy walking distance of a small body of water, known previously as Long lake, but to which the name Cobalt lake is now given. This lake is less than a mile in length and is skirted by the railway on its north-west side. The railway plans provide for a station at this point, so that, on the completion of the line, the mines may be reached most conveniently by rail from North Bay.

The first detailed work on the geology of this area was conducted by Dr. A. E. Barlow during the seasons of 1892–94, and the results of his investigations are contained in the well-known report constituting Part I Vol. X of the annnual reports of this survey. This report is accompanied by two excellent maps, indipensable to anyone travelling in the region.

Discovery of cobalt.

While the right of way of the Timiskaming and Northern Ontario railroad was being pushed through the region in question, towards the close of the open season of 1903, the attention of certain individuals



To accompany Part A, Vol. XVI.

was attracted by the obviously metallic nature of some of the outcrops near the rock-cuts towards the foot of Cobalt lake.

Mr. T. W. Gibson, Director of the Bureau of Mines of Ontario, recognizing the importance of the discovery, directed Professor W. G. Miller, the provincial geologist, to make as thorough an examination of the deposits as the season would permit. The results of Professor Miller's work appeared in *The Canadian Mining Review* Dec. 31, 1903, This article was also issued in pamphlet form as a reprint as soon as possible after the completion of his investigations. Practically the same matter appears under the caption 'Cobalt-nickel Arsenides and Silver' in the twelfth report of the Bureau of Mines 1904.

For general economic purposes it may be considered that three valuable ores occur, smaltite, niccolite and native silver. Besides these, which constitute the bulk of the ore masses, a whole host of minerals of less importance has been identified, including erythrite, annabergite, chloanthite, dyscrasite, argentite and native bismuth. There is no doubt that laboratory work on the specimens collected will reveal many more mineral species. In the following notes the purely scientific side of the subject must be disregarded and all detail omitted until such time as the examination of rock sections, the making of analyses, etc., justify the issue of the complete report.

La Rose property.

The first discovered property referred to by Professor Miller as No. 1, is now known as the McMartin or LaRose property. It constitutes mining claim J. S. 14 and is owned by Messrs. McMartin, Dunlop and Timmins. The ore here is chiefly native silver and niccolite, the former mineral occurring as leaves and strings in the latter, as well as free in the accompanying calcite veinstone. Sufficient smaltite and other cobalt minerals are present to give the characteristic pink stain of cobalt-bloom to weathered surfaces of the outcrop. Without a large series of analysis, or the more satisfactory test of a mill or smelter run, it is very difficult to estimate the value of such extremely rich ore as is being produced from this property. Suffice it to state here that exceedingly high and variable values in silver are obtained from different parts of the deposit as well as important amounts of nickel, cobalt and arsenic. An average fragment of niccolite gave Prof. Miller 5.02 oz. silver per ton, 26.64 per cent nickel, 6.16 per cent cobalt and 46.64 per cent arsenic. The above figures in no way express the silver contents, as the specimen was one in which no silver could be observed. The silver mixed with the niccolite occurs in the mass of the latter mineral as flakes and leaves of variable size and weight, in some cases forming as much as 15 to 25 per cent of a hand specimen.

Assays.

An average sample of the niccolite weighing 321.5 grammes, on being crushed for assay, yielded 34.5 g. of silver which refused to pass through the sieve. The sifted portion gave 1138 oz. to the ton. This would, in all, correspond to a silver content of 11 per cent. It is in the calcite, however, that the larger pieces of silver are seen, as well as between the vein and the wall rocks, in considerable sheets, a foot or more in diameter. In the talus at the foot of the hill numerous pieces of silver have been obtained, upwards of a pound in weight.

The high value of the ore is undoubtedly proved; the question of the extent of the deposit is yet to be settled, but enough work has been done to justify the statement that a deposit of definite economic value has been exposed.

This property is situated practically on the railway, and the main outcrops of ore occur along the edge of a bluff across which a cut has been driven in the course of railway construction. The ore mass is vein-like in nature but subject to much fluctuation in width; it also shows a strong tendency to run off in stringers, at a low angle to the general direction of the vein.

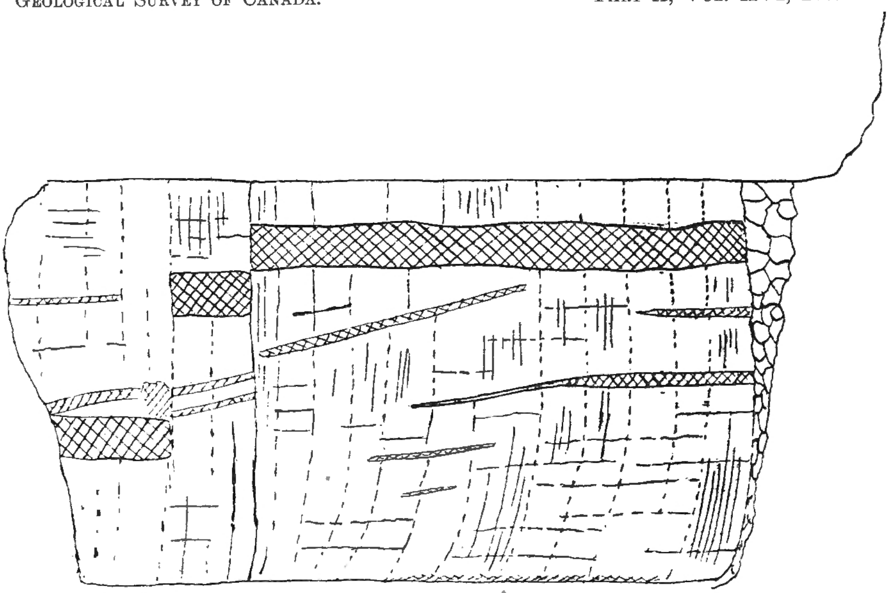
Composition of the vein.

In places, the vein consists entirely of ore, and in other parts, presents a calcspar gangue. The leaves of silver are in close association with the calcite, although they appear in the niccolite and smaltite, as already mentioned. The maximum width of the vein stuff is about eight inches, but a width of 14 to 18 inches of mineralized matter is presented in certain parts of the deposit. Without considering isolated shows or stringers connected with the vein, a continuous vein of ore has been traced a distance of about 140 feet, with an average strike of 60 degrees east of north. The north-east end of the outcrop does not entirely pinch out but passes into a small swamp. The accompanying sketch will give an approximate idea of the deposit, but this is of course liable to considerable alteration, as the work of development proceeds.

It is the intention of the owners to exploit the vein actively during the coming winter. A shaft will be sunk on the property near the widest part of the vein, and drifts carried in each direction from there. A substantial house has already been erected for the accommodation of the men and a successful winter's work is looked for.

Cobalt mine.

The next important property to the south-east is the so-called 'Cobalt Mine'. It is situated on mining claim R.L. 401, consisting of 168 acres, the property of Chambers, Ferland & Co. who intend to carry on work under the firm name of the Haileybury Mining Co. The



FACE OF THE OPEN CUT AT COBALT MINE.
(Scale about four feet to the inch.)

main outcrop of this vein is about 100 feet above Cobalt lake and but a few chains inland. The ore in this property is of quite a different nature from that of the La Rose mine. It consists pratically of smaltite, without any vein stuff, and contains little if any silver.

Pending further analyses the figures given by Professor Miller, in the report above cited, will serve to indicate the character of the ore. Analyses.

—	1	2	3	4	5
Cobalt	16 8	16.7	16.76	19.8	21.70
Nickel	.....	6.8	6.24	4.56	....
Iron	7.0	7.5	....	6.20	8.89
Arsenic	6.3	62.0	66.60	60.30	63.55
Sulphur	69.00	7.0	3.37	4.09	5.38
Insol. Silica	.9	....	....	2.40	.60
Water	......	....	....	2.00	....
Totals	100.00	100.00	....	99.35	100.12

Although these specimens were taken from different parts of the vein they are seen to be fairly uniform in chemical composition, and therefore may taken to express the general nature of the ore. As before stated, the ore is essentially smaltite, but small grains of niccolite may be seen scattered through the mass. The general appearance of the ore is dark lead-gray metallic, in some places more shining than in others; this is especially seen in the crystals which are common in the wall-rock near the vein. Wherever the veinstuff is fractured, erythrite appears on the surface and is found also to occupy secondary cavities in the ore body. Several tons of cobalt-bloom were taken from one such opening in the work of exploiting the deposit. Bloom also occurs in small cracks in the country rock near the vein and wherever the cobalt ore appears at the surface.

The first work in this vein was done near the top of the hill, about 100 feet above Cobalt lake, on the main outcrop, where a shaft was sunk and a cut run along the vein, following the strike, which is E. 55 S. At the time of my visit in June, this cut was 34 feet long and 9 feet 5 inches wide, at the widest part. At the southerly end of the cut, the shaft was sunk to a distance of about 30 feet. The face of the vein, as exposed on the south side of the shaft is, or rather was, very instructive. The cross-cut shows, from N.E. to S.W., the following appearance: one foot of dark slaty quartzite, ten inches of solid ore, two inches of rock, one half inch of ore, ten inches of rock with small amounts of ore, one half inch stringer of ore and fourteen inches of rock with Work done.

numerous approximately parallel stringers of ore. This rock is very fine-grained and filled with small cubes and octahedra of ore. The rock is followed by from three to six inches of irregular, decomposed rock and mineral, closely banded and much fractured. This belt probably represents the limit of the ore-bearing rock, for little or no mineral occurs from here to the limit of the shaft, a distance of four feet. In this rock, however, joints, parallel to the vein, occur, and on the extreme edge of the cut a half-inch stringer of impure ore forms a sort of line of demarkation and an imperfect limit to the shaft and open cut.

Strike and dip.

As already stated, the strike of the vein is E. 55° S. The dip appears to be about 8° to the south-west. Rock movements have displaced the vein to a considerable extent. At a distance of five feet below the shaft platform, a displacement, about equal to the width of the vein, has moved the lower strata to the south and west. A horizontal movement in the same direction has again displaced the vein at a depth of twenty inches below the first slip. The displacement is considerably greater here than in the first instance.

Lineal extent.

A rough sketch of the appearance of this face is seen in fig. II. On my return to this property, in the fall, it was found that the shaft had been sacrificed to continue the open cut along the vein, and that more than 200 tons of selected ore had been mined, as well as an undetermined amount of second grade material. It is impossible to say how great a lineal extent this vein may possess, for it is covered by a heavy deposit of soil to the south-east. In the opposite direction it continues to Cobalt lake, not, however, with the same strength observed near the open cut. In the bottom of the cut the ore is seen to continue in numerous stringers and in some wider veinlets. The great vein seems to be broken and shifted by the approximately horizontal faulting already referred to. On this account, it would appear at first sight as if the deposit were decreasing in value at greater depths. It is very unlikely, however, that a vein with the strength and persistency of this one would pinch out at such a limited depth. It is far more likely that the local faulting of the rock has led to a repetition of the two displacements so clearly shown, and that the vein will be found as strong as ever to the south and west of the present line of working. Disregarding the arsenic and nickel, and basing the value of this ore on the cobalt content alone, it is worth about $150 per ton. The cost of winning, at the present level at least, can not be more than $5 per ton. It is apparent, therefore, that much smaller stringers can be profitably worked, and that the high value of the ore will make it possible to subject the run of the mine to extensive hand-picking.

Stringers.

On the same property several small stringers of cobalt ore essentially similar to the main vein are found. Most of these are in association with the deposit described above, but one decided stringer starts from the water's edge at about the same point as the main vein and strikes due east with a vertical dip. This stringer reaches the considerable width of three inches in places, and has already been traced 100 feet up the hill.

Cobalt-bloom

At several points, also, along the water's edge and elsewhere on this location, cobalt-bloom has been found in small quantities, all pointing to the remarkable dissemination of cobalt in this vicinity.

Little Silver mine.

The high rocky land on which the last described deposit is situated continues to the south and west along the shore of Cobalt lake. It is cut, however, by a deep ravine containing a very small creek which discharges into Cobalt lake at the bight of a small bay in the south-east angle of the lake. On the northerly side of the escarpment caused by this ravine, and about fourteen chains from the water, occurs a third important mineral deposit. This mine is known locally as the 'Little Silver,' and is the property of Messrs. Ferland, Chambers & Co., the Haileybury Mining Co., which is also the owner of the 'Cobalt Property.'

The general trend of the bluff is north and south; straight up the side, almost ideal in its development, extends the vein, a distance of sixty-four feet. How far it extends below the level of the valley remains for development to reveal. The horizontal outcrop of the vein along the top of the hill, as well as its general strength, will be best seen by the following tabulation:—

From edge of bluff to top of bluff—the slope of the brow—39 feet, striking about 80 degrees.

Parting of the vein.

At the top of the bluff the vein breaks into two portions, including a lenticular space 37 feet long. One vein is 6 in. and the other 5 in. wide. General strike, 78 degrees. Vein 9 in. wide for a distance of 15 ft. 6 in. at 80 degrees strike.

At the eastern extremity of this portion the width increases to 1 ft. 4 in. of vein and mineralized rock. Here a second division occurs, a stringer leading off at about 70 degrees, but the main vein continues at 80 degrees a distance of 21 feet continuously traced. At this point the stripping is done at intervals only, but numerous outcrops are to be seen for 150 ft. farther. The vein does not pinch out here, however, but is merely covered by the heavy accumulation of soil not yet removed in the process of development. At a distance of about 70 feet from the end of the last outcrop, a third bifurcation of the vein is observed, and very rich ore is accumulated at the angle where the two components separate.

Near the top of the bluff, the vein is from six to ten inches wide and is composed of a number of lenticular portions of harder matter separated by bloom and native silver, the whole much decomposed. Ten feet down, the banded lenticular nature of the vein stuff gives place to a distinct bilateral vein, with the filling material reaching from both walls to an indistinct line in the centre.

Description of vein.

Towards the bottom of the bluff the distinct vein-like nature of the deposit is less pronounced. Here, where considerable opening up has been done, the vein stuff is less decomposed and is seen to consist of fine, granular smaltite mixed with the quartzite which forms the the country rock at this level. The vein shows lenticular masses of this ore, pinching out almost entirely in places. The fissure is by no means so clean cut as appears from an examination of the surface of the bluff, but the ore seems to run in sheets, parting from the main vein at a low angle and either pinching or returning to the vein again, so as to enclose a lenticular portion of the country rock. As above stated, these sheets of ore consist of fine, granular smaltite with rock matter. Almost invariably, each sheet is lined on both sides with a generous layer of native silver, which mineral also permeates the ore in small leaves and grains. On breaking down the bands of smaltite, the silver is seen adhering to the wall rock in considerable sheets. A large amount of dirty ferruginous selvage matter is met with in many parts of the vein; on assaying, this is found to be surprisingly rich in silver, running as high as 36 per cent. An average of several samples assayed in the laboratory of the University of Toronto gave 9,450 oz. per ton. The maximum width of the main vein, not all ore, however, is 1 ft. 5 in.

Offshoot of the vein.

About nine feet to the south of the main vein, a narrow seam of similar ore, rich in silver, is found. This nine feet has been removed in making an open cut in the side of the hill. The stringer seems to be nearing the vein, and is probably an extreme example of the habit of the vein to embrace lenticular inclusions of the country rock.

Although a large amount of cobalt is present in this property, it is to the silver that we must look for its greatest value. Assays of such exceedingly rich material are not of any value, as uniform sampling is out of the question. Much material is extracted which can not run less than 70 or 80 per cent in silver; some of the poorest contains from 15 to 25 per cent of the precious metal.

Loose silver is common in immediate proximity to the vein; every depression in the rock on the top of the hill contains much free silver. The earth occupying these depressions is deemed by the owners of sufficient value to sack and ship for treatment. A local process of washing is not satisfactory, as the flaky nature of the silver causes it to be borne away by a stream of water. Loose silver.

There can be no doubt that a very valuable deposit of silver exists on this property, R.L. 404. The richness of the ore is established. The future value of the mine will depend more on the maintenance of strength in the vein than on the assay value of the ore.

The Haileybury Mining Co. are now driving a tunnel into the bluff at the bottom of the hill. The ore taken out is to be sacked and shipped for treatment.

It is considered advisable to quote here the results of assays given in Prof. Miller's report already cited.

All the below mentioned samples are of the earthy, weathered ore from the Little Silver mine. Analyses.

—	I	II	III	IV
Silver	23 97	27 00	26 24	16 60
Cobalt	2 85	2 80	8 34	3 91
Nickel	0 97	1 00	5 26	1 42
Arsenic	18 30	19 30	13 28	19 79

A short distance east of the vein the quartzite is seen to be highly impregnated with fine granular galena. This is at a level just below the contact with the conglomerate. It may throw some light on the origin of the silver to note that this rock gave 1 oz. 5 dwt. 16 grs. to the ton. As the galena forms but a small portion of the material assayed, that mineral itself must be very rich in silver.

Almost at the southern end of Cobalt lake, a little distance up the easterly shore, is situated the Darragh and McKinley mine on location J. S. 14. This valuable property was discovered by Messrs. Darragh Darrah and McKinley mine.

and McKinley, with whom became associated Mr. Anderson. The property was taken up in the names of these three men and a certain portion was subsequently sold to Mr. Gorman of Ottawa. The firm is now actively developing under the name of the 'Cobalt-Silver Mining Company.' The main outcrops are situated in and along the side of a small bluff running parallel to the shore of the lake and about forty feet inland. Much local disturbance is evident in the immediate vicinity of the vein, including minor slipping of the rock and glacial disturbances. These effects have caused some trouble in getting down to a continuous vein, which has now happily been accomplished. The main vein runs almost due east and west, and is accompanied by many small stringers which caused considerable difficulty and annoyance in the exploiting of the property. It can serve no useful purpose now to describe the various stringers which were so anxiously watched during the early days of development. At present there seem to be three parallel veins of fairly constant strength, one four, one six and one seven inches in width, enclosing about twenty-two inches of ore, calcite and rock matter. This mineralized band has been traced about 250 feet. The ore is essentially smaltite with large amounts of native silver; of course, many other arsenides and sulphides, as well as native bismuth and considerable niccolite, occur. It is hoped that when the complete report is issued these mineral curiosities may be more fully dealt with. Here, for purely economic and practical purposes, it will suffice to consider the ore as consisting largely as above indicated. It will give a good general idea of the nature of the ore to quote again from the report of Professor Miller.

Composition of ore.

'A sample of the ore, which weighed $15\frac{1}{4}$ oz. and showed native silver, together with smaltite and considerable cobalt-bloom, was found by Mr. Burrows to possess the following composition:

	Per cent.
Silver	11·10
Cobalt	15·08
Nickel	5·56
Arsenic	49·68
Sulphur	2·55
Gold	None.
Iron	6·38
Insoluble matter	5·50
Undetermined, water, &c.	4·15
	100·00

As the work of development proceeds on this property the quantity of native silver obtained is astonishing. Until a statement is made by the owners the actual yield cannot even be estimated. Assay values mean little or nothing in a deposit where masses of silver of several pounds weight are constantly being encountered. (A specimen of smaltite, apparently devoid of silver, gave 26 oz. per ton.)

In the Darragh and McKinley mine the presence of considerable calcite accompanying the ore suggests the manner of occurrence in the McMartin property. The character of the ore is also much the same except for the much greater predominance of niccolite in the McMartin vein. At the Darragh and McKinley the rock has been greatly fractured at the time of the formation of the fissure. This is proved by the presence of a great number of stringers of calcite permeating the rock in all directions near the vein.

It is the intention of the owners to sink a small shaft on the most promising part of the outcrop and to ship the product for treatment.

Hudson's Bay Co's claim.

South and west of the railway and a few chains in from the corner of the lake, a claim has been located by the Temiskaming and Hudson's Bay Company. The prospect consists, at present, of a small crevice striking east and west with a vertical dip. Calcite is seen in the crevice, and also stains of cobalt-bloom. Much work is necessary before any opinion can be passed as to the value of the deposit.

J. B. VI claim.

Another very valuable property is J. B. VI., situated near the north-west corner of Cobalt lake. The outcrop is a few chains inland, but in immediate proximity to the railway. The vein strikes E. 25° S., and has been traced about 250 feet. The maximum width of the vein is about eighteen inches, with seven or eight inches of solid ore. The ore is of much the same nature as in the Darragh and McKinley, consisting of cobalt arsenides and a wonderful amount of native silver. A considerable amount of calcite vein-stuff accompanies the ore. Towards the westerly end, the vein is of less strength and seems to be less argentiferous. Reference was made above to the astonishing silver content of this vein. It is almost impossible to speak of the percentage of silver raised, when slabs of an inch or more in thickness and a square foot in extent are commonly met with, as well as great irregular knobs and masses in the calcite gangue and in the cobalt ore.

This property is owned by Mr. W. G. Trethewey, who is erecting a substantial living house and who intends to put in a small boiler and pump to clear the mine and to work steam drills in sinking the proposed shaft, which is to be carried down on the richest part of the vein.

Cross Lake claim.

Other properties have been located in the district, but only one requires note here, and that is a prospect belonging to Mr. Glendenning, situated near Cross lake, to the eastward of the mines already described. This prospect consists of a small vein of smaltite, the size of which has not yet been determined.

Cobalt-bloom has been observed at many places throughout the region, and it is a reasonable assumption that other valuable properties will be located as the region is more thoroughly prospected. At present the area known to produce cobalt and silver is rather small, being confined to the immediate vicinity of Cobalt lake. The extremes of even slight indications do not reach a greater distance than from Cross lake to the Montreal river. (It is worthy of note that Prof. Miller has seen bloom to the north-west of New Liskeard.)

I am indebted to Mr. J. W. Blair, O.L.S., of New Liskeard, for the following list of claims located in the vicinity of Cobalt lake, up to December 1. This list does not include all the claims located, but only those regarded as presenting reasonable prospects. These are, in addition to those described in the text :—

Other claims.

J. B. 7, south of the Trethewey mine.
Claim on lot 6, con. VI., Coleman (near Sasaganiga lake).
Claim south-east and west of the McKinley and Darragh, J. B. 3.
Claim on north-west corner of lot 2, con. IV., Coleman.
Claim on north-east corner of lot 3, con. IV., Coleman.
Claim on south-west corner of lot 2, con. V., Coleman.
Claim on north-east corner of lot 3, con. V., Coleman. (This location is said to present native silver occurring in the gabbro.)
Claim on north-west corner of lot 2, con. V., Coleman.
Claim on south-west corner of lot 3, con. VI., Coleman.
Claim on the south-east corner of lot 3, con. VI., Coleman.
Claim on lot 1, con. VI. (doubtfully reported).
Claim in the centre of lot 2, con. V., Coleman.
Galena on island in the east end of Gereau lake.

Geological formation.

Stated briefly, the geological formation of this region is a series of approximately horizontal sediments. Although minor exceptions may be found, these sediments consist of a series of fragmental matter modified by the action of water. The general, if not universal, sequence is, in ascending series, fine slate-like clastic rock ; medium-grained grit represented in places by quartzite : breccia-conglomerate. (Repetitions are known, and although the general sequence is as above, it is best to consider the three as different phases of the same series.) The lower rock is dark or light gray to black in colour, very fine-grained, reasonably hard, and weathers to a dirty white material with comparative rapidity. This rock passes into the second series without abrupt change. In this region, a typical fine-grained 'quartzite'* is the most prevalent example. The upper rock is a strange mixture of rounded and angular fragments of pre-existent material cemented in a matrix more or less comparable with the lowest member of the series. In this conglomerate are found rounded pieces of granite, felsite and many other acid rocks. Examples of the basic series of igneous rocks do occur, but much less frequently than the acid series.

In addition to these crystalline rocks the fragments present examples of the fine-grained metamorphosed schists of an older formation. It is worthy of remark that these latter are more likely to be angular in outline than the igneous fragments. Until the rock sections are examined it would be premature to speak further of the petrography of the series.

Age of the rocks.

The age to be ascribed to this group of rocks and its position in the complex formations constituting the most ancient rocks of the earth, is a matter to be approached with some hesitation. When the greatest authorities differ it is very difficult to decide on the proper nomenclature, so that the present writer feels that it would not be out of place to point out the different ways of regarding the subject.

The rocks near Cobalt lake are practically horizontal, but are bent into a number of low anticlines and synclines, the former of which by double plunging present flat-topped domes. Many magnificent exposures are seen in the rock-cuts along the railway from Cobalt lake to Montreal river. The sequence of the series is difficult to determine in these railway cuts, quartzite and conglomerate appearing in neighbouring cuts without any apparent relationship to each other. It would appear from some observations that repetitions occur, and that local conditions determine which should be at the bottom. In the great majority of cases, however, the slate is the foundation upon which rest conformably quartzite and then the breccia-conglomerate. This is well seen at the Little Silver mine, where the fine-grained rock at the bottom passes imperceptibly into the quartzite, the whole forming a bed forty-two feet in thickness, which is covered by twenty-two feet of breccia-conglomerate to the top of the hill. The dip of these beds seems to be 0°—10° to the westward.

Anticlinal dome.

At the Cobalt mine a distinct anticlinal dome is observed, the fracturing of which, near the summit, is responsible for the existence of the vein. The wall-rock belongs to the lower or middle member of the series, the upper having been removed by erosion. The conglomerate

* This rock is popularly called 'quartzite,' owing to it macroscopic appearance. It weathers white, however, and doubtless contains much feldspar.

does, however, occur on descending the hill; this is rendered possible by the decreasing dip of the rocks as the summit is receded from.

The other mines do not exhibit the structure of the country as well as the two above cited, but the same series of rocks is exposed in each, with nothing to indicate, in any case, that the metallic matter shows a preference for a particular member of the series.

Gabbro.

Large masses of gabbro occur on the outskirts of the metalliferous region and even approach within short distances of the mines. Whether these masses have any connection with the deposition of the silver, nickel and cobalt is merely a matter of conjecture.

We have, then, a circumscribed area, characterized as above, in which extremely valuable deposits are found; it is obviously of importance to trace this belt of rocks to its end, and thus ascertain the area in which a possibility exists of another series of deposits like that at Cobalt lake. By the direction of Dr. Bell, I left the immediate vicinity of the mines and spent the greater portion of the summer in working up the northerly extension of the silver and cobalt bearing series.

The metalliferous rocks are interrupted, to the north of the immediate region of productiveness, by masses of gabbro, limestone of the Niagara period, and a series of schists, the nature of which will be considered later. Following, or more or less interacting with, these interruptions lies the great mantle of clay which hides the rock for many miles to the north and west of lake Timiskaming. That the exposures of silver-bearing rock near Haileybury are actually continous to the northward is evidently not true, but that a great extent of precisely similar deposits stretches beyond the interruptions mentioned above is a fact, hinted at in some earlier reports, but established beyond doubt by the investigations of last summer.

Area of the metalliferous rocks.

Without going into details it may suffice for this report to state that the belt referred to extends in a somewhat narrow band from the outlet of Windigo lake in the township of Marter to the height-of-land north of Opazatica or Long lake. There is evidence that its trend there becomes more easterly and that it follows the great height-of-land ridge farther into Quebec. The south-easterly limit of the belt is approximately a line from the south end of Fish lake on the international boundary to a little beyond the north-east angle of the township of Ingram. The extension of this line to the north-east will be found to impinge on the shore of Opazatica lake near the northern end. This is in accordance with the facts. Here, however, as already observed, the tendency of the belt is to turn eastward and it swings off in that direction, following the great hills of the height-of-land. The north-western limit, stated in the same rough way, extends from the centre of the township of Marter to the north-east angle of Larder or Present lake, thence to the south shore of Labyrinth lake, then swinging east and south, it crops out on Island lake, and continues westward along the northern flank along the height-of-land idge. The further extension of the formations eastward was not examined, beyond a mile or two by overland trips. That similar rocks crop out still farther east is seen in the following note from the Summary Report of Mr. J. F. E. Johnston for 1901: 'On an island at a quarter of a mile from the inlet, a volcanic breccia is exposed, containing slate pebbles, pyrite and a pseudomorph, probably siderite after pyrite.' This is on lake Lois, about thirty miles north and east of Island lake, but along the height-of-land ridge, which bends quickly to the north a short distance east of Island lake. It is also interesting to note that Mr. Johnston does not again mention either breccia or slate in any amount until he reaches the *west* shore of Kekeko lake. This lake comes close to the height-of-land east of the north end of Opazatica lake. I would conclude from Mr. Johnston's observations that the belt of rocks in which we are interested extends as a narrow elevated belt approximating to the height-of-land at least as far as Lake Lois.

Breccia-conglomerate has been reported on Kenogami lake by Mr. Wilson, Mr. Bolton and Mr. Kerr; according to the last named it overlies Keewatin rocks, tilted at high angles. Our work on the north branch of the Blanche shows that the conglomerates of Kenogami lake are not continuous with those of Lake Present but that the two areas are separated by Keewatin rocks. Northward from Kenogami lake Mr. Wilson reports conglomerates across the height-of-land to Kekekdo lake. That these rocks are of the same age as the silver series is undoubtedly true; that they are as likely to hold silver as the Haileybury rocks is probably not so certain, as their slight extent and somewhat disturbed condition show different physical conditions. Between the Blanche and the Montreal rivers, a large area of gneiss occurs towards the north part of the region examined. The southern part shows Lower Huronian rocks and large masses of eruptive. That the upper series comes in here is probable, though the work of the summer revealed nothing of their extent. On lots 5 and 10 in the township of Beauchamp rather clastic looking rocks were seen, as well as large boulders of conglomerate. Also, on lot 5 in the IV concession of Henwood, was seen a gritty sandstone belonging to some upper

Breccia-conglomerate

series but not necessarily to the group exhibited at Haileybury. The region is covered by clay, and these outcrops are far apart and of limited extent. All the other isolated outcrops encountered are of basic eruptive. There is no doubt that some upper clastic rocks occur in this section, but having abandoned my camp, and being pressed for time, I was unable to penetrate far beyond the limits of the roads. I consider that a close examination of the westerly parts of the townships of Henwood, Cane and Bryce might reveal rocks of the silver series.

White river.

The White river is a stream of considerable size, discharging into Lake Timiskaming by several channels (chenaux). The average width near the mouth is from two to three chains. The waters are decidedly muddy : hence the name of the stream. The matter suspended in the water is chiefly clay derived from the erosion of the extensive agricultural areas of which this river is the chief drainage agent. Small steamers ply as far as Tomstown, the pioneer village about twenty miles up. During high water the navigation is easy for these little vessels, but some difficulty is experienced from sand bars below Tomstown during the periods of drought. No rock is exposed on the river thus far, but rough morainic hills are rather conspicuous, and it is worthy of note that huge boulders of the breccia-conglomerate are to be seen in these drift deposits. About two miles above Tomstown the first rock is encountered in the form of a narrow point on the west side. Macroscopically, the rock appears to be a diabase with very white feldspar. The White river is an almost ideal drainage system, branching as it does into a number of symmetrical tributaries. This is seen a few miles above the rock referred to. The most easterly branch is known as the Abitibi branch or East branch ; the former name is given to it owing to the fact that a canoe route exists via this stream to Abitibi lake.

The central stream is known as the north branch. This member divides into two a short distance above its confluence with the most westerly or south branch. The south branch drains a large area to the west, and north-west and also, by a minor tributary, the south-west or Jean Baptiste branch, stretches into the south-west.

East branch.

Abitibi branch—The east branch shows much more current than the main stream and is more crooked than is indicated on the Ontario township plans. Extensive scarped banks of stratified post-glacial clay are exposed at many points. This stream flows from Windigo lake. At its head is a portage of a mile and a half, and two small ones occur below. At the lower portage an exposure of fine-grained compact gray clastic is seen.

On approaching the long portage more exposures of a similar rock are observed. A somewhat lighter colour and more quartzose appearance are presented and a careful search revealed *some small granitic pebbles in the rock* (a little higher up, large ones occur). About twenty chains above the foot of the long portage a picturesque fall is seen, where the river drops vertically about fifteen feet. The rock is a breccia-conglomerate with large (as much as five feet in diameter) fragments of granite and other rocks. The whole is distinctly stratified, layers, in which are many large fragments, being sharply interstratified with beds in which are none. Above this fall are a flat table-like surface and a second cascade of two feet, over a coarse clastic layer of rock, in which however no large fragments occur. We have, in these rocks, the first and only outcrop of the silver-bearing rocks to be met with on the White river proper.

Wendigo lake.

A somewhat different rock is seen towards the eastern end of the long portage. It is doubtfully clastic in origin and not exactly comparable with the rocks at the falls.* Darker and lighter bands occur in a very irregular manner, while the whole is traversed by numerous stringers of quartz. The same rock is seen on the south-west angle of Wendigo lake and continues southward along the eastern town-line of Marter to about the middle of Con. II, where it is cut off by a huge mass of gabbro. South of this point the rock is hidden by drift. To the south-eastward, however, other rocks occur which will be noted later.

Order of the rocks.

Hills of from 150 to 200 ft. elevation occur on both sides of Wendigo lake. The rocks exposed consist of fine slate-like examples, quartzite passing into graywacke and breccia-conglomerate. On the small lakes south of Wendigo the same thing is seen, while some of the islands show gabbro, and a large mass of gabbro occurs farther south, as already indicated. At the narrows, towards the eastern end of Wendigo lake, one of these hills was ascended, and the following order was noted:—

Rock at bottom, a fine chocolate-coloured slate, ferruginous in places, 54 ft.

Hard fine-grained clastic rock, quartzite or graywacke, 10 ft.

Slaty rock like that at bottom, 26 ft.

Fine to coarse quartzite passing into grit, and at the top, into a distinct breccia-conglomerate, 90 ft.

*This rock may be of the older series. A microscopic examination will reveal its nature.

Raven lake.

From Wendigo lake a chain of small lakes leads in a north-easterly direction to Raven lake on the interprovincial boundary. A high ridge follows the southerly side of this chain of lakes, and a less pronounced ridge the northerly. The southerly ridge was ascended at several points and, universally, the same succession of rocks was revealed, roughly, slate, quartzite or grit conglomerate in ascending series. *All these rocks dip away from the lakes, i e., south-easterly at a low angle.* The northerly ridge is less constant in its petrographic expression but consists essentially of the same series, though more broken and injected by later eruptions of diorite, etc. Veins of quartz occur in this fractured zone. No very rich examples were collected but several specimens yielded good traces of gold. (It is possible we are on the border of the Keewatin here.)

Lizard lake.

Raven lake makes a sharp turn to the southward at a point about half way down. The series of slates and conglomerates follow the shores, and on this lake as well as on Fish lake farther south, *still dip away from the lakes, in this case to the south-west.* These rocks continue southward until cut off by the granite mass of Lizard lake. The Haileybury rocks were observed to be folded into low domes or doubly plunging anticlines. The same thing on a larger scale is seen here, but the anticlines have fractured. The two strings of small lakes occupy the axes of two anticlines which originally converged to a V shaped point near the present position of Raven lake. Lateral cracks have given origin to the steep lake valleys observed at several points, especially along the southerly side of the long chain of small lakes.

Lake Present.

Lake Present discharges into Raven lake by a considerable stream, entering the latter lake near its outlet. On this river the same series of rocks are exposed, and on Lake Present they occur along the east shore, and on the south side of the north-east arm. The northern side of this arm shows sericitic schists, etc. Slates and conglomerates also occur on the point stretching into the lake from the north shore. Certain of the islands in the southern part of the lake are likewise composed of these rocks. The rest of the shore presents rocks which I am disposed to separate from the even-bedded upper series, and classify as Keewatin. These rocks are chiefly altered acid and basic eruptives, but, in the field, showing more fracturing and being more injected with quartz stringers.

Beaver House lake.

Northward, from Lake Present, a series of small lakes leads to Beaver House lake, a long narrow sheet of water stretching in an S-shaped manner a distance of about twelve miles. Over practically all this region, i.e., from the slates of Lake Present to the extremity of Beaver House lake, the rocks are more or less alike, consisting of hard greenish-gray quartz schists (altered acid rocks), belts of diorite and dioritic schists, rusty dolomitic rocks and sericitic schists. Many belts of beautiful porphyry cut through the series. On the third small lake, north of Lake Present (Lake Malone), are highly ferruginous schists, with an average strike of W. 30° N., and a dip of 30° to the northward. On a small island in the lake the dip is reversed to 80° S. while the strike remains the same. Here the slaty rock becomes highly charged with magnetite, but, as far as present indications show, no economic deposit is disclosed. This deposit would appear to be an easterly extension of the iron range in the township of Boston. On the fifth small lake north of Lake Present, a slight exposure of conglomerate should be noted. This occurs on an island near the eastern end of the lake. Among the pebbles enclosed in the dark gray matrix were noted jasper, granite, gray schist, felsites, etc. The whole is somewhat stretched and shows evidence of much alteration. The surrounding rocks are all green fissile schists. It would seem justifiable to regard the small exposure of conglomerate as merely an outlier of the upper series.

Throughout this region the soil is sand and gravel, no considerable amount of clay having been observed since entering Wendigo lake. The timber is, for the most part, small, and not comparable with that observed on the lower parts of the White river. Soil.

The north branch of the White river breaks out of the southern end of Beaver House lake in a small falls over rusty and dolomitic rocks. These rocks, with some fissile, sericitic schists and altered diorites, are the only examples seen, with the exception of a small exposure of crushed conglomerate, just above the point where the third small lake north of Lake Present (Lake Malone) makes its way, by a short narrows, into the north branch. A short distance north of the north boundary of the township of Catharine, a trail leads off on the west side to the Jean Petit copper mine. The rock at the mine seems to be a basic eruptive, but bands of an acid nature striking W. 30° N. occur close to the deposit on the north side. Farther to the north the basic rock occurs again. Both calcite and quartz, particularly the former, occur in the fissure, with a considerable amount of copper pyrites. The condition of the property does not permit of any opinion as to its value. Similar occurrences of copper pyrites were noted at several places in this district. On the west side of the river, at the northern boundary of Catherine, and at a height of 100 feet Jean Petit mine.

above the water, sericitic schists are exposed. Many bedded quartz seams occur in the rock, and the region should be worth prospecting. (Strike, W. 10° N., Dip, vertical).

Navigation.

Although interrupted by a few short portages, the navigation to this point from Beaver House lake is fairly easy; below, however, the stream passes between high and rocky hills, rendering it very swift and producing long rough rapids. Just east of the river, on Con. II Catherine, the ridge was again ascended in order to examine the outcrop of rock. The lower part of the hill is diorite that seems to show quartzose schists overlying it. All is much mixed, however, and the whole hill is mostly of eruptive origin. A remarkable dike of beautiful porphyritic diorite crosses the country in a direction N. 30° E.

Below the long rapids, several portages are encountered past rather abrupt falls; the longest is the Sand Hill portage, of 1300 paces, over a high hill on the east side. Fall is 162 ft. aneroid. Elevation of summit of hill 216 ft. Rock is fine-grained diorite, well glaciated.

Tomstown to Lake Timiskaming.

Having thus established the western limits of the Upper Huronian belt, I was very anxious to find its southern boundary in the region to the east of Tomstown. This section is inaccessible to a canoe; it was, therefore, decided to make an overland expedition eastward from Tomstown and down the provincial boundary to Lake Timiskaming. Clay soil and alternating stretches of large and small timber continue to near the eastern boundary of Ingram, where a large swamp is encountered. This swamp continues to the southward as far as the boundary of the township. On meeting the surveyors engaged on the township of Pense, we altered our route and went a half mile along Con. II. of the new township. Soon, the country rises out of the big swamp, and a hill of rough eruptive (gabbro) is encountered. It is a possible assumption that this hill represents the gabbro mass seen south of Wendigo lake, which would thus seem to have a south-easterly trend. Again we turned south and proceeded along the northern line of Brethour to the boundary of the province. No rock was encountered, a heavy mantle of clay covering the whole region. This clay area is deeply dissected by ravines, rendering it very rough for agricultural purposes. Good timber is almost continuous. One half mile south of Ingram, and a little east of the boundary, the first rock is encountered; this is a dark gray micaceous schist striking N. 5° W. The schist is mixed with a massive basic rock and crossed by an 18 in. dike of felsite striking N. 70° E. This felsite seems to pinch out in the schist to the westward and to pass into an area of white granite to the east. It may be that this granite is continuous with the mass of similar rock encountered on Lizard lake. Between this point and the crossing of Wright's creek, several exposures are seen of the white granite and the dark schist, with a persistent strike a little west of north. Southward from here, no more granite is met but, at the bridge on Wright's creek, near the boundary, the mica-schist comes in strong and continues for some miles down the river. (Seen near post at Lots 9 & 10 Con. II & III Brethour). At certain places, where the lumbermen have conducted some operations, this mica-schist is seen to advantage. When fresh, it has a somewhat blue colour, and shows a glistening surface on the planes of parting. It is a distinct and well-defined rock in the field and has not been previously mentioned in these notes, but its occurrence will be referred to again. No other exposures of rock are seen to the shore of Lake Timiskaming.

Micaceous rocks.

From the head of uninterrupted navigation on the Quinze river, a road known as Klock's road leads to Lac des Quinze. Along this road are exposed rocks comparable with the above described mica-schist. In places, the micaceous structure is not so apparent and the rock resembles a graywacke. The strike is, at first, a little west of north, but towards the granitic contact to the eastward, it swings around to a direction nearly east and west. The same series of rocks crosses the Quinze river and crops out at many places, particularly at the rapids and falls. A glance at the map will show that granites and gneisses cut off this rock about half way across Klock's road. They continue along Quinze lake and follow the lakes of the Abitibi route to a point rather more than half way up Opazatica lake. Here we find the outcrops of a dark gray rock, which becomes schistose and micaceous in places, increasing in this peculiarity towards the north.*

At the north end of Opazatica, the dark micaceous schist-like rock strikes 70-80° east of north and dips at varying angles to the northward. I feel assured, as far as macroscopic examination and the relations in the field are concerned, that the rocks at Wright's creek, on Klock's road, on the Quinze and on Lake Opazatica are the same. The whole probably belong to the lower series for they are certainly not at all comparable with the silver-bearing rocks. Their origin is probably eruptive and they are associated with eruptives at many places, notably near the first outcrop on the east side of Opazatica lake. The development of schistosity and the production of mica would seem to be the result of alteration and dynamic forces.

* A section of the massive parts of this rock points to a distinctly eruptive origin.

Conglomerate

The conglomerate of the Upper Huronian overlies this secondary mica schist *unconformably* at the head of Opazatica lake. Westward, the conglomerate rises immediately into hills and seems to lie on the flank of a large mass of fine, greenish, quartzose rock, which crops out at the north end of Opazatica portage and on the small lake to the north. Over the height-of-land portage a more variegated example is seen. On the point on the east side of the little lake above, a more whitish variety crops out, while on the point at the north end of the lake a gabbro occurs, which also shows at the narrows to Island lake. Along the south and east shore of Island lake, the fine, greenish rock is overlain in places by conglomerate. In this vicinity, immediately inland from the water, the country rises into high hills: some of these were ascended and, in nearly every instance, showed the same sequence of rocks as exhibited on the Raven lake chain, namely, slate, quartzite and breccia-conglomerate. Just south of Labyrinth lake is a hill of 350 feet presenting the typical series. The Devil's Swinging hills, south and east of Island lake, show the conglomerate, but the quartzite is more extensively developed. The elevation is 760 feet above Island lake. The great height-of-land ridge, with an elevation of 550 feet, stretches to the eastward and presents precisely the same series.

Chaminiss hill.

Just east of the provincial boundary, and a few miles south of Labyrinth lake, is a remarkable flat-topped hill, known to the Indians as Chaminiss. This hill is a very conspicuous object in the region, being visible from Lake Abitibi on the north and from Lake Temagami (information from Indians?) on the south. A special expedition was made to this hill, as it was hoped that its perpendicular sides would furnish an excellent section of these upper rocks. In this we were not disappointed, as will be seen from the following notes:—

The total height of the mountain above Lake Present is 756 feet (aneroid). The lowest rock is a remarkably fine-grained slate-like substance, no doubt a fine mud or ash rock; it weathers whitish and soft, although fresh surfaces are hard and almost flint-like in their nature (315 feet). This is followed by 135 feet of quartzite passing into grit. On the top of all are about 100 feet of breccia-conglomerate. We have therefore, a vertical section of 550 feet exhibiting the rock in the sequence to which we have already become accustomed. Close to Mount Chaminiss, towards the south-west, is a great ridge, some 600 feet high, which forms the divide between Raven lake and Lake Present; on its northerly side is a flanking hill of less elevation. Both these likewise show the same succession of rocks.

A magnificent view of the structure of the country and the topography of the region is obtained from this elevation. An account of this must be reserved for the final report.

Diorites.

The shores of Island lake, as well as those of Labyrinth lake and the lake to the east of Island lake, show the fine-grained greenish to bluish rock passing into diorites towards the north. In places, the greenish rock shows signs of fracturing and recementation (autoclastic). This rock is much like the lowest member of the Upper Huronian series but it lacks the even bedding, is more injected with diorites, and shows spheroidal weathering in many places. Awaiting the examination of sections I am disposed to place it with the lower series.

South branch of Whit rive

The South Branch of the White River.—This stream enters the main river a short distance above the Abitibi branch. As far as the confluence of the south-west branch the stream flows between banks of stratified clay rising to considerable altitudes. The current is strong, and, in low water, difficult of navigation, owing to the presence of great numbers of "snags." Just above the mouth of the south-west branch, in Lot 10 Con. IV, Evanturel, a series of flat rapids, over limestone, occurs and continues as far as the line between Lots 10 and 11. This limestone is of Niagara age, and is not rich in fossils. Enough were collected, however, to permit of its identification. Subsequent work proved that the limestone is continuous with the mass forming Wabi point on Lake Timiskaming. Just above the limestone, exposures of a dark gray rock are seen. At the Clay falls, which immediately follow, these are seen to be mixed with basic eruptives. The portage is on the northerly side, is a mile and a quarter long, and shows an elevation of 225 feet above its foot. The actual fall in the river is 180 feet (aneroid). Gray schist and eruptives occur above, and the former is seen to be baked, at its contact, with the injected rock. All the way across the township of Dack, as far as the point where the river breaks out of Long lake, in Lot 10 Con. IV, the prevailing rocks are eruptives, presumably diabases, which are associated with dark gray as well as sericitic schists. Several falls and short portages occur on this stretch.

Long Lake portage.

At the portage into Long lake very coarse diorite, passing into amphibolite, occurs. Along the lake as far as the turn in Lot 7 Con. III Robillard, the outcrops consist of diabases and diorites in various degrees of texture. The bend in the lake is occasioned by a great ridge of diabase following the westerly shore and extending a distance of about two miles westward. The rock approaches close to the shore in Lot 8 Con. II Robillard, where it forms precipitous cliffs. This ridge continues to the north-west the full length of Long lake but is cut off by gneisses in the fifth concession of Truax. The gneiss is exposed on the narrows to the next lake above (Kenogami Jiging,) but is not seen again at the water's edge the full length of the chain of lakes, or on the river above, as far as travelled. Expeditions, both east and west, revealed nothing but gneisses, exposures of which were encountered at many points e. g. on the south half of Lot 4 Con. V Sharpe, on the north half of Lot 4 Con. IV Sharpe, on the north half of Lot 3 Con. IV Sharpe, on the south half of Lot 3 Con. V Sharpe, and on the south half of Lot 1 Con. V Sharpe. No further rock is exposed for six miles westward. Towards the head of the last lake (Cushong) the soil, which has been excellent all along the river and lakes, begins to give place to sand, and, on entering Gross, heavy deposits of sand cover the country.

Sandy soil.

Council creek.

A canoe route leaves the White river a couple of miles above the head of Cushong. The first portage is upwards of two miles long, over sand plains, and several other long portages connect shallow muddy lakes, which finally bring us to a stream flowing into the Montreal river. The navigation of this creek is hard, almost impossible in low water, so that another long portage is necessary to reach the mouth of the creek near its confluence. This stream is known as Council creek and enters the Montreal river near Indian chute. On this route no rock, except gneiss, was seen. The soil is all sandy and the timber for the most part small. The portages are but little used and are difficult to find. In ten year's experience in northern Ontario I have never seen a region where moose are so plentiful as around the small lakes on this route. The muddy shores are so tramped in places as to resemble cattle yards.

Moose plentiful.

A strip of about ten miles in width to the south of the section afforded by this canoe route was not examined. The country here seems to be very rocky. Towards the eastern edge of this strip occasional outcrops of rocks were observed in the fine agricultural regions of Hudson, Henwood, Kearns, Beauchamp and Bryce. The exposures were for the most part gabbro, but a rock ressembling the upper series was seen associated with large boulders of undoubted conglomerate on Lots 5 and 10, in Con. VI of Beauchamp. Also, a coarse, gritty sandstone of some upper series (not necessarily the silver-bearing rocks) outcrops in hills of considerable height, with a good vertical exposure on Lot 5, Con. IV Henwood. That rocks of the upper series occur in this region is undoubted; owing to reasons already stated, I was unable to further investigate them. The less easily accessible parts of Henwood, Bryce, Beauchamp and Cane are worthy of further investigation. The present writer is confident that interesting rocks of a later age than the lower Huronian lie between the agricultural lands and the gabbro ridges to the west.

On Lot 3, Con. V Hudson, even-bedded ferruginous slates occur, on which mining claims have been located. These rocks continue westward as a ridge, until they reach a considerable elevation, with a fine vertical exposure on Lot 9 Con. III Hudson. Here they are cut off by gabbro which entirely surrounds Twin lakes in the south-west corner of the township. Gabbro also breaks through these slates towards the south and east of the place where they are first mentioned. The ferruginous slates probably form part of the slaty series of the Upper Huronian, for very similar rocks were observed intimately associated with the common slate-like variety on the hills south of Windigo lake. Ferruginous slates.

NORTH BRANCH OF THE BLANCHE RIVER ROUTE TO ROUND LAKE.

The stream flowing from Round lake joins the main north branch just below the high falls at the sand hill portage. The current is not excessive, but the navigation is rather difficult on account of a number of small falls and rapids which necessitate portages. Round lake is a very beautiful sheet of water with picturesque sandy beaches, in sharp contrast to most of the lakes of the region. Gneissoid rocks occupy the south and west shores, while altered diorites and nearly vertical schists occur on the east side. The river above Round lake lies in a low area; its current is slight and its shores muddy. Excellent agricultural land is found in this region. Round lake.

On Kenogami lake the prevailing rocks are Lower Huronian schists with altered diorites, etc. Towards the eastern end are outcrops of conglomerate associated with slaty rocks comparable with the series at Cobalt lake. These may be regarded as outliers of the Upper Huronian series. Kenogami lake.

The township of Boston, lying to the east and north of Round lake, is becoming important on account of the discovery of the iron range rocks. Ferruginous members of the Lower Huronian series form a sort of crescent, crossing the township about the middle, with the horns pointing towards the two northern angles. Several outliers of the upper series are seen in different parts of the township. Boston township.

On the iron range in Boston many claims have been located, and some also in the north-east corner of the township of Otto. A sample of ore from this locality is said to have yielded forty-five per cent iron.

At the point where Boston creek crosses the line between Boston and Otto, impure iron ore has been discovered.

Economic resources.

The occurrence of nickel, cobalt and silver has already been as fully dealt with as the nature of this report requires. Copper also occurs in many parts of the region, both in the vicinity of the mines at Cobalt lake and at various points along the north branch in the townships of Catharine and Marter. The most important show of copper pyrites is at the Jean Petit mine, already described. On Beaver House lake also, copper pyrites in quartz has been discovered in several places. None of the shows are promising. From the wide dissemination of copper there is a reasonable hope that a workable deposit may yet be discovered.

Good gold prospects.

As far as I am aware no gold excitement has ever disturbed the calm of this particular region ; nevertheless, quartz veins carrying gold were located during the summer along the string of lakes stretching from Windigo lake to Raven lake. As already stated, the upper rocks occupy the south shores of all these little lakes, but the northern shores are only in part covered by typical clastics of the upper series. Diorites and other rocks disturb the even-bedded clastics along the northern shores. Many quartz veins intersect the whole assemblage, and traces of gold were found in several samples. I consider this region well worth prospecting for gold. The same remark is true of the high hills along the north branch of the Blanche in the township of Catharine.

The iron range rocks in Boston and on Malone lake may yet yield mines of importance; but their productiveness is not yet proved.

Timber.

The pine has been cut over practically the whole of the territory examined, but spruce, balsam, birch and poplar still remain. As elsewhere in northern Ontario, forest fires have destroyed extensive areas. Particularly may be mentioned the region immediately around the mouth of the Blanche, the sand plains around Lake Cushong stretching almost to the Montreal river, and portions of the territory north of the south branch of the Blanche.

Besides the common trees of northern Ontario already enumerated, some species are met with expressive of the fact that we are here on the border land of the hard-wood belt. A grove of maple is seen near the mouth of the Blanche, and American elm is met with, in patches, over nearly the whole region. Black ash, also, is a common tree along many of the rivers.

Numerous excellent water powers exist on the different branches of the Blanche. At Sand hill portage on the north branch, a vertical fall of about thirty feet affords an excellent location for a generating plant Some of the waterfalls on the South branch have been recently examined by Mr. W. J. Blair, O.L.S., who has kindly communicated his results to me.

At average low water the high falls near the border of Dack and Evanturel are estimated to be able to yield 2000 horse power. In this fall are three cascades of 55½, 38 and 28 feet respectively. This makes a fall of 121½ feet. The elevation recorded by aneroid was 180 feet. Part of this difference is accounted for by the rapids between the cascades, but the aneroid reading is probably somewhat too high. Falls at Dack.

The falls below Sunday creek, on Lot 7 Con. IV Dack are estimated to be able to furnish 450 horse power continuously. Sunday creek falls.

In the light of recent developments it is impossible to close this report without some comment on the agricultural possibilities of the region. A great mantle of evenly stratified clay overlies a large portion of the region examined, but it by no means covers all the townships surveyed. Making allowance for sand plains and outcrops of rock, the general boundaries of the clay land, as far as Ontario is concerned, are roughly as follows:—West of a line drawn from the north-east corner of Brethour to the north-east corner of Otto, and east of a line from Kenogami lake to the head of Lake Cushong and thence to the south-east corner of the township of Bucke. The soil is a fine white clay devoid of stones, but lacking in vegetable mould. Farmers working in the section inform me that the best results from such land can be expected only after the soil has been well worked for several years. While some good crops were observed, especially of peas and clover, the writer was much disappointed in the appearance of many of the fields examined. The best results seem to be obtained where the more extensive clearing is done and there can be little doubt that, when the region is all cleared, conditions will set in which cannot fail to result happily for the cause of agriculture. Agriculture.

Raised Shorelines along the Blue Mountain Escarpment.

By Mr. A. F. Hunter.

On October 25, I began the work of tracing the ancient high level shorelines along the flanks of the Blue mountain escarpment, south of Georgian bay, and continued the investigation as long as the weather Introduction.

permitted. During the time I was thus employed I traversed the district from Orangeville northward to Thornbury.

Transverse valleys.

The straight course of the escarpment, extending about N.W. by N. from the head of the Nottawasaga valley for many miles up the Bruce peninsula, is one of its most noteworthy features. Its face, however, is not perfectly straight. At nearly regular intervals, there are transverse valleys, some of them as much as ten miles deep, set into its face, not at right angles to the course of the escarpment as one might expect, but at an angle of about sixty degrees. This phenomenon presents no difficulty, as, on inspection, the projecting ridges dividing the transverse valleys are seen to have the N.E. by N. direction of the primary rock ridges commonly observed over the easterly or Laurentian parts of Canada. Accordingly, the so-called escarpment is really a series of niches into the edge of the Niagara limestone and the underlying formations which form the tableland of western Ontario. In each of these transverse valleys the springs and rainfall form a considerable stream. The rivers thus formed, in the district I examined (proceeding southward from Georgian bay), are as follows; Silver creek, Pretty and Batteau rivers, with the several arms of the Nottawasaga, namely: Noisy, Mad, Pine, Boyne, Twenty-Four and Nottawasaga (main branch) rivers, and finally the Humber river.

Erosion.

Throughout these valleys there are well developed terraces or benches from which it is evident the valleys are not the work of erosion in recent geological times. Erosion only of the loose materials of the terraces has taken place in recent times; and even this is not general, but may be seen only where the conditions for erosion are favourable. As the terraces from the lake shore pass uninterruptedly to every transverse valley without change in character, the latter were evidently bays in the period of submergence. The shape of the rocky face has therefore changed but little, remaining substantially the same as before the submergence. The surface features of the district are entirely due to denudation and subsequent erosion of the loose materials, not to glacial action, the terraces referred to and shorelines having been formed since the so-called glacial period.

Shore cuttings.

Shore cuttings are to be seen here and there, at every thirty or forty feet of altitude; but there are a few broad terraces more conspicuous than the others and evidently denoting distinct epochs. Each of these broad terraces represents a period of strong activity, or one of stationary condition of the surface of the water body, or perhaps both.

For the greater part of the distance under consideration, the Algonquin shoreline forms the base of the rising ground. A mile west of Kirkville it becomes substantially the base of the mountain or precipitous edge of the tableland, which here approaches closely to Georgian bay. In the territory examined, I found the altitude of the Algonquin varied considerably. Near Craigleith, it is 790 feet ; near Stayner, 765 feet ; and at Beeton, near the head of the Nottawasaga valley, about 740 feet. Its deformation is therefore considerable, the dip to the south-east being as much as two feet per mile in some places. Along the easterly side of the Nottawasaga, it dips at the same rate towards the south-west. That is to say, its deformation is similar on the two sides of the valley, viz., a dip into the valley from the height in front of the main basin of the Georgian bay. From this circumstance I conclude that the deformation of the Algonquin shoreline in the valley is a local phenomenon, and not the result of any general earth movement, but an effect of sagging or collapse of the loose materials of drift toward the head of the valley. In those parts, we know, from operations connected with the sinking of artesian wells, that the drift deposits are about 350 feet thick. Our conclusion as to the cause of the deformation of the shoreline is further confirmed by the fact that the strong, high terrace at 1,430 feet along the rocky shelves of the escarpment, where the drift deposits are comparatively shallow, is substantially horizontal, without uplift or subsidence of any appreciable amount.

Algonquin shoreline.

The next shoreline above the Algonquin, worthy of attention is one about 180 feet higher. Its deformation, as one proceeds up the valley, is equal to, or perhaps a little greater than, that of the Algonquin itself.

Second shoreline.

The next important terrace in ascending order is about 300 feet higher than the Algonquin, and its deformation does not seem to differ much from that of the two below it, although it has some irregularities of altitude of a local character that are sometimes puzzling. Notwithstanding this peculiarity, it is a strong terrace, and entitled to rank with the strongest. If deformation of shorelines be a phenomenon peculiar to the loose materials of drift, and be greatest where the drift deposits are deepest and most loose, i.e. have most sand and gravel in their composition, then some of the irregularities possessed by this terrace may bear explanation.

Third shoreline.

The three shorelines just named are doubtless the three which Dr. Chalmers traced across south-west Ontario in 1902.* They represent,

*Geol. Surv. of Can. Summary Report 1902, pp. 272-274.

those in the basin of Georgian bay, the same three periods of greater activity, or longer stability of the water surface.

A large terrace.

Above these three terraces there are several others of equal or even greater strength, occurring regularly along the escarpment. But there is one of the high terraces that has exerted more influence than any other in the formation of the physical features of the surface. Its altitude is about 1430 feet above sea level, and it is substantially horizontal throughout the district examined. There are some strong terraces above as well as below it, with high marginal cliffs, and with very similar geographical positions. But I have traced the one in question, as it is the strongest of the high continuous shorelines and has a considerable range through the district. It is, indeed, a broad terrace, rather than a shoreline, having in some places the stupendous width of a mile or more, measured from its cliffs.

Niagara formation.

In many places, the 1430 foot shoreline, throughout its entire length along the escarpment, has high rocky cliffs of Niagara limestone, at whose bases the old waterline is to be seen. With this shoreline there is more denudation of the primary rocks than with the other shorelines, the most frequent exposures being rugged cliffs of the Niagara formation, which Dr. Bell traced throughout this district in 1859. All the way along the escarpment, this shoreline and the Niagara formation are singularly coincident in altitude and position, through there are a few differences; and it is almost entirely owing to the operations of the water body when at this height that there are so many good exposures of that formation.

Average height.

The mean of a number of observations, carefully made in favourable circumstances, at different times and places, was 1430 feet above sea level. I have been unable to find any deviation of the shoreline from the horizontal, i.e. it has no observable uplift or deformation of any kind. This fact is significant when we consider that it rests close to the primary rocks, without much drift material underneath it. Where the lower shorelines rest upon thick deposits of loose materials (300 feet thick or more) there is most deformation, especially where they pass toward the head of the ancient Georgian bay.

Width.

The foregoing shorelines have a width of two townships opposite Orangeville, and converge into one precipice within half a mile of each other at Craigleith. Here all the intervening shorelines close in upon each other at this abrupt and picturesque part of the escarpment, but the mountain slope is too steep to preserve many traces of the minor shorelines between the broader terraces.

MINERALS OF THE OTTAWA VALLEY.

By Mr. C. W. Willimott.

In the early part of the year I was engaged in making various experiments in connection with my report on pigments, which will soon be published. I also made up a number of collections of minerals and rocks, which have been forwarded to various schools, the names of which will be found in Dr. Hoffmann's report. Much of my time is necessarily taken up by persons bringing in minerals for identification: generally, however, the physical attributes of these specimens are sufficiently pronounced to prove their identity without the aid of chemical agents. Introduction.

Later in the summer, I visited several places in Ontario and Quebec and secured many interesting minerals as well as a quantity of other materials for making up collections. A report of these minerals, together with a description of almost every other mineral found in Nova Scotia, Quebec and Ontario, is being prepared for the press. There are, however, three minerals to which, on account of their economic importance—an importance as yet scarcely appreciated by the people of Canada—I desire to call immediate attention.

Lepidolite.

The only occurrence of this mineral in Canada is, so far as I am aware, on lot 25 range 7, township of Wakefield, Quebec, where it occurs in a large pegmatite vein, holding grayish orthoclase and albite, white transparent to translucent quartz, large cleavable masses of a light green amazon stone, crystals of black and green tourmaline, pale purplish fluorite in rounded cubes and octahedrons and specks of uraminite and gummite. Masses of black and smoky quartz, sometimes penetrated by long black crystals of tourmaline, are associated in this vein. Lepidolite.

About twenty years ago this mineral, having been mistaken for muscovite, was mined to a small extent. About a ton was taken out in cleavages sometimes two feet across and over six inches thick, of a light copper colour. A few fair-sized plates were cut from these masses, and thin cleavages were perfectly transparent and resembled muscovite.

The fusibility of this mica naturally precludes its use as a refractory mineral, but owing to the large percentage of lithia it contains its economic importance deserves the attention of dealers in this salt. Dr. Hoffmann found it to contain over five per cent. Salts of lithia.

SERPENTINE.

Serpentine.

The translucent or noble serpentine, which is confined to the Laurentian rocks, has a very wide range in the Dominion. It is usually found in association with the crystalline limestones or dolomites or enclosed in the latter, in specks, patches and veins, constituting at times handsomes marbles.

This serpentine must not be confounded with the dark green or gray variety of the Cambrian rocks of the Easterns Townships, although this latter would also contribute excellent material for ornamental use. At the village of Old Chelsea, on lot 14 range 8, township of Hull, probably overlying a crystalline limestone, is a serpentinous marble of a noticeable width. It can be traced along the strike into the next lot, in a series of hillocks. The serpentine, which occurs in patches and veins, in somewhat weathered on the surface, but assumes tints of various shades of green, at a short depth. If this stone were opened up, it might afford some handsome marbles, and being situated on the main road, little more than a mile from the Chelsea station, its transport would be reasonably cheap. There is a brook running through the property that could supply all the power necessary for sawing the stone.

Chrysotile.

On lot 20 range 1 township of Wakefield, there is a small exposure of very much weathered serpentine-limestone. The serpentine is distributed throughout the limestone in spots and patches, often to such an extent as to make up a large proportion of the mass. Small veins of an inseparable chrysotile sometimes intersect.

On lot 30 range 4 of the same township a large amount of stripping has been done for chrysotile where some promising veins appeared on the surface. The serpentine has been uncovered at intervals over an area of about forty-six acres. In some places it has been penetrated about three feet, showing the continuance of small veins of chrysotile. A very large proportion, however, is free from these veins. Blocks of a fair size occur, ranging through shades of green. Yellow and brown blocks were also seen and were quite translucent. Possibly blocks of a very large size might be obtained, but the distance from a shipping point must necessarily detract from their value.

At one place the serpentine is associated with a white crystalline dolomite. At another place large patches of pink calcite rarely enclosing apatite crystals were embedded in the serpentine.

In the township of Denholm this mineral is met with on several lots, intersected with small veins of chrysotile. On lot 42 range 1 a mill was erected some years ago for grinding the serpentine that contained the small veins of chrysotile, for making asbestic, (an improved plaster.)

As an ornamental stone it could not be very well recommended, being seldom free from small veins of chrysotile. On lot 27 range 2 township of Cawood, a small exposure of serpentine occurs intersected by a vein of chrysotile, the fibre of which was about three quarters of an inch in length.

FUCHSITE.

This mineral occurs in small scales of a light emerald green colour, slightly translucent, and, with magnesite or dolomite, forms schistose rocks found in several places in the townships of Bolton and Sutton, in the province of Quebec. A specimen of this mineral, cut and polished, revealed a wavy structure of a light and dark emerald, the two tints generally alternating in broken lines and patches, enclosing spots of a brownish material, together with other minute specks of a brass yellow. Mr. G. F. Kunz in his pamphlet, in 1903, on the production of precious stones, writes, on page 44—" Among the " various green minerals used by the ancients for decorative purposes, " compact fuchsite must now be included. An interesting account is " given by Prof. H. A. Miers of London of a fragment of a Roman " statuette composed of this mineral. It was found in the Oxford " collection, but with no record of its source. The specimen is three " inches long, and represents the thigh of a human figure from hip to " knee. It is well executed, and is referred by archæologists to the " best period of Roman work. The piece is bored at both ends as " though the figure was made of portions fastened together, thus sug- " gesting that the material was scarce and not to be had in large pieces. Fuchsite.

" The stone is of an emerald green colour, translucent and beauti- " fully polished; it is not uniform in tint, having clouds or patches of " a deeper green, and also of brown. There are bright internal reflec- " tions, resembling flawed emerald; but the fractured surface shows " the textures of a compact micaceous mineral consisting of minute " flakes or plates."

The resemblance between the mineral from which the statuette was made and the fuchsite schists found in Canada is most interesting, and although this substance does not take such a high polish as that described by Prof. Miers owing to the slight admixture of magnesite or dolomite, it nevertheless presents a fairly good gloss, and is quite compact and readily commends itself as a unique ornamental stone.

This chromiforous mica-schist is found associated with beds of magnesite and dolomite which are often of several inches in thickness, and which constitute the upper portions of the beds. Sometimes it is dispersed in scales throughout the entire bed, lending its emerald green colour to the whole mass.

Geology of Part of the County of Ottawa.

By Professor Ernest Haycock.

Introduction.

On July 20 I received instructions from Dr. Bell to proceed with the work of filling in the geology of the "Mining and Topographical map of the Lièvre River and Templeton Phosphate District," and on the 26th began a careful study and detailed mapping of the rocks at the southern margin of the sheet in the vicinity of Perkins. This work was continued during the next two months, and includes the following areas:—

Templeton Township, ranges 8 to 13.

Wakefield Township, ranges 3 to 7. Templeton gore.

Portland Township (West), ranges 1 and 2, as far east as Lakes McFee, Dodge and Newton.

Complicated rock outcrops.

In spite of this concentration of attention, the rocks are so intricately mixed, the exposures so frequent, their structure so complex and composition so variable, that the portions most closely studied were not exhausted, nor does the most detailed mapping fully reveal the variety and relative abundance of the various rock types.

GENERAL PRINCIPLES.

Laurentian rocks.

The great area of crystalline rocks forming the Laurentian Highlands of Canada, of which this map-sheet forms a part, has been studied ever since the inception of the Survey. It has occupied for years the attention of the most acute and skilful geologists the Survey has known. A vast amount of literature is in existence concerning it, and the name Laurentian has become of world-wide significance among geologists. In entering upon the study of such a region the geologist is treading upon hallowed ground, and he would be sanguine indeed who would hope to gain, in a period of two months, more than a small acquaintance with this vast assemblage of the oldest known rocks.

The work assigned was, however, apparently simple. It consisted of locating upon the above mentioned map, which is on a scale of 40 chains to the inch, the various rocks found, and their geographical distribution. In the field, the rocks proved so variable in mineral composition, and their distribution so irregular, that an almost infinite amount of time and patience would have been required to fully describe and map every occurrence within even a square mile. The large scale of the map, and the numerous exposures, necessitated the examination of every prominent outcrop. To connect outcrops of similar rocks a half mile apart—one inch on the map—was not consistent with accuracy, as repeated lists proved. Some intervening outcrop would, in the majority of cases, at least during the earlier weeks of field work, reveal some totally different type of rock. In referring to these rocks, Sir William Logan says, 'The dips avail but little in tracing out the structure: for in the numerous folds of the series the dips are frequently overturned, and the only reliable mode of pursuing the investigation is patiently and continuously to follow the outcrop of each important mass in all its windings as far as it can be traced until it becomes covered up by superior unconformable strata, is cut off by dislocation, or disappears by thinning out.'*Such being the case the differentiation and establishment of types of rock sufficiently abundant to justify a separate colour in mapping, the determination of their approximate mineral composition, and ascertaining their structural relations to one another consumed much time and demanded a scheme of colours often tentative and always elastic.

Difficulties of accurate mapping.

Mr. White had already coloured on the map those rocks bordering the lake-margins and islands. These margins and lakes lies in the most disturbed portions. To bring all the areas into harmony with a new colour-scheme, it was found necessary not only to travel over the ground already studied but to trace the intervening stretches of wooded wilderness.

At the end of the season, nine separate and easily distinguishable types of rock were located; it was attempted to locate two or three more, but the complexity of the rock occurrences caused the attempt to be abandoned. The main facts of composition, structure and distribution, and the theory at present held as regards the origin and inter-relations of the nine rocks located, are as follows:—

Nine types of rock.

1. Banded (bedded), usually fine-grained, gray or dark-coloured, thoroughly crystalline hornblendic or biotic rocks with schistose foliation, and ranging from typical gneiss to mica or hornblende schist.

Hornblendic or biotic rocks

* Geology of Canada, 1863, p. 43.

Strike and dip almost always discernable, often variable in small areas, though fairly persistent on the average. Twisting and contortion usually not extreme, often absent, and bedding distinct. Occasionally, as at the south end of Newton lake, the bedding is so little obscured that their sedimentary origin cannot be doubted. These rocks have continuity on a large scale, though much broken and interrupted by various intrusives. They are usually associated with, or interbedded with, quartzites and garnetiferous gneisses and together with these occupy by far the greater area of the country examined.

Quartzites.

2. Bands, beds, or masses of white or light gray rock, almost wholly of quartz, but containing variable minor quantities of reddish feldspar, mica, hornblende, or other minerals. Foliation obscure or absent. This rock occurs in interbedded sheets among the gray gneisses, less conspicuously among the garnetiferous gneisses, or forms considerable masses of the country rock, and is thin, white and very finely granular, almost saccharoidal, as at the south end of Clear lake. Its composition is that of altered sandstone of varying purity, and its distinctly interbedded character is indicative of a sedimentary origin. This rock is widely distributed, and is quite prominent in the belt of rocks running north-easterly from McGregor lake past Battle and Rheaume lakes. It is often abundant near the limestones, but its relation to them is not clear.

Garnetiferous gneiss.

3. Bands or beds of gray to reddish crystalline rock with garnets, pale red feldspar, quartz and various silicates in minor volume. They are foliated and would usually pass for garnet gneiss. They merge into the bedded fine-grained gray gneiss, are not usually more contorted than, and frequently alternate with, beds of the latter. Structurally they have the same characteristics as the gray gneiss and have the same origin. They are typically developed in the hills just west of Perkins, are variously distributed in the belt extending north-easterly to Battle lake, and are prominent along Grand and McArthur lakes.

Sedimentary origin of the banded gneisses and quartzites.

These three rock types, in many cases, without doubt, are mineralogically differing beds of the same series of altered sedimentary rocks; where least disturbed, their interbedding is exactly what we find in Palæozoic strata, though the fragmental shapes of the component grains have been completely obliterated, and the mineral matter entirely rearranged and recrystallized. This recrystallization has taken place without intermingling of the chemical constituents of contiguous strata, to an extent sufficient to obliterate the evidence of original stratification. There seems no other possible interpretation of the conspicuous banding almost everywhere observable.

4. Coarsely crystalline limestone, usually white or light gray with large portions serpentinized. It contains numerous accessory minerals as asbestus, apatite pyroxene, feldspar, graphite, and includes coarsely crystalline masses which are largely white orthoclase, but contain many other minerals. Within the area of the sheet, these rocks are usually massive in structure, only occasionally showing thin, siliceous partings that may represent originally alternating beds of different composition. These are usually grotesquely twisted and contorted, or broken into disjointed fragments. The angular boulders of rusty weathering quartzite, often found freely sprinkled through the masses, may have come from such broken layers. Limestones.

These rocks are very irregularly developed, widening out and showing numerous outcrops for a short distance and then disappearing, their place being taken by the banded gneisses or intrusives. When mapped, the outcrops show some linear distribution, and this may indicate original continuity subsequently destroyed by the crushing from associated heavily bedded and more resistant banded gneisses and quartzites, and intrusive masses. They are regarded as of sedimentary origin.

The structural relations of these limestones to the other sedimentary rocks among which they occur are not cleared up as yet. They are all so disturbed and broken by intrusives that their relations are not very easily interpreted even when contacts with the quartzites and banded gneisses are exposed. About Perkins, where they were most carefully studied, their distribution, and their relation to the underlying rocks, as revealed along the Blanche river, were easily explainable upon the hypothesis of their unconformable superposition and subsequent infolding with the gneiss and quartzite, the whole then being disturbed by the acid intrusives. About McGregor lake no clearly contradictory evidence was seen, and the contacts and distribution appeared to be in accordance with this view. About Grand lake the evidence was in favour of interstratification with the gneisses and quartzites, and subsequent observations in other localities were not wholly favourable to either view.

The limestones are certainly associated closely with the banded rocks, more especially with the quartzite, and its occurrence in volume came to be a signal for the occurrence of a limestone mass. On the other hand they lack the continuous development to be expected if they were interstratified. It may be that they are pinched out by pressure and by instrusive masses, but limestones are usually more persistent than the other sedimentary rocks, and in this field unevenness in original deposition appears the most natural way to account for the erratic distribution.

Pyroxene rocks.

5. Light gray or greenish, granular masses of rock, mainly pyroxene, but often with a considerable volume of disseminated calcite. They often occur in the line of trend of the limestones and are so associated with them, and in composition they sometimes so approach each other in intermediate varieties, as often to suggest a similar origin, the present differences being merely due to original differences in composition. They are well developed near the shores of both McGregor and Grand lakes. They have as much continuity as the limestones, though thought to be less in volume, and may be traced in a broken way for considerable distances in line with the general trend of the altered sedimentary rocks.

Other pyroxene rocks occur, namely dark-coloured, or augitic, which are more irregular in distribution, and doubtless of intrusive ingeous origin. They are most intimately connected with the deposits of mica and apatite.

Massive gneiss.

6. Massive, light gray, reddish or pinkish crystalline rock, largely composed of dull red or pinkish orthoclase, with quartz, hornblende, etc., in varying proportions, but relatively of minor importance in the rock. Texture usually granitic with gneissic foliation, not banded, but sometimes showing a heavy bedding not characterized, as in the banded gneiss, by marked difference in mineral composition. Southwest of Wakefield lake interbanding of rock of similar composition with layers rich in hornblende and of a dark colour, was noted, but this feature was not common in the Templeton areas. Distribution irregular, forming considerable masses among the banded gneiss, as in the hills along the north side of McGregor lake, and extensions north-east and north-west, forming a rough and broken V-shaped area. They are regarded as of igneous origin, but whether older or newer than the surrounding rocks, or of contemporaneous origin, was not determined.

Hornblendic gneiss.

7. Usually a gray or dark gray coarsely crystalline rock, composed mainly of a gray feldspar and abundant hornblende. Quartz usually present. In mineral composition apparently simple and uniform. Massive with gneissic foliation, a heavy bedding sometimes descernable as in the previous group, with which it corresponds in structural characteristics. It is not very different in mineral composition except in the absence of the pink feldspars and relatively more abundant hornblende. A comparatively large area lies between Grand and Wakefield lakes, extending to beyond the boundary of the sheet. Similar

rock occurs south of McFee lake. Near the northern township line of Templeton, the two kinds of massive gneiss are considerably intermixed. It is regarded as of igneous origin, but its relations to the other groups were not clearly made out.

8. Very coarse red orthoclase and quartz rocks. These minerals occur, usually, in nearly pure aggregates up to a foot or more in diameter. Other minerals absent or in very small quantities, though large aggregates of hornblende sometimes occur. The orthoclase is usually bright red in colour and contains sharp crystals of quartz as inclusions, forming a typical pegmatite. Graphitic granite not uncommon. This rock is widely and quite uniformly distributed throughout the district, and also crops out near East Templeton station where large pits have been opened in it for the feldspar it contains. It is intricately disseminated in masses of varying volume and shape through all the rocks previously described. This volume, with relation to that of the rock cut by it, is variable, but is estimated roughly to be from one to two thirds the total volume in the belt of banded gneisses and quartzites north-east of McGregor lake. This rocks shows no foliation, and is newer than all the preceding groups. It appears to be more abundant in the localities rich in mica and phosphate, and to have had a real connection with the concentration of those substances into deposits of economic importance. Pegmatite.

A few somewhat larger masses, essentially the same in composition, but of granitic texture, though not true granites, were observed, the largest lying between the south-east and north-west arms of Wakefield lake. These have the same relations to the surrounding rocks as the pegmatites.

Dark coloured basic rocks, of variable texture, but usually fine-grained and compact, individual minerals indistinct, designated for field purposes as trap, or greenstone. This rock occurs in dikes, usually vertical, and one or two chains in width, generally lying in an east and west direction, cutting all previously mentioned rocks, and remarkably persistent in width and direction. Several of these cross the south-western corner of the sheet at intervals of about a mile. Trap or greenstone.

East of Grand lake, between Green lake and Dam lake, a huge boss of a more coarsely crystalline rock of approximately similar composition, comes in and trends north-easterly with the prevailing strike of the rocks to the south-east. It was traced as far as Newton's lake, but its limit in that direction was not reached. It is regarded as a relatively later intrusive, and no pegmatite was observed within its boundaries.

Economic minerals.

The deposits of apatite and mica have been studied for many years, and their relations appear to be pretty well understood. Very little attention was therefore given to them, but sufficient to gain the conviction that many, at least, are in true fissure veins, and not igneous intrusives. Most of the old abandoned pits were already located on the map, and those now working are in the same localities. These deposits occur in the series of banded rocks and limestones regarded as altered sediments. The main volume of these rocks trends in a north-easterly direction diagonally across the sheet. An arm branches off in a northerly direction along Grand lake and divides, sending branches north-westerly along McArthur lake, and east and north-east along Green lake to Dodge lake.

Surface deposits.

Surface deposits in this district are scanty and confined to the valley bottoms near the Blanche river and its tributaries. These deposits are usually gray clays, free from boulders, and often stratified. Glaciated boulders and erratics are rare, but the bedrock is generally glaciated; north-facing hills and knobs show characteristically rounded contours. The striae trend southwards, modified locally by the directions of the valleys.

Physiographically the country is a tumbled confusion of steep, wooded hills of no great elevation. The massive, gneissic rocks, and basic intrusives furnish a surface particularly rough, broken and difficult to traverse. The forest fires of the previous season swept great patches of woods out of existence, and the partly burned and fallen timber, interwoven with a summer's growth of vines and blackberry bushes, rendered travelling exceedingly slow and laborious.

Lakes.

Lakes are thickly sprinkled among these hills. The largest, consisting of McGregor, Grand, Green, McArthur and Wakefield, form with short portages, a waterway from Perkins to the northern boundary of the sheet. From Green lake, by way of the Mountain portage to Dodge lake and the Lièvre river, the pioneers in the early days brought in their supplies and even took out grain to the mills on the Lièvre to be turned into flour, but the wilderness ways are now deserted except by the stray sportsman, or a joyous party of student priests who have rest-houses through the region and travel back and forth in birch-bark canoes in true voyageur fashion.

Lake basins due to erosion.

Almost without an exception the lakes, large or small, lie in areas characterized by the occurrence of limestone. In the hilly tracts between the lakes this rock is as generally absent. Their origin thus appears due, in the main, to the removal of these less resistant rocks by the slow process of subaerial erosion. They have clearly not been dammed by glacial debris, as rock hills generally surround them, and their outlets flow over the solid ledges. Neither are they due, in any special way, to glacial erosion, though ice action has doubtless played its part in bringing about the final result. They are not trough-like, but notably irregular in form, conforming only to the trend of the more or less calcareous rocks among which they lie. Some are credited with considerable depth; Battle and McGregor lakes are said to have from 300 to 500 feet of water in certain places. With their pleasing scenery and opportunities for camping, canoeing, and fishing, they offer, at the present time, the chief attraction of the country for the outside world.

Mining prospects.

Although at present the mining industry in the district is very quiet, the deposits of merchantable mica do not appear in any way exhausted. Even the old pits formerly worked for phosphate, when cleaned out, as some have recently been at Battle lake, give very promising shows, and new ones are still being discovered. One such find, about three-fourths of a mile east of Dam lake, in the Gore, was opened during the summer, and was showing very large crystals of excellent mica. When last visited, buildings were being erected, and other preparations made for its vigorous development, There seems no reason to doubt that, with a regular demand for the product, these rocks will continue to yield steadily for an indefinite time.

Geology of Part of the County of Ottawa.

By J. F. E. Johnston.

Introduction.

In accordance with Dr. Bell's instructions I left Ottawa on the 8th of August and proceeded to make a geological examination of the area contained within the limits of Sheet No. 2. of Mr. James White's "Mining and Topographical Map of the Lievre River and Templeton Phosphate District."

Description of area examined.

This is the more northerly of the two sheets composing the map, and includes nearly the whole of the townships of East and West Portland, together with portions of the townships of Wakefield, Denholm, Bowman, Villeneuve and Derry. The area is divided into two nearly equal portions by the Lievre river, which flows in a general south-easterly direction.

Owing to the fact that the map has been compiled on a very large scale (half a mile to the inch), and that very detailed work is, therefore, required to properly show the geology, which is of a most intricate nature, the work done during the past season must be considered as only preliminary, and at least one more season will have to be spent in an examination of this area.

An extensive forest fire swept over a large part of this section of country in the spring of 1903, and, during the summer, the area thus burned was overgrown with weeds, wiry berry-bushes and other shrubs, which rendered hill climbing very difficult.

As the examination on which the present report is based was begun very late in the season, only a comparatively short time was spent in the field, thus militating against much progress being made.

However, the ground was fairly well covered in a general way, and a reconnaissance was made of the whole district comprised in the map-sheet, and a good idea of the character of the underlying rocks was thus obtained. A large number of hand-specimens were brought back for purposes of close study during the winter, with a view to obtaining much more detailed knowledge of their mineralogical composition.

Topography

The country included in this map-sheet lies within the Laurentide hills, and is generally rough and mountainous; the valleys between the different ridges are covered with clay and sand. The hills rise to a height of about 700 feet, and are generally timbered, except where fire-swept. To the east of the Lièvre river the flats are nearly all clay, but in the vicinity of Poltimore the land is much more sandy. In many places along Priest creek, on the western portion of the sheet, the line of demarkation between the overlying sand and the clay was found to vary from about three to ten feet from the surface.

There are no large lakes within the area, excepting Wakefield, of which a portion of the northern end, about two miles in length, extends within the sheet. There are a number of small lakes, the largest of which seldom exceed three-quarters of a mile in length, and there are two large creeks, Priest creek in the western, and Clay creek in the eastern, portion of the sheet. The former flows in a south-easterly direction, joining the Lièvre on lot 12 con. IV of East Portland, near the line between cons. III and IV. Clay creek flows in a southerly direction, and joins the Lièvre river on lot 11 con. IV of the same township, near the line between lots 11 and 12 and less than a mile above Priest creek.

Tamo lake was formerly about three miles and a half in length and, in places, over half a mile wide, but a small landslide, caused by the breaking of a mill-dam and the consequent rush of water, almost completely emptied this large body of water in the short space of three hours and a half. The lake to-day consists merely of a small pond, at the extreme upper end of the old lake, about 15 chains in length and 10 in width. Tamo lake.

A bay on Tamo lake extended to within about 10 chains of Muskrat lake, from which it was separated by a bank of clay about 10 chains in width, through which a small brook formed an outlet from Tamo lake to Muskrat lake. A saw-mill and dam were built here, and it was the breaking of this dam that caused the above mentioned occurrence. The intervening clay was swept into Muskrat lake, the upper portion of which, for a distance of 15 chains, is filled up. The evidence as to the date of this occurrence is conflicting, but the best informed settlers name April 22nd, 1896. The bed of Tamo lake is now traversed by roads, and parts of it are under cultivation, while a cheese factory has been built on what was the centre of the old lake.

The roads traversing the area included within the sheet have been considerably changed in places since the map was compiled some years ago. Owing to the complete cessation of development in the phosphate industry of late years, nearly all the old mine-roads have fallen into disuse and are now covered with growth, and blocked with fallen timber. New roads have been built and portions of some of the old ones altered. During the summer the necessary surveys to indicate the roads as they now exist, were made. Changes in the roads.

All the rocks, within the area examined, belong to the Grenville series, or Upper Laurentian system, and consist principally of granitic, very quartzose, micaceous, rusty and syenitic gneisses, crystalline limestone, quartzites, feldspar rocks, pyroxenites, mica, apatite and small areas of diabase and of mica-diorites.

There is comparatively little limestone in the country east of the Lièvre river, but in the western portion of the area, limestone outcrops are much more extensive. Principal rocks.

Rocks east of the Lièvre river.

Notre Dame de Salette is a small village on the east bank of the river, and, about the centre of the sheet above this, on the road to Villeneuve, the hill-ridges extend in places to within a few chains Rocks north of Salette.

of the river bank, while in others they are distant from it from a half to three-quarters of a mile. West of the road, in the N.W. corner of West Portland, there is a ridge of a reddish-gray, granitic gneiss striking approximately S. 12° E.,* and a quarter of a mile south of this, on the east side, the gneiss is more banded, and strikes about S. 13° W. On lot 6 con. VIII the rock is principally quartz and feldspar, striking S. 3° W. On lot 6 con. VI the ridge is just alongside the road, on the east, and here there is a massive bluff of a smooth worn, much weathered rock, very rusty near the surface and consisting principally of quartz and feldspar.

Just east of Salette, and north of the R. C. Church, there is a hill consisting mainly of a rock made up of a bluish-purple quartz and plagioclase, with very little mica and holding small inclusions of altered pyroxene. This rock is met with in many localities in the area examined. Associated with it here are pyroxenite, apatite and syenite-gneiss (leopard rock). West of the cemetery there is a small hill of the same bluish-purple quartz with the plagioclases very abundant, and between this hill and the river is seen a small exposure of crystalline limestone. On lot 3 just south of this there is a small outcrop of gneiss striking S. 3° W.

South of Clay creek on lot II con. IV crystalline limestone is exposed on the west side of the road. It occupies a very small area and is coarsely granular with minute particles of graphite, in the form of flake, disseminated through it. It contains numerous inclusions of rusty gneiss, in pieces of varying sizes up to a couple of feet in length, and intersected by pegmatite veins.

Rocks south of Salette.

North of the line between cons. III and IV the road, which has been running over flats from the church at Salette, strike the base of a range of hills, and the rock here is a micaceous gneiss associated with the plagioclase purplish-quartz rock, before mentioned. On the west side of the road, opposite the mouth of Priest creek, micaceous gneiss and quartzite outcrop, striking S. 8° W. and dipping easterly at about 45°. From here to the line between cons. II and III, the road is very rough and hilly, and on both sides of the line, east of the road, the ridge is composed of the plagioclase-quartz rock, associated with fine-grain quartzose and micaceous gneisses. A hill of limestone extends for about a quarter of a mile across lots 11 and 12, on the

* Throughout this report all bearings in connection with strikes, striae, etc., are true bearing and an average constant magnetic variation has been allowed for of 12° W. Mr. White found the average variation about 11° but, in the time elapsed since his surveys were made, the annual increasing variation would make it now about 12°.

N. E. side of the road. The limestone is bedded; the hill rises almost perpendicularly alongside the road and its general direction is about north-east.

North of Malcolm creek, where the road runs off the sheet, the rock is principally grayish quartzite and micaceous gneiss striking S. 23° W. and dipping N. E. at a high angle. A dike of dark mica-diorite, about two chains in width, intersects it about eight chains north of the creek.

Rocks in vicinity of Tamo lake.

The rocks in the vicinity of Tamo Lake are similar to those closer to the Lièvre. At the top of a high hill, on the west side of the old lake, near the corner between lots 14 and 15 and cons. V and VI, East Portland, gneiss, with pegmatite veins, strikes N. 11° E. and dips easterly at about 45°. The same rock occurs along the road from Tamo lake to Salette, for about a mile. Here, gray gneiss, with large masses of pegmatite, is associated with the plagioclase-purplish quartz rock. The ridge leaves the road and runs off in a north-westerly direction to Crafts mine on lot 25 con. VII.

On what was a little island on Tamo Lake, about the middle of lot 13, con. XII, banded gneiss strikes N. 55 W. and dips S. W., almost perpendicularly; this is intersected by a reddish, fine-grained, granitic gneiss. This banded gneiss is also seen on the east shore of the lake, where is strikes in the same direction. The granitic gneiss is also exposed on lot 13 con. VI, where it strikes N. 53° W. and is tilted practically on end, and appears again on the lake bed, a quarter of a mile south of the line between cons. VI and VII.

The rock of the ridge along the west shore is principally gneiss and quartzite. At the southern end of the lake, on the western half of lot 1 con. IV, micaceous gneiss outcrops, and along the east shore the ridge is composed of quartzose gneiss and quartzite. Between the narrows of the old lake and the North Star mine, the rocks are quartzose gneiss, with a little epidote and quartzite, striking from about S. 18° E. to S. 9° E. with an easterly dip.

Rocks between London mine and Tamo lake.

On the road from the London mine to Tamo lake the rocks, at about the line between lots 6 and 7 con. II, are quartzites and gray gneiss striking N. 42° E. and dipping almost perpendicularly. From here to the crossing of Cobb creek, gneiss and quartzite are seen and, from the creek, for a distance of half a mile, the road runs over flats to a small hill of coarse diabase. Gneiss, containing considerable pegmatite and associated with quartzite, strikes N. 15° E. and dips southerly on the northern side of a small branch road on the line between cons. III and IV, and about half a mile west of the main road. There is another area of coarse diabase on the east of the road, a short distance south of the schoolhouse.

A road runs from the schoolhouse down through the S. W. portion of Derry, and is divided about the middle of con. IV of Portland, at the line between lots 1 and 2, into two branches which reunite on lot 5, con. III of Derry. Micaceous gneiss and quartzite are seen on the north side of the north branch as far as the town line. On the southern end of lot 4, con. IV, Derry, the gneiss strikes S. 8° W. and dips almost perpendicularly. South of this there is a small area of serpentine and limestone, and then gneiss, striking in the same direction, is again met with. On the south branch the rocks are quartzite and gneiss, and from the forks at the junction of the two branches, the road runs through tamarack, cedar, spruce and balsam swamp, to the middle of lot 4, con. II. Here there is a big bluff known locally as the "Roc Rouge", composed principally of feldspar and epidote. Just west of this there is micaceous gneiss and, with it, perthite, and on the Portland side of the town-line there is a ridge of quartzite and quartzose gneiss, striking S. 89° E. South of the road, on lot 3, con. II, Derry, banded gneiss, striking from S. 63° W. to S. 73° W. and dipping N. N. W., is seen.

Asbestus.

Asbestus occurs on lot 10, con. III, Derry, and several small surface seams were seen, the largest of which was about one in thickness.

Gneisses.

On the south side of the road between Crafts mine and the Chapleau mine micaceous gneiss is exposed striking S. 40° E. on lot 23, con. VII, and on lot 22, anorthosite, from lot 21, up to the Chapleau mine, is seen. The road is covered with growth. On lot 20, on the north side of the road, a very micaceous schistose gneiss strikes S. 21° E. and has an almost perpendicular dip. The main road from Crafts mine runs north-easterly from lot 21 and skirts the base of a ridge of reddish quartzose gneiss for half a mile. On con. VIII, near the south end of the line, between lots 23 and 24, the gneiss strikes S. 40° E. and dips north-easterly at 45°. Near the Philadelphia mine the same gneiss strikes in a similar direction and dips north-easterly at about 70°. Along the road from lot 22 on the line between cons. VII and VIII, a reddish quartzose gneiss, associated with quartzite, occurs up to above the middle of lot 17 con. IX. The strike varies from N. 29° W. at the southern end of lot 21, con. VIII, where the rock is dipping north-easterly at 70°, to N. 41° W. about the middle of the lot, N. 17° W. just north of the line between cons. VIII and IX, and N. 8° E. about the middle of lot 17 con. IX.

A dike of dark mica-diorite crosses the road near the southern end of lot 21, con. VIII, and a small area of ophi-calcite (serpentine and limestone) occurs just south of the line between cons. VIII and IX

On the west side of the road, running north from the old narrows of Tamo lake to Clay lake, a very much weathered gneiss strikes S. 40° E. and dips almost perpendicularly. With it are associated whitish gray quartzite and pegmatite. North of the line, between cons. VIII and IX and on the west side of the road, there is an exposure of quartzose-gneiss striking S. 21° W. On the S. E. corner of lot 15, con. X, there is a small exposure of crystalline limestone, and the same rock is seen again about half a mile south of Clay lake.

A new road has been built from the corner of lots 12 and 13, cons. IX and X, running north-easterly into Derry, and on its north side on lots 8 and 9, Portland, rusty micaceous gneiss with pegmatite veins is exposed. Gneiss and quartzite are seen near the town-line, and on lots 1 and 2, con. IX of Derry, biotite-gneiss with pegmatite veins and quartzite, strikes S. 37° W. and dips S. E. at 75° to 80°.

On lot 7, con. IV of Portland, quartzite gneiss strikes N. 36° and dips S. E. at 45°, and one hundred yards west of the town-line, schistose, micaceous gneiss, with quartz and pegmatite veins, strikes N. 51° E. and dips N. E.

Throughout the whole area examined, bands of pyroxenic rocks with which is associated apatite, occur, running generally through the gneisses and quartzites.

Rocks west of the Lièvre river.

Rocks on west bank of Lièvre river.

The road leading south from Chalifoux ferry towards Priest creek, runs over clay to lot 4, con. V where it skirts the base of a ridge on the west. The rocks here are very much disturbed and consist of limestone, micaceous gneiss with masses of quartz and pegmatite, and also the purplish quartz-plagioclase rock. On the opposite bank of the river there is a small exposure of limestone. The gneiss is older than the limestone. One hundred yards farther south, the hills are composed of gneiss striking N. 68° E. with a varying northerly dip. This road stops north of Priest creek which has not yet been bridged. On lots 4 and 5, con. VI, just west of the river, a ridge of gneiss striking from S. 69° E. to S. 89° E., extends back for half a mile. The gneiss contains numerous veins and masses of pegmatite. Phlogopite and muscovite have heen mined near the river, but no development work is going on at present.

On the south-west side of Ross mountain quartzose and micaceous gneisses, associated with the purplish quartz-plagioclase rock, occur, and with them bands of pyroxenite. About the middle of lot 1, con. VII the strike is S. 74° E. and the gneiss is considerably iron-stained. At the western end of lot 4 con. VII biotite gneiss strikes S. 32° E. and dips N.E. at a high angle.

Rocks between Poltimore and Salette.

On the road running from Poltimore, West Portland, to Salette the first rock met with is a very rusty sillimanite-gneiss situated about a quarter of a mile east of the R. C. Church, containing considerable pegmatite and striking S. 47° E. with an almost perpendicular dip. About 12 chains farther the rock is bluish-gray in colour, weathers very rusty, and consists of plagioclase, mica and quartz. Dolomite occurs in a hill just east of this, and on the northern end of lot 21, con. VII the rock is a very rusty, much decomposed gneiss with an approximately general north and south strike and an easterly dip of about 45°. On lot 20, in the same concession, there is a small hill of coarse granular crystalline limestone, with minute particles of graphite disseminated through it, and associated with the limestone is a rusty gneiss. On the line between lots 18 and 19, con. VII, the gneiss is striking N. 5° E. and is associated with quartzite. The outcrop is the first found on the south of the Poltimore road. About the middle of con. VII and on the line between lots 14 and 15, the gneiss strikes about N. 5° W. and clearly defined glacial striæ were here observed running S. 25° E. On lot 11, con. VII and on the north end of lot 12, con. VI, alongside the road, mica-schist, very rusty and twisted in places, has a general strike of from N. 61° W. to N. 57° W., dips south-westerly at about 50°, and is associated with the purplish quartz-plagioclase rock, containing small inclusions of altered pyroxene. Near the line between lots 8 and 9 and cons. VI and VII, the road meets the base of a ridge, running off to the north-west, which it skirts for about a mile. The ridge is composed principally of rusty micaceous gneiss and quartzite, but on lot 7, con. VI the gneiss is more granitic, strikes N. 68° W. and dips south-westerly at about 50°.

Glacial striæ.

Here again, glacial striæ are well defined, having a direction of S. 27° E. The immense fires that have swept over this area have blistered the rocks in many places, obliterating surface-markings, and this is probably why striæ were not found more frequently, the two places referred to being the only ones where reliable striæ were observed.

An old road, now fallen into disuse, runs from Chalifoux ferry to the site of Holland's mill, which was burnt down some years ago. Where this road crosses the east line of lot 7 con. VI, a small patch of crystalline limestone is seen, and just past it, gray gneiss strikes N. 82° W. and dips N. at about 80°. A little more than a quarter of a mile before reaching the mill, quartzose gneiss strikes S. 53° W., and dips south-easterly, and about ten chains farther the gneiss is very rusty. At the mill, it is striking 10° west of south and dipping easterly at 60°.

To the east of the road, on lot 14, con. VII, there is a hill of banded gneiss about a quarter of a mile in length and ten or twelve chains in width. The gneiss is striking S. 12° E., and dipping east at 70° to 75°.

A road running to Buckingham leaves the Salette-Poltimore road at the corner of lots 13 and 14 and cons. VI and VII, traversing the southern part of the sheet in a south-easterly direction. Just west of this corner, there is a hill of coarse granular, crystalline limestone, and, outcropping at its base, is a small mass of quartzite. On the top of the hill, fresh-water shells (*Planorbis*) were found. Several small hills are located crossing con. VII, between the road and Harper's lake, and at the base they are generally composed of quartzite, occasionally associated with bands of rusty gneiss striking N. 10° E., and dipping W. at from 50° to 60°. The upper portions of the hills are composed of crystalline limestone.

Fresh-water shells.

The road across cons. IV and V follows the east bank of Wright's creek, a tributary of Priest creek. The hills to the east of the road are composed of quartzite and gneiss, while, to the west of the creek, there is a belt of crystalline limestone. Sharp differentiation is shown on the east side of the road near the line between cons. IV and V, where, in the space of a few yards, the rock varies from a quartzite to either a hard granitic gneiss, a hornblende schist, or a hard, smooth hornblende.

About half way across con. V there is an occurrence of asbestus on the east side of the road, on lot 16, the property of Mr. Nicholas Orange. Some development work has been done here, and seams an inch in thickness are said to have been found, but half an inch was the largest noted.

Asbestus.

Almost midway across con. IV, the hill east of the road is composed of red granite gneiss striking N. 38° E., and dipping S.E. to 60°. South of this, there is a hill of massive feldspar and quartz, weathering white, and intersected in places by numerous small veins of hornblende. To the west of the creek crystalline limestone is exposed. Near the line between cons. III and IV, on both sides of the road, the plagio clase purplish quartz rock is found, and S.W. of the road, on about lot 8 con. III., there is a knoll of gneiss and a white weathering rock, quartz and feldspar. Reddish gneiss strikes S. 35° E., and dips N.E. just north of the road on lot 7 con. III. A light gray, granitic, acid gneiss, with very little mica, is striking S. 35 E., and dipping N.E. at about 60° on the north side of the road in lot 7. A ridge runs off, a little west of north, from the lower part of lot 2, and is made up here of a basic granitoid gneiss, hornblende and biotite; intersected by occasional small veins of pyroxene rock.

Crystalline limestone.

On the road from Poltimore to big Blanche lake, a low ridge, about a quarter of a mile long and three to four chains in width, extends from the crossing of the line between lots 28 and 29, con. VII., Portland, in a direction of about S. 27° E. It is composed of hornblende and mica-schist, and just south of it there is a similar low ridge of a fine-grained basic gneiss, the same rock being exposed on the N. W. side of the road. Very quartzose gneiss and granite, striking N. 24° W., and dipping easterly at about 45°, occur to about the middle of lot 29 on the north side of the road. Here a small bluff of massive, very coarse-grained, whitish, crystalline limestone, with particles of graphite disseminated through it, is met with and extends for about two chains.

A hill of the same limestone, about three-quarters of a mile long and a quarter of a mile in width, its axis lying in a general northerly direction, occupies the area between the two heads of St. Germain creek in con XI., Wakefield. These hills are much weathered and decomposed near the surface, and the broken up, decomposed rock found everywhere at the base of their slopes somewhat resembles rock-salt in appearance. A small knoll of the same rock is seen just east of the Presbyterian Church on con. X and another just west of the road and south of the line between cons. IX and X, the latter a little finer-grained and more of a dolomite than the former. East of McMullins lake the ridge is composed of rusty gneiss, mica-schist and the plagioclase purplish quartz rock with the altered pyroxene inclusions. On the road west from Poltimore, a big hill of the coarse crystalline limestone is met with on the north side of the road, at the Denholm-Portland line. It contains numerous inclusions of a very rusty gneiss in pieces of all sizes. A knoll of the same rock lies just south of the road to the west of the line.

On the west of the road north from Poltimore, fine-grained micaceous gneiss is seen about 15 chains south of the line between cons. VIII and IX, Portland. Between this exposure and the line, also on the west of the road, there is a knoll of limestone. A small hill of limestone a quarter of a mile in length lies to the west of the road in con. X. The road forks at the line between cons. IX and X, one branch running to the north-east, known as the German settlement road, and the other to the north-west running up into Denholm. Near the latter road, 100 yards north of it and just west of the forks, there is a big hill of limestone, and west of the town line, on lot 47 of Denholm, there is a knoll of red gneiss, striking N. 47° E. and dipping S.E. at about 45°. West of the corner between Bowman, Denholm and Portland, red gneiss strikes S. 18° E. and dips easterly.

The country, south and east of the German Settlemant road, is burnt and weed-grown for a distance of about a mile. On lot 19 con. X Portland, there is an exposure of very micaceous gneiss, and half a mile further, the road strikes the base of a big ridge of the coarse, granular limestone, which it skirts for a distance of about half a mile. A small hill of gneiss occurs on lots A and 1 con. V Bowman, and here the strike is N. 51° E. A few chains further there is another small hill : in this, limestone and rusty gneiss occur and at a point just about the line between lots 4 and 5, banded gneiss strikes N. 19° E. and dips S.E. at about 70° Gneiss.

On the Ross Creek road, running north from the present Holland Mill Post Office, rusty gneiss is met with about the middle of con. IX, on the west side of the road, and a quarter of a mile further north, there is a small hill of coarse crystalline limestone with inclusions of rusty gneiss. The gneiss is met with again near the line between cons. IX and X, striking S. 67° E. and dipping northerly at 50°. Just past it, a big ridge of very coarse granular, crystalline limestone runs off in a north-westerly direction. To the east of a brook, which here runs along the road, there is a big ridge of gneiss, mostly reddish and fine grained, striking S. 29° E. and dipping easterly at about 70°. About the middle of lot A. in con. V, Bowman, there is a small knoll of a dolomitic limestone, much finer-grained than was found in most of the other hills.

With regard to economic geology, the chief interest in the whole area is attached to the occurrence of apatite and mica, both of which were mined on an extensive scale for years, though unfortunately at the present time little or no development is being done. In fact, only one locality was noted where active operations were being pursued Economic geology.

during the past summer, and this was at O'Brien's mica mine, on lot 19, con. VIII West Portland, where work was carried on during a part of the summer.

Phosphates.

Since the early nineties, when the enormous development of the phosphate industry in the Southern States reached a point at which it was impossible for the Canadian mines to succesfully compete, the phosphate mines in this area have all been shut down, and no development work is now being done at all.

No particular attention was paid, during the past season, to the occurrence of phosphate and mica in this area, the subject being one which has occupied the attention of, and been fully investigated by, many well-known geologists. Among those who have contributed to our knowledge on this subject may be mentioned Sterry Hunt, J. W. Dawson, G. M. Dawson, Harrington, Adams, Torrance, Dawkins, Kinahan, Falding, Bell, Coste, Ingall, Penrose, Selwyn, Davidson, Ells, Osann and Gibson.

As the only places in this area, where the occurrence of phosphate can be well studied, are at the mining pits, and as these pits are now full of water, examination must be confined mainly to the dumps. These consist principally of gneiss, quartzite, pyroxenite and mica, and an examination of nearly all the mines *showed that the apatite is always accompanied by pyroxenite.*

Prof. Osann's conclusions.

In regard to the relation between the pyroxenite and the apatite, some results arrived at by Prof. Osann, who made a close study of the occurrence of apatite in this field in the fall of 1899, may be quoted.

He says : " The apatite veins are always accompanied by so-called pyroxenite ; they seem to be connected with its occurrence." Again, speaking of the apatite deposits : "They are all of the same origin, and younger than the associated gneisses. They are accordingly true veins which have been formed in the same way as all other ore-veins."

SURFACE GEOLOGY OF EASTERN QUEBEC.

By Dr. R. Chalmers.

Work during winter of 1903-1904.

The winter of 1903-04 was spent by Dr. Chalmers in the office compiling the fieldwork of the previous summer and preparing a bulletin on *Peat in Canada.* In this paper a description of nearly all the known peat bogs of the Dominion is given, together with an account of the processes employed in preparing this material for fuel, coke or moss litter. Information concerning peat bogs was furnished to persons interested in these, in answer to inquiries from different places in Canada, and some time was also taken up examining drillings and logs of wells bored for oil, gas or water.

On the field work accomplished during the past season Dr. Chalmers makes the following report:—

Field of work for 1904.

The work assigned me for the season of 1904 was the study of the surface geology of the St. Lawrence valley, principally to the north and east of Quebec city, including that of the Gaspé peninsula, and of the Saguenay river and Lake St. John district. Before commencing this, however, a short time was spent at Brockville, Kingston and northward and north-westward into Renfrew and Hastings counties along the border of the Archæan area, with a view of obtaining, if possible, further evidence as to an axial uplift in the Post-Tertiary period north-east and north of lake Ontario. Stratified beds of sand and gravel, with a flow-and-plunge structure, deposited by waters flowing eastwardly were observed in several places between the St. Lawrence river and Renfrew, occupying different elevations, the highest being met with between Sharbot and Calabogie lakes at 800 and 850 feet. Lower beds of the same character occur to the west near Madoc Junction, also to the east three or four miles north of Smiths Falls. At these places, the elevation is 502 feet and 440 feet respectively. Further, certain yellow sands and gravels, holding calcareous concretions, common in the basins of lakes Ontario and Erie, have also been transported eastward at this period and deposited upon the Leda clay and Saxicava sand along their western border. These were observed as far east as Prescott. From the facts obtained, it became evident that, at the time of the formation of these sand and gravel beds, different relative levels existed, the granite axis being lower than at the present day, and the waters in which the highest of these beds were laid down must have overflowed from the ancient lake Ontario out upon the St. Lawrence marine plain at various points.

At Brockville and Kingston.

Western limit of Leda clay and Saxicava sands.

Conclusions from observations made.

The conclusions tentatively arrived at from the investigations are, that (1) The marine beds of the St. Lawrence valley reach their western limit at Brockville and along a line passing by Maberly station (Canadian Pacific railway), Lanark, Calabogie and northward, and are overlapped, in places, by fresh-water sands and gravels from the west.—(2) The deposits of the basins of the Great Lakes are glacial and lacustrine; and (3) The St. Lawrence valley and the lake region must have stood at a lower level at the close of the Pleistocene* and beginning of the Recent Period of Post-Tertiary geology than at the present day, and the Archæan axis referred to, slightly higher than these, holding in lake Ontario or a still larger body of water. This condition of things was followed by a downward movement of the so-called Archæan neck and granite axis, with correlative uplifts to the east and to the west. The raised marine shore-lines on the one hand, and those of lacustrine origin on the other, must have been formed during certain pauses in the oscillations referred to. Taking all these facts into account, there would seem to have been only one general subsidence of this axis during and since the glacial period with two or three cessations of the stresses which produced the oscillations, and one upward movement still in progress, as shown by the present position of the Iroquois beach, and by the observations of Dr. Gilbert of the United States Geological Survey.‡

A brief preliminary note embodying the results of the investigations was prepared and published in the September number, 1904, of the *American Journal of Science*, entitled *The Geomorphic Origin of the Raised Shore Lines, Etc.*

Work in the Gaspé peninsula.

On returning to Ottawa, a few days were spent in routine work in the office, and in preparing the paper referred to. On the 27th of June I left for the regular field work of the season, proceeding first to Gaspé peninsula. In carrying out the work intrusted to me there, I started from Metapedia, going thence to New Carlisle and Paspebiac, where a few days were occupied making examinations in the rear settlements and along the coasts towards Port Daniel. At Gaspé basin the surface deposits, glaciation and raised shore-lines were investigated while arrangements were being made for a trip around the north shore of the peninsula. With camping outfit, and a man and boy, I started on this difficult and laborious journey, having only a single horse and express waggon. A considerable part of the trip was, however, accomplished on foot; but occasionally, in the mountainous country, we hired a second horse. The roads are the worst in Eastern Canada, especially between Fox river and Sainte Anne de Monts, passing over hills 800 to 1,500 feet high, and descending into the narrow valleys at the mouths of the rivers, where the fishing villages are situated. In several places these roads are so bad, and the hills so steep, that we had to take to the shore and follow it to the

* The term Pleistocene as employed here embraces that period beginning at the close of the Pliocene and ending with the deposition of the Leda clay and saxicava sands.

‡ Recent Earth Movements in the Great Lakes Region, Eighteenth Annual Report, U.S. Geol. Survey, 1896-97, Part II, pp. 601-647.

next fishing village. Most of the coast district between Fox river and Valley river is unsettled, except at the fishing stations. Generally speaking, it forms an undulating plateau from 700-800 feet to 1,200-1,500 feet high, trenched by rivers and brooks, and with a steep face to the gulf. The banks, which are angular, abrupt, and without that rounded appearance so characteristic of ice-worn surfaces, have undergone tremendous erosion by the sea, the regular curving form of the coast line being largely due to this cause. Inlets at the mouths of rivers and brooks are enclosed between steep, angular bluffs, the upper brow of these being sharp in outline and bearing no traces of ice action. Nor do the higher hill sides and summits exhibit any erosion by ice, sub-aerial decay and waste having apparently had full sway here. These features characterize the coast district from Fox river, or Anse au Vallon, to Ste. Anne des Monts, this part of the coast being higher than that to the east or to the west. No ice seems to have impinged against it, or passed over it from the north, south, east or west. A thick coat of decayed rock *in situ* forms the superficial covering, but no boulder-clay nor transported material was observed except such as was found on the shore and the lowest terraces. Atmospheric erosion and the action of the rivers were the principal factors in the reduction of the surface on the higher grounds. Doubtless glacier ice occupied the central and mountainous parts of the interior, but it does not seem to have reached this part of the coast.

Absence of glaciation in some parts.

The surface geology of the Gaspé peninsula was examined, many years ago, by Dr. Bell, and the local character of the drift described by him in a paper published at the time*; it was also referred to by Dr. Ells in his report on the geology of Gaspé†. In Dr. Bell's paper he remarks that he failed to discover a single stone which had not been derived from the rocks of the country, until he visited Cape Gaspé and Point Peter, where boulders of Laurentian gneiss were found in abundance on the sea beach. The truth of this statement was borne out by the facts observed by me on the north coast, no foreign drift or boulders having been met with there, either, except such as had been transported thither by floating ice. As soon as we pass Cape Gaspé, going west, the gneiss and granite boulders referred to by Dr. Bell, evidently derived from the Laurentides, begin to appear and can be traced, with little or no interruption, on the lower grounds westward to Rivière du Loup, Quebec city and Lake Champlain. In proof that these must have been transported thither by floating ice, it may be stated that

Dr. Bell's paper on the surfacc geology of Gaspé.

*On the Superficial Geology of the Gaspé Peninsula by Robert Bell, C.E., of the Geological Survey of Canada, Can. Naturalist, Vol. VIII, 1863, pp. 175-183.

†Report of Progress, Geol. Survey of Canada, 1882-83-84, Part E.

they were not met with above the limits of the Pleistocene submergence, which at Gaspé, was 240 feet, increasing westwardly, though with some irregularity. Boulders of local rocks are, however, plentifully distributed thoughout in the peninsula.

Coast scenery.

From Ste. Anne des Monts, or, indeed, from Valley river westward, the coast scenery changes and becomes less elevated and bold along the St. Lawrence. At the first mentioned place, a number of hills, remnants of denuded ridges, occur to the east of the village, and now form separate peaks. Boulder clay, which had not been seen since we left Anse au Vallon, or Fox river, again appeared and glaciated blocks, apparently derived from the Shickshock mountains, were also noted. The hills now began to recede from the St. Lawrence river, and low bosses were observed to be rounded and worn on the south sides, evidently by ice that flowed northward from the mountains referred to. The surface beds here, too, contain large quantities of material derived, apparently, from the interior of the peninsula ; but the Laurentian gneisses and granites are still plentiful along the coast.

Ste. Anne des Monts.

From Ste. Anne des Monts, or Cape Chat westward, the country is settled for two or three concessions back from the river, near which good land was observed. This farming belt or terrace widens as we proceed up the St. Lawrence valley, the hills retiring more and more. At Metis the marine plain is two or three miles wide, and the foot hills of the Notre Dame are three or four miles from the river. Here, good evidence of northward ice-movement was shown by bosses, glaciated on the south sides, by transported blocks and drift from the interior, and by the presence of thick beds of undisturbed decayed rock material on the north or lee side of the foot hills. One of these beds can be seen under the snow-shed immediately to the north of Little Metis station, (Intercolonial railway). It is a mass of decayed slates *in situ*, lying on the northern brow of the ridge, and fronts the open St. Lawrence valley, thus showing that no ice from the north impinged against these hills at this place.

Conclusions respecting glaciation of Gaspé peninsula.

The investigations of the past season established the conclusion that, as was first shown by Dr. Bell in the paper cited, the glaciation and the transportation of the drift in the Gaspé peninsula, are entirely local, except such material as is due to floating ice on the north side. On the south and east sides the ice of the glacial period flowed outward from the elevated grounds of the interior, towards the periphery*. North of the range of mountains terminating at Cape Gaspé, the ice

* Annual Report, Geol. Surv. Can. Vol. II, 1886. *Ibid.* Vol. VII, 1895, pp. 88-90 M.

movement was eastward, veering apparently to a north-eastward course as we go up the coast towards Fox river. Here, or between this and Anse au Vallon all traces of ice action are lost and are not again met with till we approach Ste. Anne des Monts. It cannot be doubted that ice gathered upon the higher parts of the interior, but owing to the divergent courses of the river valleys and the elevated character of the coast border between the two places mentioned, the ice upon the mountainous country, in the central part of the peninsula, must have found outlets in other directions. A portion flowed eastward, and probably south-eastward, following the rivers which fall into Gaspé basin and the Baie des Chaleurs, while other parts, further west, descended northward more directly to the St. Lawrence river along the Ste. Anne des Monts and other river valleys. Whatever explanation is given, the fact remains that it is only along that part of the northern coast border, which rises from 800 to 1,500 feet above the sea, that the evidences of glaciation are wanting. From Ste. Anne des Monts westward to Metis, Levis and, indeed, to the International Boundary near Lake Champlain, there are abundant striæ proving northward ice-movement from the Shickshocks, Notre Dame and Sutton mountains into the St. Lawrence valley. These striæ are especially well-marked at Metis, Trois Pistoles, the south side of Cranbourne mountain, at Inverness and South Somerset, Richmond, and in Brome and Mississquoi counties, and boulder-clay, without Laurentian boulders, but evidently derived from the mountain ranges to the south, occurs in the localities mentioned. To the west of Quebec city, but not to the east, striæ are found superposed upon this south-to-north set produced by ice which came from the Laurentides. This ice spread over the greater part of the Eastern Townships and province of Quebec, west of Bellechasse and Dorchester counties, and appears to have crossed the International Boundary in a number of places, and to have flowed up the Lake Champlain valley. Another and later glacier from the Laurentides moved south-westward and westward up the St. Lawrence valley, the source of which appears to have been the high grounds between Lake St. John and the head of the St. Maurice and Batiscan rivers. Striæ produced by this glacier were found to be superposed on those of the earlier ice of the Laurentides. These systems of striation were described in a previous report,* and the latter ice movement will be referred to on another page in describing the glaciation of the Lake St. John and Saguenay region.

Ice in the interior.

Returning to the Gaspé peninsula, it may be stated that a considerable part of the region traversed on the north side contains arable

Agricultural character of region.

*Annual Report, Geol. Surv. Can. Vol. X. 1898 pp. 25-54 J.

land, even upon the higher grounds. The thick capping of decayed rock material lying upon the unglaciated portion forms, in most places, a good soil, and does not contain more stones than are found in other parts of the country. These lands are still largely covered with the original forest growth, which consists of spruce, fir, cedar, hacmatac, birch, maple, poplar, ash, beach, etc. Except in the vicinity of Fox and Magdalen rivers, no forest fires have over-run the country. From Grand Vallée to Magdalen river, where lumber operations were carried on some years ago, thence nearly to Ste. Anne des Monts, little of the original forest covering has been cut away. Lumber mills are now in operation only at Grand Vallée and Ste. Anne des Monts. At Valley and Chat rivers, and some smaller streams, the manufacture of birch into spool wood is carried on. This finds a market in Paisley, Scotland.

Fishing industry.

The primitive and isolated condition of this coast region is very remarkable, considering its proximity to the oldest and most thickly populated parts of Canada. The fishing industry seems to be the main dependence of the few scattered settlers, and the lack of easy communication with the rest of the world retards progress in various ways. The natural resources of this coast area are, therefore, still largely undeveloped. The seigniorial tenures doubtless hinder settlement in some places; and though the soil is suitable for mixed farming, early frosts interfere with the successful production of the crops. A much better state of things would undoubtedly prevail were the coast provided with good roads and other means of communication.

Striation at Chicoutimi.

After completing investigations in Gaspé, my intention was to examine the north side of the St. Lawrence and the Saguenay and Bersimis rivers, and if weather permitted, go as far as Point des Monts. Crossing from River du Loup, work was commenced at Tadousac, but bad weather setting in, we were obliged to wait, meantime making an examination of the Saguenay river and the basin of Lake St. John. At Chicoutimi, glacial striæ were found trending S. 74° E. and S. 79° E., while, on the road to Kenogami lake, they were observed to have a bearing of S. 86° E. West of Roberval, grooves were noted having approximately the same course. At the Grand Discharge the striæ run S. 75° E. From these data it appears that the ice, which occupied the Lake St. John basin and the Saguenay valley, flowed in the direction of this valley towards the St. Lawrence, but whether overriding the mountains at Trinity and Eternity capes remains to be discovered. Glacial grooves, with approximately the same courses as those at Chicoutimi, were noted in the vicinity of Tadousac.

Glaciation of the region around Lake St. John.

The glaciation of the region to the south and south-west of Lake St. John, comprised within the counties of Quebec and Montmorency, when studied along with that described above, indicates an ice-shed where the present water-shed exists, from which glaciers flowed westward and south-westward, southward and south-eastward, apparently in radial lines, those of the latter course descending the Saguenay valley as already shown. The ice producing these divergent courses probably had its source to the north of the ice-shed referred to above, and, if so, the fact that a portion of it was guided in its movement by the valley of the Saguenay, or drained into it, would show that it was not sufficiently thick or massive to be beyond the influences of the local topographic features. On the south of the mountains properly called the Laurentides, which front the St. Lawrence from Point des Monts, westward, the striation is light and, as already pointed out, the ice which produced it does not seem to have crossed the St. Lawrence river at any place below Quebec city. On the west of the ice-shed referred to, the ice-flow, as mentioned above, was south-westward and westward. Striæ with these bearings are recorded by Mr. Low in his list* in which courses varying from south to west are given as observed in Quebec and Portneuf counties. This ice followed the trend of the river valleys, as pointed out by Mr. Low. Whether the divergent striæ, found upon the higher grounds of this region, indicate two or more systems of glaciers has not been ascertained. No striæ have been met crossing each other on the same exposure; nor have two boulder-clays with inter-glacial beds been observed, as on the south side of the St. Lawrence valley. West of Quebec and Portneuf counties, however, striæ with a westward trend were found by me in 1896-98 superposed on others produced by the earlier Laurentide glacier, or glaciers, at St. Jerome, Montreal, Lachute, Calumet, Soulanges canal, Prescott, Lansdowne, etc., and on the south side of the St. Lawrence valley at Ste. Julie, Warwick, Richmond junct, Shefford mountain, Beauharnois canal, Valleyfield and westward.† In many of these localities the superposition of the westward-bearing courses is so clear, that the facts cannot be explained except on the theory that two separate glaciers passed over the region. Strange to say, however, no interstratified beds of sand or clay have yet been met with between boulder-clay deposits on the north side of the St. Lawrence, or upon the border of the Archaean area.

Striæ near Quebec.

Striæ in the St. Lawrence valley.

*Report on the Geology and Economic Minerals of the southern portion of Portneuf, Quebec and Montmorency counties, P.Q. Geol. Surv. Can. Vol. V, 1890-91 pp. 48-52 L.

†Report on the Surface Geology and Auriferous Deposits of South-eastern Quebec, Annual Report, Geol. Surv. Can. Vol. X, 1898, pp. 26-38 J.

Shore lines.

Shore lines and all evidences of a lower level of the land at a former period were everywhere observed on the Gaspé coast, in the St. Lawrence and Saguenay valleys and around Lake St. John. On the south side of the St. Lawrence, local deformations were noted in a number of places. The presence of transported gneiss and granite boulders, scattered about up to a certain limit, assists, in many places, in defining the uppermost high water mark of the pleistocene submergence. Near Cape Gaspé this is about 240 feet, at Rivière Manche d'Epée it is 310 to 315 feet, at Claude river it is only about 267 feet, while at Ste. Anne des Monts it is about 300 feet. Near Little Métis the highest shore line is 420 feet, but at Ste. Flavie, further west, it is only 345 feet. At Trois Pistoles it was found to be 375 feet, and at River du Loup 475 feet.* It will thus be seen that there were at least two local sags or uplifts, as the case may be,—one between Rivière Manche d'Epée and Ste. Anne des Monts, and the other between Little Métis and River du Loup, and there are possibly more.

Changes of level, in the lower St. Lawrence valley.

At Tadousac.

On the north side of the St. Lawrence, these unequal changes of level were further noted, particularly in the Lake St. John basin and along the Saguenay gorge. At Tadousac several shore lines were seen, the highest, which is a very good one, being 405 feet above mean tide. Another lies below it at 180 feet. To the east of the village, the higher one extends along the St. Lawrence for three miles or more, and is one to two miles wide, undulating slightly in that distance. A great deal of its surface is covered with blown sand. At Murray Bay, the highest well-defined shore line is at 378 feet, which is 27 feet lower than the highest one at Tadousac. It rises to the west, however, being 479 feet at Les Eboulements, 540 at Ste. Anne de Beaupré, and 560 feet at Charlesbourg, north of Quebec.‡

At Murray Bay.

Terraces at Saguenay river and Chicoutimi.

Returning to the Saguenay river and ascending it, we find four well-defined terraces south of Chicoutimi. The relaton of these to the St. Lawrence valley terraces is, however, somewhat doubtful; the lowest is 265-270 feet above mean sea level, the second 325 feet, and the third 485-490 feet. The fourth and highest is wide, extending across a considerable part of the country between Chicoutimi and Kenogami lake at a height of 510-515 feet. Near this lake, gravel terraces occur at 525 feet, which, however, appear to be lacustrine. As regards the other terraces and shore lines, they are probably marine, being near the head of the present tide waters, though I did not find any marine

*These heights are all based on mean sea level.

‡Additional altitudes for the uppermost shore lines on both sides of the St. Lawrence valley are given in Annual Report, Geol. Surv. Can. vol, X, part J.

shells in the clays or sands here. Pleistocene marine fossils have, however, been reported from this locality.

At St. Jerome, near the foot of Lake St. John, the 515 foot terrace (513 feet here), a mile or two wide, was also noted. Another narrow one, at the base of the hills west of this village, was found to be 570 feet high, and in the narrow valleys, or indentations in the hill sides, with terrace bottoms water lines occur at 675 to 700 feet. At St. Jerome.

West of Roberval, an extensive plain of sand and clay occurs at about the same elevation as that of the St. Jérome and Chicoutimi terrace, namely, 515 feet, (here it is 518 feet in places.) At the foot-hills there is a narrow terrace at 655-665 feet, and a higher, broken one at 710 feet. These appear to be parts of the terraces observed at St. Jerome at 675 and 700 feet.* Near Roberval.

The wide terrace at the same altitude, (515 feet) at Chicoutimi, St Jerome and Roberval is, therefore, practically horizontal for 65 to 70 miles, and the question arises, is it marine or lacustrine, that is, did the sea enter the Lake St. John basin in the Post-Tertiary period, or was this great terrace formed in the bottom of the ancient body of water representing this lake. At present this question cannot be satisfactorily answered. Sea shells have been reported from the clays of the Lake St. John basin, but I could not find any, though some time was spent in searching for them. In a brick-yard at Roberval, however, a species of *Unio* was discovered in the clay. Near tide head at Chicoutimi, marine shells were reported to have been found in clay beds, presumably Leda clay, but whether in the highest terraces, or near the present tide level, I could not ascertain. If this extensive terrace be marine we must have had a differential elevation of the region, that is, the Lake St. John basin has risen 110 feet higher than the country at the mouth of the Saguenay, 70 miles to the south-east. On the other hand, if the Lake St. John terraces be lacustrine, where was the barrier which held up the waters to this height? The clays there, it must be admitted, do not resemble the Leda clays of the St. Lawrence valley; on the contrary, they are somewhat similar to the clays in the Lake Ontario and Erie basin. This fact and the occurrence of *unionicæ* in them seem to be against the marine hypothesis. The question as to their marine or lacustrine origin therefore remains in doubt. Wide terraces near Lake St. John. Differential elevation.

There is, however, another problem in connection with the altitude of the terraces referred to, which cannot be passed over without some Problem in connection with terraces.

* All the heights were based upon those of the Q. and L. St. John railway as given in White's "Altitudes."

attempt at explanation. Taking the depths of the Saguenay, between the mouth and Chicoutimi, at tide head, into consideration the difference between the deeper and shallower parts is so great as to be inexplicable on the erosion or deposition theory. The St. Lawrence. opposite the mouth of the Saguenay river, is 120 to 180 feet deep, Inside of the mouth of the Saguenay river, the depth is 600 to 648 feet, while above this, at Point Laboure, it is only 300 feet. In the narrowest part of the valley, below the mouth of Ste. Marguerite river, the general depth is only 200 to 300 feet, though in one spot 432 feet. At St. Jean bay it is 708 feet, and at Eternity Cove, now called Echo Cove, in the guide books, 870 feet; above Trinity, 870 to 876 feet, the last two soundings being in the deepest part of the whole river. From this to the entrance to the Ha Ha Bay, the average depth is from 870 to 708 feet. Above Ha Ha Bay the river shoals, and is only 492 and 360 feet, diminishing in depth further up to 180 feet and less. It will thus be seen that the Saguenay, in its tidal part, is a great trough 70 miles in length, from half a mile to two miles in width, and from the hill tops on either side, 2,000 to 2,500 feet deep in the deepest part, namely at Cape Eternity. In the shallower parts, however, it is not more than 800 to 900 feet deep. In its present form, therefore, it does not seem as if it could be simply a valley of erosion; and yet erosion must have been one of the principal agencies which contributed towards its formation. The inequalities in the bottom, as well as in the width, constitute the chief difficulties in regard to its origin, and the question arises, could unequal deposition of sediment, with unequal erosion by the river, or by tidal scour, produce these inequalities. Where the valley is narrowest, namely, below the confluence of Ste. Marguerite river, it is shallowest. One thing is indisputable, namely, its great age. It seems certain that it has been an outlet for the waters of the interior ever since the land rose above the sea. Differential movements, transversely to the general direction of the gorge, must have taken place, probably throughout its whole geological history, and continued into the Post-Tertiary period. The St. Lawrence valley, from Orleans island eastward, does not appear to have been affected by differential or local movements in the same manner, its bed being comparatively even and regular. The border of the Archæan area must, therefore, have been for ages an oscillating zone, especially that part of it crossed by the tidal waters of the Saguenay river. Only on this theory are we able to account for the great differences in the depth of the valley. Glaciers have probably enlarged it laterally, and deepened it in some places, but they could not produce the gorge or leave it in its present form, for some of the shallowest parts, it will be seen, are where it is narrowest, and the hills lowest, and the deepest parts are at Trinity

Depths of Saguenay river.

Inequalities of its bottom.

and Eternity capes, where they are highest. Though a considerable part of the Saguenay gorge lies below the level of the bed of the St. Lawrence opposite, thus proving that it traverses a sunken area at present, yet the amount of the vertical displacement, relatively, is difficult to calculate. The marine shore lines of the Post-Tertiary period afford only a partial answer to this question. Leaving out of consideration the terraces around Lake St. John, as it is doubtful whether they are of marine or fresh water origin, we shall compare the altitudes of those along the tidal portion of the Saguenay river. At Tadousac the highest was found to be 405 feet, and at Chicoutimi (tide head) 515 feet, the difference between these being 110 feet. Not to speak of more local deformations, this may mean either that the uplift in the upper Saguenay region was greater than towards the mouth of that river, or that a greater subsidence took place between Chicoutimi and the St. Lawrence. The latter view seems more in accordance with the facts, the bottom of the Saguenay being lower than that of the St. Lawrence. The hypothesis of a subsidence of the margin of the Archæan, or rather of that part of it between Chicoutimi and the St. Lawrence traversed by the Saguenay river, appears to satisfy all the conditions of the case. This subsidence and the local deformations shown by the form and condition of the bottom of the gorge seem to have taken place concurrently. Taking all the facts together it is quite probable that a change of level has occurred on the north of the St. Lawrence, in the region between Quebec and Bersimis, or Point des Monts, by which a portion of the margin of the Archæan, at least, has sunk some hundreds of feet relatively, to the region on the south, and possibly on the north also, though the evidence points to a post-glacial differential uplift at Tadousac and Chicoutimi.

Subsidence in the region traversed by the Saguenay river.

The drainage features of the Lake St. John district exhibit some peculiarities. This lake seems at one time to have had at least two outlets,—one by the present channel by the Grand discharge, another by Kenogami lake into Ha Ha Bay, the latter probably leaving the lake at La Belle Rivière. The Kenogami channel is now drift-filled from the south end of the lake to St. Alphonse, at Ha Ha Bay, and is levelled off to the same height as the general surface on both sides. Chicoutimi river, the present outlet of Kenogami lake, has a number of waterfalls in its course and is evidently a new river. What caused the damming of the ancient channel between the lake and Ha Ha Bay has not yet been ascertained, but it was probably the drift thrown into it during the glacial period.

Drainage features of Lake St. John district.

In this region, a number of very interesting problems in regard to the glaciation, geomorphic changes, altered drainage lines, etc. offer themselves for investigation and study this region but they can only be dealt with in a detailed report.

Surface deposits in the district examined.

The surface deposits met with in the districts examined during the season, are as follows, in descending order :—

(1). Peat bogs and decomposed vegetable matter.

(2). Lacustrine and fluviatile sands and clays sometimes containing shells of *Unio*. Except for the presence of these shells it would be difficult to distinguish the sands of this series from Saxicava sands.

(3). Saxicava sand, and Leda clay, } Champlain of United States geologists.

(4). Boulder-clay.

(5). Decomposed rock *in situ*.

Decomposed rock.

The last has been noted in a great number of localities on both sides of the St. Lawrence valley. As already shown, it occurs in thick sheets on the north shore of the Gaspé peninsula, in a belt about a hundred miles in length and of variable width. In this unglaciated coast district, it constitutes the principal covering of the rocks. Along the foot-hills on both sides of the St. Lawrence too, it is found in thick beds, because in these places it has been protected from the erosive action of the glaciers.

Boulder-clay.

Boulder-clay has not been observed in very heavy beds in the districts examined, except quite locally. On the north side of the St. Lawrence, it is often a sandy clay filled with boulders, owing to the abundance of sand upon the southern border of the Archæan. Most of the boulder-clay is local, that is, the materials composing it have not been transported any great distance. The boulders, however, have been in some cases carried long distances, especially those which have been moved about by floating ice and which are now met with on the lower levels. The Laurentian gneiss and granite boulders, scattered on the north coast of the Gaspé peninsula, are examples. These have been borne thither by the drift ice from the north side of the St. Lawrence and carried eastward.

Leda clay and Saxicava sand.

The Leda clay and Saxicava sand, which apparently form two distinct beds, are well developed along the St. Lawrence, and often constitute thick deposits. The materials of these are chiefly of local origin, though in the indentations, wherein lie the estuaries of the rivers, there is a considerable proportion of it which has been transported some distance. Fossils are plentiful in the clays and in the lower part of the sands. Notwithstanding the fact that the Leda clay and Saxicava sand are often separated by a tolerably distinct line of demarkation, apparently demonstrating succession in the beds, yet they must frequently be of contemporaneous origin, that is, while the Leda clay was being laid down in deep waters, the Saxicava sand may have been deposited in the shallow parts, and may be largely a littoral formation. The fossils contained in it are usually shallow-water species, *e.g. Macoma Balthica, Mya arenaria*, etc., and the sands sometimes show tidal or wave action. In other places it occurs in wind-blown ridges or mounds. No boulder-clay was found overlying the Saxicava sand, though boulders commonly rest upon it, or are embedded in it; but in river valleys and on the borders of lakes, sands and clays of fluviatile or lacustrine origin are met with, and, near the coasts, these rest on the marine beds (Leda clay and Saxicava sand). On the west side of Lake St. John, fresh water shells (*Unio*) were observed in a clay bed at a height of 25 to 30 feet above the lake. The lake itself is 341·314 feet above mean sea level, so that the sea which formed the 405 foot terraces at Tadousac could also have formed those at Lake St. John, if no differential changes of level had occurred since. Besides the fact of fresh-water fossils being met with in the clays of this lake basin, it may be stated that the deposits resemble those of lakes and rivers of the interior more than they do the marine beds of the St. Lawrence valley. But the basal portion of the series was not seen and this may be marine, like the beds at Sorel, Three Rivers, etc.*

Fossils.

The soil of the Lake St. John basin consists of a deep loam containing considerable quantities of vegetable matter, with a gray brick clay underneath, resting on boulder-clay in some places, or on the rock surface. The Lake St. John district is not as far north as some parts of the Gaspé peninsula; but from its inland position the climate is, I should judge, somewhat different.

Soils and climate.

The Copper-Bearing Rocks of the Sherbrooke District, P.Q.

By Dr. J. A. Dresser.

According to your instructions received, on June 10 last, my available time, two and a half months, during the past season, was devoted to the examination of the copper-bearing rocks of the Eastern Townships of the Province of Quebec. This is a continuation of the work of 1902 and 1903, and is now so far advanced as to make it possible

Introductory.

* Summary Report for 1903, p. 142.

to prepare a final report on the area covered during the past three seasons. This will be prepared during the course of the coming winter.

Scope of investigations.

This investigation is concerned mainly with the Pre-Cambrian rocks, which occupy, in this part of the Province of Quebec, three principal areas. One of these is a band whose extent is not yet very accurately known, along the boundary line of the State of Maine; the second extends from Lake Memphremagog to Carthby and includes the Capelton hills and Stoke mountain; the third, or Sutton belt, extends from the International Boundary along the central part of the State of Vermont, to the county of Bellechasse, nearly south of the city of Quebec, and some thirty miles from the St. Lawrence river.

These belts have been known to be, in general, copper-bearing, and have been mapped as sedimentary. Recent investigations by the writer, however, having shown that the copper is chiefly confined to certain igneous portions, not hitherto recognized as such, the chief object of the present work has been to make a petrographic subdivision of the Pre-Cambrian strata, so as to distingusish for practical use the copper-bearing volcanics from the sedimentary rock, in which the copper is generally of little, if any, importance.

The past season's work was done principally in that part of the Sutton belt of the Pre-Cambrian area which lies between the St. Francis and the Chaudière rivers. This includes, wholly or in part, the townships of Cleveland, Shipton, Tingwick, Chester, Ham, Garthby, Wolfestown, Halifax, Ireland, Leeds, Inverness, Thetford and Broughton, as well as certain portions of the counties of Lotbinière and Beauce.

Bog-iron.

A special examination was made, by direction, of a bog-iron deposit near the village of Stanfold. A few days were also spent, toward the end of the season, in examining the copper deposits of St. Flavien, Nelson and Drummondville, which are the extensions, toward the north-east, of the Acton and Upton series. These are contained in, or closely associated with, igneous rocks intrusive through strata as late in age as Cambro-Silurian, and hence they are very different in age and structure from the deposits in the localities named above.

Nicolet Branch mine.

A large number of occurrences of copper, in the area covered this season, were recorded in the reports of the Geological Survey for 1863 and 1866. These have been visited, and several of the more important prospects have been examined. The greater number of occurrences are in, or nearly associated with, the ancient volcanic rock.

In the fourth range of Ham, and the 28th lot, is the mining location once known as the Nicolet Branch Mine. Copper pyrites and bornite here occur in dolomite, which lies on the south-east slope of a volcanic ridge. The general conditions are favourable to the view indicated by the history of the workings, that a considerable deposit of copper may here be found. As in several other occurrences, copper has apparently been concentrated by the breaking down of the volcanics in which it originally occurred. The first rock above these is dolomite, which frequently carries fragments of the volcanics, as well as masses of copper ore. Similar conditions are found in the 9th, 10th and 11th lots of the XI range of Leeds. Here, chalcopyrite and bornite are found in dolomite within a few feet of the volcanic rocks. As in Ham, the dolomite is cut by numerous veins of quartz, and in them the copper most frequently occurs. This locality seems worthy of more careful investigation than it has yet received.

Similar conditions were also noted in several parts of Chester, notably on lot 6 of range III.

Lower Ireland.

In the vicinity of Lower Ireland, copper and iron pyrites are found in different conditions. The country rock is there so highly metamorphosed as to be almost completely recrystallized, and its original characters are thus far a matter of doubt. It is also invaded by dikes of a granitic appearance, and on the margin of one of these, as well as in the enclosing rock nearby, pyrrhotite, pyrite and chalcopyrite appear. These are in lot 1, range IV of Inverness, and lots 13, 14 and 15 of Craig's Road, range of Ireland. It is a locality which warrants careful prospecting.

Talc.

On lot No. 2, of Craig's Road, range of Ireland, is an apparently large deposit of talc. Associated with this are some small irregular masses of copper ore, of which the following assay by Gwillan and Johnson, Slocan City, B.C., was given me by Mr. W. J. Porter:—Copper, 41.2 per cent; silver, 19·2 per cent; gold, $16 per ton.

Chalcopyrite.

In the fifth lot of the IX range of Chester, chalcopyrite occurs in quartz veins within a rock that seems, from a preliminary examination, to be an altered sediment. The ore was not seen in important quantities. Galena is also said to occur here. I did not find any, but saw some specular iron which has been mistaken for silver, in several places, throughout this district.

Tingwick.

In lot 17, range IX, of Tingwick, is a property on which some work was formerly done for copper. There is no ore in sight, except a little chalcopyrite, found in the shaft. The rock seems to be an altered sediment and not likely to carry much copper.

On the 25th, 26th and 27th lots of the IX range of the same township, however, there are somewhat better indications of copper. A large mass of igneous rock which extends through parts of these three lots contains irregular bodies of quartz, on one of which some trial pits have been sunk. They are said to have yielded a little copper. The present condition of the work did not admit of a conclusive examination.

The well-known deposits of the Harvey Hill and of the Halifax mines have already been frequently described in the Geological Survey reports. The country rock from these, however, will be subjected to microscopic examination.

Sutton hills

Proceeding north-westward from the boundary line between the State of Vermont and the township of Sutton, the hills of the Sutton belt become gradually lower, and the volcanic portion forms a corresponding part of the Pre-Cambrian rocks. This, apparently, results from the volcanic ridges being more and more deeply covered by the flanking sediments, as the former decline in height.

Topography.

The distribution of the volcanics in the northern part of the district is still further connected with the topography. They are most commonly found along the southern base of the highest north-east-south-west-running hills. This is apparently due to the fact that over a large part of the area there is a distinct cleavage dipping at angles 20° to 40° towards the north-west, and, accordingly, the longitudinal valleys are deepest towards their north-west side, and the hills have their steepest gradients on the south-east. The volcanics are consequently most frequently found at the foot, and for some distance up the hills on the south-east side, being best exposed where the erosion has been deepest. They generally form elliptical areas, which are often nearly continuous, seemingly indicating the position of the highest volcanic ridges at the time of their first submergence. These ridges are frequently traversed by streams of considerable size, which afford a rather complete cross-drainage, and, incidentally, afford good cross-sections of the ridges—where they are not too deeply drift-filled. Such are the west branch of the Nicolet, the middle branch of the same river, and the series of lakes and streams from Black lake to the Becancour river. These valleys are commonly from six hundred to a thousand feet lower than the intervening hills. They are probably, in general, valleys of streams antecedent to the uplift of the ridges, but in some instances, as in the vicinity of Lake William, their formation is probably due, in part at least, to cross-faulting. The extent of the volcanics will be shown by a map in the final report, which is now in course of preparation. Their most northerly appearance in the Pre-Cambrian area is in the northern part of Leeds, and in the seigniory of St. Marguerite, in the county of Lotbinière. This is only eight miles from the Chaudière river.

But in the region of the Gilbert river, twenty miles to the south of the Sutton belt, and on the north-eastern side of the Chaudière, the same type of volcanic rock occurs. It is there indicated as Cambrian on the Geological Survey Map of 1886, and in the short time available there were no means of satisfactorily examining the data for determining the age. Lithologically, this rock is a quartz-porphyry, and is identical with that of the Capelton hills and Stoke mountain, but from its position it is more likely connected with the Pre-Cambrian rocks of Lake Megantic. A further fact of importance, in this connection, is that this is the bed-rock of the lower part of Gilbert river, and only on, or below, this rock, as far as could be ascertained, does gold occur in important quantities. Michel, as early as 1866, pointed out that the gold was limited to a certain district, and accordingly a representative specimen of the country rock of that district was taken for examination, with the result that it is found to belong to the volcanic series. Gold

On Stoke mountain, in the township of Dudswell, where alluvial gold also occurs in important quantities, a similar rock forms the bed of the Kingsley, Rowes, Big Hollow, and Hall brooks. It is also well known that gold occurs in most of the copper ores of the Ascot Stoke range, the celebrated copper mines of Capelton hill having originally been opened as a gold proposition. The upper Chaudière valley and the gold bearing regions of Ditton and Risborough should, accordingly, be prospected for copper as well as gold. Inter-relation of copper and gold.

The gravels of all streams whose bedrock belongs to this volcanic series, and especially to the quartz-porphyry type, should also receive careful attention in all parts on and lower than the volcanics, wherever conditions suitable for the formation and preservation of alluvial deposits have obtained.

The pyrrhotite ores, also, which form important deposits near the serpentine belt further to the south-west, appear from place to place throughout this district. In Garthby they compose the well-known Garthby mine at Lac Coulombre, and also occur in a noticeable, and probably important, amount on lot 19 of range II. Pyrrhotite.

Copper ores.

Totally distinct from the Pre-Cambrian rocks in age and mode of deposit, are the copper ores of St. Flavien, St. Appollinaire, Nelson and Drummondville. These occur in amygdaloidal volcanics of much later age, which are intrusive through sediments as late as Cambro-Silurian. These intrusions form a series of apparently uniform petrographic character, and appear at intervals from Roxton to St. Apollinaire, a distance about one hundred miles. Sometimes, as at Acton, the most famous of these occurrences, and at Upton, the ore is chiefly in the rock which has been invaded by the intrusive, but near or often in contact with it. At Roxton and Wickham, it is both in and near the intrusive, while at Wendover, opposite Drummondville, and at St. Flavien it is chiefly in the intrusive itself. Extensive work has been done on these deposits, especially at Acton and St. Flavien, while those at Upton still seem to warrant further attention.

Bog-iron ore

The deposit of bog-iron ore, reported from Stanfold, is generally similar to much that occurs around the edges of the St. Lawrence valley. On the farm of J. A. Leclair, range VIII, lot 18, the ore was found to be fifteen inches in thickness in the spot first opened. It rests upon boulder-till, which carries pebbles of Laurentian gneiss, and hence a recurrence of the ore at greater depth need not be looked for. It is covered by only two or three inches of humus and sandy soil. One or two other places, on being tested, showed a lesser depth of ore, and one, at three hundred yards distance, has a depth of only three inches.

Some ore, said to be two car-loads, has been taken from lot 19 of range VIII (St. Cyr's), by the Canada Iron Furnace Co. The ore is here also generally less than a foot in thickness; it is about two miles from Stanfold station. Although the quantity of ore yet disclosed is not large, these and adjacent properties should be better tested.

In lot 22, of the XI range of Inverness, on the farm of Jos Gagné et Frères, a similar but probably larger deposit of bog-iron ore was observed. There, along a small watercourse, a few rods east of the Becancour river, bog-iron appears very frequently for nearly half a mile. No work has been done, but the ore is said to have been found three feet in thickness, at a point where it was once dug through. This excavation was not open at the time of my visit. The property is six and a half miles from the Grand Trunk at Lyster, and is twenty-five miles from the deposits mentioned in Stanfold. Both deposits are similarly situated topographically, occurring in the flat land of the St. Lawrence basin, at a short distance from the older highlands at the south.

The Lotbinière and Megantic Railway line discloses indications of bog-iron ore in several places between Lyster and Kingsburg junction. This part of the country is not yet sufficiently opened to admit of satisfactory examination, but a continuation of the iron ore deposits of Drummondville may be looked for throughout this district when the land is cleared and the region becomes accessible for examination.

Botanical Work.

By Mr. J. M. Macoun.

Introductory

Since the completion of Prof. Macoun's catalogue of Canadian plants, the botanical work of this department has fallen by degrees into my hands, so that at the present time the greatert part of this work is done by me, subject to revision by Prof. Macoun. The work connected with this branch of natural history has grown greatly in bulk and importance in recent years. The number of active botanical workers in Canada increases every year and, with very few exceptions, critical determinations and difficult species are referred to us. By degrees, our former custom of submitting our collections to specialists has been abandoned, as our increased knowledge and larger botanical library have made it possible for us to determine doubtful specimens and describe new species, and while it is still necessary to occasionally ask some acknowledged authority for assistance, this is never done until we have ourselves reached some conclusion. In other words, instead of sending away specimens to be named, we name them ourselves and then sometimes ask the opinion of a specialist. As our herbarium grows, there is constant need for re-arrangement; as soon as monographs and revisions are published, our herbarium material is re-examined and, when necessary, renamed. This entails considerable labour but the result is that the herbarium is kept in almost perfect order. The relabelling is done by Miss Stuart under my instructions.

Work done.

My examination, last spring, before the Committee on Agriculture and Colonization, occupied several weeks. With this exception, my whole time last winter and spring was spent in office work. Reference has been made by Prof. Macoun, in his report, to a part of this work. In addition to such assistance as I gave him, I worked up the collection of plants made by myself in the Peace River region, and examined many collections sent to me for determination.

Bay of Chaleurs

Prof. Macoun's absence, during the summer, made it necessary for me to be in Ottawa for the greater part of the collecting season and considerable work was done in this vicinity. Advantage was taken of my being at Percé, on the Bay of Chaleurs, to have me make a botanical examination of the region, and collections were made covering a radius of ten miles from that place. Though the season was early for flowering plants, everything collected is of value to the herbarium, as we had no specimens from that district. Enough was seen of the character of the flora to show that it would well repay careful study for a whole season. After my return from Gaspé, a month was spent in the office and on August 18, pursuant to instructions, I went to Berthier (en haut) to study the aquatic plants growing in the St. Lawrence. Collections of all flowering plants of interest were also made. Berthier is well situated for the study of aquatic plants, as there are numerous islands in the river, and on both sides of the stream there are bays and stretches of slack water. Two species of Potamogeton, *P. natans* and *P. perfoliatus*, grew everywhere, the other species noted being less conspicuous and of more restricted distribution. The most important of these were *P. heterophylla*, *P. pectinatus* and *P. pusillus*. All the species of the *Naiadaceæ*, known to occur in the St. Lawrence, were collected and, with them, the representatives of allied orders. Of the lower aquatic forms, such as *Chara* and *Isoetes*, few species were seen, and these have not yet been determined. The luxuriant growth of *Potamogeton*, where the current is not strong, makes it difficult to keep a channel open where there is not frequent traffic, but no easy way of destroying these plants or preventing their growth has yet been devised.

Hudson Bay region.

The autumn months were spent in the usual office work, which, this year, included the completion of the flora of the Hudson Bay region. This was almost ready for the press last winter, but two large collections, made last summer, have added greatly to our knowledge of the distribution of the plants growing in the region included in this work. The larger of these collections, numbering 238 species of flowering plants, was made by Mr. W. Spreadborough, who acted as Mr. O'Sullivan's assistant in his survey of the west coastof James bay. The second collection was made by Dr. L. E. Borden, the physician with Mr. Low's expedition. Not more than half of Dr. Borden's plants could be included in the Hudson Bay flora, as they were collected north of Hudson strait, a region outside the scope of this work. Large collections were made, however, at Fullerton, Southampton island, Port Burwell and Wakeham bay, and these have been included. All these plants have been determined and, while they include no species new to science, they add much to our knowledge of the flora of the

Hudson Bay region, and there is, perhaps, no other part of Canada that has been so thoroughly worked up.

Statistics.

During the past year, 2,805 sheets of botanical specimens were mounted and placed in the herbarium, 1,692 being Canadian flowering plants, 672 foreign plants and 441 cryptogams. Not so many specimens as usual were sent from the herbarium in exchange for specimens received, as no time could be spared for labelling and distributing these, and we are still deeply in debt to some of our correspondents. More than 1,000 cryptogams were distributed and 1,194 flowering plants. These latter went chiefly to Kew, the Gray herbarium, the New York botanical gardens, the Missouri botanical gardens, the U. S. National herbarium and the Botanical Museum of Copenhagen.

GEOLOGY OF CHARLOTTE COUNTY, NEW BRUNSWICK.

By Dr. R. W. Ells.

Surveys in Charlotte Co.

The first part of the season of 1904 was spent in completing the study of the geology of certain parts of Charlotte county, New Brunswick, the surveys of which, owing to lack of time, were left unfinished last season. This work included the examination of the rocks of Grand Manan island, and of portions of the shore of the Bay of Fundy, between Beaver Harbour and Point Lepreau, where, at different places, through the agency of intrusives, the ordinary sedimentary rocks of Silurian and Devonian age had become altered to the condition of schists of Pre-Cambrian aspect. Surveys necessary to connect the work of last season with the shore roads were also completed, but there yet remains the survey of the railway between St. Stephen and St. John, of which no plans are available, in order that the map of the county may be properly compiled.

Rocks of Grand Manan island.

On the island of Grand Manan, the western side, and in fact the greater portion of the island, is composed of trappean rocks or diabase, similar to those which form the North Mountain range of Nova Scotia. No trace of the Triassic red sandstone was observed. The rocks of the south-eastern portion comprise large masses of eruptives, similar in character to those already described as occurring on Campobello and Deer islands to the north-west, which are intrusive through slates and conglomerates of Upper Silurian age, with small areas of limestone, the whole resembling what was found in Letang peninsula, south of the village of St. George on the mainland. The slates are greenish and gray with purple beds, and the action of the intrusives on these is

Upper Silurian slates.

quite marked. In places they have become schistose. The actual contact of the traps or diabase was seen at only one point on the shore north of Seal cove, on the south side of Red head. Here, the extremity of the point is occupied by reddish and greenish gray slate, and at a distance of 300 paces west from the point, there is a sharp contact between the reddish slates which dip N. < 60 degrees, with a band, at the base, of about two feet, which is crushed, and holds pebbles of altered slates and trap. The first part of the igneous rocks consists, at the contact, of about fifty feet of conglomerate composed of augite pebbles in a dirty green augitic paste, beyond which the trap is columnar for some distance along the shore in the direction of Seal cove. The trap pebbles are of all sizes from that of a walnut to masses of a foot or more across. Seventy paces west of the contact with the slates, a band of similar conglomerate, about six feet wide, extends up the face of the columnar trap, filling an apparent line of fracture in the latter, after the manner of a later dike.

Trap and slate contact.

Contact at Fish Head.

As to the other eruptives of the island, associated with the Silurian rocks, possibly the best exposure of these is seen at the north-east point, known as Fish head, on the north side of Cameron cove, which lies just to the north of Flaggs cove. They form the whole shore between the light-house and Whale cove, and consist of greenish diabase, reddish feldspathic rocks and imperfect syenites. Their contact with the slates is well seen on the north side of Cameron cove, and is here clearly intrusive. The slates are not only altered along the junction of the two series, but portions of the slates are caught up in the intrusive mass. Just where the outer light-house point joins the main mass, there is an intrusive dike of the trap similar to that of the west shore, with a breadth of about fifty feet, cutting across the diabase of Fish head in an almost east course. These rocks have been described in such detail in the Report by Prof. Bailey, 1870-71, that minute descriptions here are unnecessary. They are similar to the eruptives found on Letite peninsula and on Campobello and Deer islands, and their action on the Silurian strata is similar. These strata have sometimes assumed a schistose structure near the contacts, with the formation of quartz veins and strings of dolomite, while certain of the associated limestones are nearly crystalline. Probably the best exposures of these Silurian rocks on the island are to be seen around Flaggs and Cameron coves, and on the shore about half a mile south of the former place. At these places the slates are associated with intrusives, generally greenish diabase, distinct from the trap rocks of the islands, which cut the other intrusives and are of a later date. As displayed on the shore below Flaggs cove, the sedimentaries consist of large ledges of purple conglomerate and sandy shales, with black slates and green schists. The

Schistose slates.

conglomerates contain pebbles of dark felsite, quartz and purple slates, are cut by quartz veins and sometimes assume a schistose structure They resemble similar rocks seen at Back bay on the main land where they contain Silurian fossils, and apparently overlie the greenish-gray slates of Flaggs cove. The contact of the conglomerates with the *slates* is often irregular, the former showing local development and with tongues of purple shale extending into the conglomerate mass. The black slates in association are like similar slates seen in Cameron cove south of Fish head, and, like them, are highly altered either by the agency of the green intrusives or in part by the trap rocks which touch the shore near this place. While from their peculiar character they were at one time supposed to possibly represent Pre-Cambrian rocks their manifest resemblance to the altered Silurian slates of the mainland in Charlotte county and of the islands to the north and west, in which Silurian fossils have been found, renders it very probable that those rocks of Grand Manan, like those of Letang and Letite may also be classed as altered Silurian.

Contacts of slates and intrusive rocks.

Along the shore the green eruptives are seen at frequent intervals to the final limit of the outcrops at Red Head where the trap of the island extends to the south-east shore. Where these slates are seen in small outcrops they are invariably altered, but preserve a general similarity of aspect. On several of the islands off this part of the coast, notably Long island, the Ducks and Nantucket, the greater part is occupied by intrusives, frequently diabase. In certain places, however, as on Big Duck island, a greenish, or sometimes purple squeezed porphyry is found, flanked by greenish and occasionally purple tinted schistose slates of the usual type. The bulk of the older rock, therefore, of this part of the island, as contrasted with the traps, may be classed as eruptive, with small areas of altered Silurian sediments. In this respect Grand Manan corresponds closely with Deer island and Campobello.

Rock of the east shore.

On the mainland the rocks of Beaver harbour and of the coast east to Lepreau were also examined. In this area several points of structure were noted concerning which some doubt existed last year. On the road from St. George to Beaver harbour, after passing over the series of slates which extend from Letite to the Pennfield ridge and which are of Silurian age, the reddish and purple weathering felsites are met with in a brook about two miles north of Beaver harbour. These extend to the village, forming hills. The felsites invade grayish, greenish and purple slates of the Mascarene series on the north side of the village with bands of conglomerate of a dark reddish tint. These rocks are schistose and overlie a thick series of generally black slates

Coast rock at Beaver harbour.

which form the headland south of the village, and which hold plant stems and are apparently of Devonian age. They are cut by masses of feldspathic granite and green diabase which have altered the beds along the contact. The eruptive rocks extend thence to the lighthouse point.

Similar rocks are seen on the east side of the harbour. It is probable that the Devonian rocks of this place have a somewhat local development and rest upon the Silurian of the Letite series.

Crow harbour and vicinity.

Going east from Pennfield ridge to Crow harbour, after passing the gravel deposits which form the large plain along the ridge road, masses of green diabase occur for a distance of a mile along the road to the shore. These are succeeded southward by gneissic diorite, and these again by felsites and gneissic granite with schists, often mixed with a basic granite. Along the shore of Crow harbour the rocks are schists of an older type, as also at Red Head cove. They are gneissic, sometimes talcose, and are associated with diorite and basic granite which are intrusive. On the east side of Red Head cove there is a copper mine which was opened in 1878-9, and reopened about five years ago, a considerable amount of development work being done. The ore occurs in the schists at the contact with the intrusives and consists for the most part of iron pyrites in irregular gashy deposits. Only a small quantity of copper is visible. These rocks, from Crow harbour east to Barnaby Head, appear to belong, as indicated on the map, to the Pre-Cambrian series.

Copper mine.

Iron ores near Lepreau.

They are continuous from this place to the vicinity of Lepreau, though in places overlaid by red beds of the Perry group. About two miles west of Lepreau village, and half a mile north of the post road, a deposit of magnetite has been developed to some extent by pits and has been proved during the past winter by a magnetometer survey under the management of Mr. Anderburgh who came out from Sweden. The rocks are dark or blackish-grey schists with masses of hard green diabase, dipping to the north-west at a high angle. These belong to the old crystalline series, and the ore appears at the surface in several small strings having a thickness of five inches in one place. Boring with a diamond drill was carried out on this place but the results have not yet been made known.

Crystalline limestones near Lepreau.

On the road leading from Lepreau to Lepreau point, a mile or so beyond Belas basin, eruptives comprising felsites and diabase cross the road and underlie the Devonian of that area. Between the shales and the eruptives are certain limestones which are highly crystalline and were supposed at one time to possibly represent the Pre-Cambrian limestones of St. John. The re-examination of these rocks shows that they are bluish limestones altered by the agency of the diabase and other eruptives and similar to the limestones of Frye's island. They underlie the Devonian shales which, at the contact of the intrusives, have also been altered. The passage of the crystalline limestone into the bluish variety can be seen at several points east of the road. The rock is seamed with small strings of dolomite.

On the south side of the limestone area, at the old limekiln, the lower portion of the rock is filled with pebbles of a reddish-brown granite. It does not present the aspect of a true conglomerate, but rather appears to be due to the action of the intrusion into the limestone. This is near the contact. Masses of the limestone are a pure white marble, but this changes as the granite recedes. The formation is directly overlaid by the brown conglomerate of the Perry group.

Post-road, Lepreau to St. George.

On the old post-road between Lepreau and St. George the crystalline schists extend westward from the former place for about four miles. From this place, west to the New river crossing, the rocks where exposed, are diabases both coarse and fine. These also extend further west in a number of outcrops to beyond the Popelogan river. Though much of the surface in this direction is covered by drift, no rocks other than eruptives of the more modern type were seen. On the old road to Spurr's mill, now abandoned, the only rocks seen are in a prominent ridge about half a mile north of the post-road, and are slaty grayish and dark felsites, cut by diabase, which extend southwesterly to the road.

East side of Lake Utopia.

On a road up the east side of Lake Utopia diabase rocks extend for nearly half a mile. Then a belt of the purple and gray slates of the Silurian (Letite series) occurs and has a breadth along the road of about a mile. Finally, these slates are terminated by a heavy ridge of fine-grained diabase, much shattered, commencing about one mile south of Missonette stream, where the granite of the St. George district makes its appearance, continuing north into the wilderness country and on to Red Rock.

St. George village.

The village of St. George appears to be built on a ridge of massive green diorite which is well exposed at several places in the streets and at the bridge across the Magaguadavic river, below which bands of hard altered slate, having only a small area, are seen near the falls.

Westward from this, the road for some miles shows no rocks other than intrusives, diabases and felsites, with some granites to the north. These rocks occur in prominent ridges on both sides of the post-road which for several miles is made along the level surface of a broad gravel terrace. No slates of Silurian age were seen in this direction east of Digdequash river crossing.

The Tobique-Nipisiguit district.

After the completion of the work in Charlotte county, a couple of weeks were spent in the study of the rocks around the head waters of the Tobique and Nipisiguit rivers in the northern part of the province. Concerning the age of those rocks as depicted on the published map of that area, 1886, some doubt had arisen, owing to the finding in 1902, by Dr. Bailey and his assistant Mr. Johnston, of certain sandstones and conglomerate on the slope of Teneriffe mountain, supposed by Dr. Bailey to be of Silurian age. An examination of this area showed that the mountain rocks consist of felsite, rhyolite and diabase, and that the sedimentary beds in question formed a limited outlier on the south-east flank at an elevation of about 388 feet above the Nipisiguit lake near the base. The outcrop is partly in a ravine and extends upward for about eighty feet with a surface breadth of about 200 paces. The lowest beds of the series are gray and brown shales containing plant stems, underlying sandstones which pass up into gray sandy conglomerates with pebbles of white quartz, light gray and purple and dark felsite, and small fragments of shale and sandstone, probably derived from the underlying beds. There is no visible alteration of any of these strata through the agency of the intrusive rocks of the vicinity. The general dip is north-westerly about 30 degrees.

Devonian outlier on Teneriffe mountain.

These rocks closely resemble the Devonian of the Gaspé coast and the upper portion of the Bay des Chaleurs. In their upper portion, where they appear to pass beneath the volcanic mass of the higher part of the hill, the conglomerate character is much less marked for several feet, consisting of a dirty green paste with a few scattered pebbles of volcanics, as if along a line of fracture. The felsite rocks underneath these Devonian strata are broken up for several feet, so that the outlier presents the appearance of having been affected somewhat by subsequent movements of the whole mountain mass.

Range of felsite hills.

The range of these felsite hills, which in many respects closely resemble certain felsite and other hills found in southern New Brunswick, extends in a north east direction from the west end of Nictor lake, and possibly from the south branch of the Tobique further west, eastward to Mount Latour which is about four miles west of Portage brook on the Nipisiguit river. They consist of feldspathic rocks of various kinds, with rhyolites, diabase and granite. East of this range the other hills to the Portage brook are entirely different in character, consisting of dark grayish, sometimes rusty hornblende and mica-gneiss and gneissic schist, portions of which closely resemble the Pre-Cambrian areas of eastern Quebec as seen in the hills about Richmond in the

Eastern Townships of that province. All the rocks of this lower group are schistose. Some are finely banded and much twisted, others are a heavy dark or blackish-gray schist, in places containing bunches and strings of white quartz. These rocks form the entire mass of the hills on the west side of Portage brook so far as examined.

Crystalline rocks of Portage brook.

On the east side of the brook there is a large ridge known as the Acadian range, so styled by Prof. W. F. Ganong. The lower portion is a reddish granite made up of red feldspar and quartz, with a green mineral, probably hornblende, but with very little mica. In places this has a gneissic structure, but the upper portion and the main mass of the ridge consists of grayish mica and schistose gneiss like the hills west of the brook, and no granite was seen on the summit. These twisted schists also contain quartz veins, and are identical in aspect over a large area with Pre-Cambrian rocks of eastern Quebec. It will be seen, therefore, that the hills of the upper Tobique and Nipisiguit are of two kinds, and it is very probable that portions of those which have been described under the head of felsites are of a much later date than either those to the east or to the west. Similar felsite hills of widely different ages are also found in the southern part of the province.

Schists of Acadian range.

As for the rocks of Nictor lake, where the southern limit of the upper Silurian is marked on the published map of that area, and where the felsite hills are coloured as probably Pre-Cambrian, the examination of these shows that the lowest beds of the sedimentary series, as seen on the small island in the upper portion of the lake, consists of green slaty schists, with scattered pebbles of reddish feldspar-porphyry, which are sometimes drawn out along the schistose planes. These schists are, in places, chloritic, and resemble closely some of the lower altered slates of the coast of Charlotte county. The dip is undoubtedly high and nearly vertical.

Rocks of Nictor lake.

On the north side of the lake below Armstrong brook, a ridge of reddish and gray-weathering felsite comes to the lake from the north-east. About fifty yards west of this, a somewhat altered grayish Silurian slate forms a small ledge with a dip to the north-west, 65 degrees. At the rocky point on the north shore, opposite Visitors island, bluish gray, somewhat altered slates dip N. 30° W. $<$ 65°, and show in places a slightly schistose structure. It is possible, therefore, that the alteration of these slates has been effected either by the direct action of the felsites of Bald mountain on the south side of the lake or by the movements which have here affected a large area of country subsequent to the formation of these felsite masses. These Silurian rocks appear to lie between ridges of felsite or other rocks along this portion of the lake.

Altered slates.

Further west an examination was made for several miles of the right-hand branch of the Tobique, in order to see the relation of the Silurian slates and limestones to the felsitic and diabase masses which cross that stream.

Right-hand branch of Tobique.

The Silurian rocks extend above the forks at Nictor for about four miles, when they are cut off by a ridge of hard green diabase and porphyritic felsite. This extends for half a mile along the stream, when the slates and limestone again form a band for several hundred yards to another mass of hard greenish-gray quartz-feldspar porphyry as below. There is no mistaking the intrusive character of the igneous rock at this point, the contact being sharply defined. Above this the rocks are largely igneous, with occasionally limited outcrops of slates. This sharp contact is at what is known as Little falls. The areas of slate above this on the stream differ in character from the typical Silurian strata. Large hills of felsitic rocks rise on both sides of the stream, and are probably the western extension of some of the masses seen to the east around the lakes at the head of the Tobique river. Some light is thrown upon the structure and relations of these Silurian, Devonian and felsitic rocks of the Nipisiguit by the section seen along the upper half of the Upsalquitch river. The rocky hills, already referred to along the Portage brook, extend for some miles north to Upsalquitch lake and preserve their schistose character throughout. From the lake north to the falls the stream is crooked and narrow with lower banks to the mouth of the south-east branch. Here, gray mottled feldspathic rocks occur, succeeded down stream by purplish-gray slaty beds with masses of diorite containing epidote. Thence, to the head of the falls, hard dense diorite, fine-grained, and in places slaty, occurs. This weathers a rusty brown and breaks into angular pieces. The falls extend in a ragged gorge for half a mile or more, the river flowing over a hard, green, conglomerate rock studded in part with pebbles of red and gray slaty felsite and some few of gray limestone, with a dip of N. 10° W. $<70°$. These rocks, in places, are filled with corals, crinoid stems, brachiopods, &c., of Upper Silurian types. The paste of the conglomerate is ashy looking, and thickly studded at times with fragments of apparently comminuted slates. These rocks appear to represent the lowest beds of the great Restigouche-Upsalquitch Silurian basin, since the slates, sandstones and limestones of that formation rest upon them.

Upsalquitch river section.

Devonian area

Descending the water to the forks of the north-west branch, slates, sandstones and limestones continue below the falls for several miles, showing a synclinal structure, the dip of which on the north side is S. 10° E. $<70°$, underlaid by hard, red, crystalline felsite, the lowest beds of the Silurian in this direction being a conglomerate with pebbles of the underlying rock or of a similar character. Below this, for half a mile, hard, green, epidotic diorites outcrop, and, three fourths of a mile below the felsites, these are overlaid by coarse gray grits and conglomerates in which white quartz pebbles are abundant, along with pieces of jaspery-red felsite and slate, as also bands of shale and sandstone containing plant stems. These rocks are precisely similar to those observed on Teneriffe mountain and are Devonian in aspect. They form an overlying patch of considerable extent upon the Silurian rocks near the Ten-mile brook. They are cut across at several points by dikes of diabase which contain calcite and small zeolites with amethystine quartz. The Devonian rocks extend down stream for several miles and at the six-mile post are underlaid by slates and shales of Upper Silurian age, the dip of which is reversed again to the north-west, and these carry fossils characteristic of the formation. Red porphyritic felsites and rhyolites cut these strata, some of which show a well-defined flow structure and resemble certain portions of the felsites near the head-waters of the Nipisiguit river. Trap conglomerates also occur in the vicinity.

Intrusive rock

The felsitic rocks outcrop at several points to within two miles of the forks of the north-west branch, below which Silurian strata again occupy the stream.

Conclusion.

It would seem, therefore, that in the area under discussion, rocks of several horizons are met with; and that, while certain of the felsitic and rhyolitic masses have a comparatively modern aspect and closely resemble similar rocks which cut the Silurian of Charlotte county, other large masses more closely resemble in character and association the felsites of Kings and St. John counties which have been classed with the Pre-Cambrian series. It is probable, therefore, that the Teneriffe outlier of Devonian is like that of the Campbell river on the Tobique, and of the Upsalquitch, and does not form part of a large underlying series upon which the great range of felsite and other hills of the area are deposited. No indication of such structure is to be observed in any portion of the field observed by us during the season.

Fossil Occurrences and certain Economic Minerals in New Brunswick.

By Professor L. W. Bailey.

Introductory.

By instructions conveyed in a letter from the Acting Director of the Geological Survey, last May, I was requested to make geological explorations in the province of New Brunswick, giving my attention mainly to two subjects—(1) to the search for fossils, wherever in my judgment, these were most likely to be found in connection with the Pre-Carboniferous rocks of York and Carleton counties, and (2) to obtaining such information, relating to the economic minerals of New Brunswick, as would form a useful appendix to my report upon the subject published by the Geological Survey Department in 1899.

FOSSILS.

Rarity of fossils.

To the first of these objects about one month was devoted, the work embracing the examination of all the larger rivers and many of the minor streams in the counties above referred to. For the past fifty years these have been the subject of close examination by a large number of explorers, including Cresner, Hind, Ells, Matthew, Robb, Chalmers, Wilson and the writer, their results being contained in various reports already published. All these reports agree as to the rarity of fossils in the great slate belts traversing this region, and it was this characteristic that induced Dr. James Robb to assign them to the Cambrian system. Though later investigations have shown that his view was erroneous, it is still true that large tracts appear to be wholly destitute of organic remains. Hence, the work of the past summer has not been very prolific of results in this direction. Still, facts have been obtained which place us in a better position to discuss the age and relations of the strata.

Rocks probably Cambro-Silurian.

As stated in my report of 1900, there is to be found in Monument settlement, Carleton county, a rather conspicuous belt of black graphitic slates, which are much disturbed and apparently intimately associated with a group of volcanic and semi-volcanic products extending thence to Woodstock. At Benton, in the same belt, numerous remains of the graptolite, *Dictyonema flabeltilorme* were found by the writer in 1900, while still further north-east on the Beccaguimic river, a distinctively characteristic Cambro-Silurian fauna, including trilobites of the genera *Triuncleus* and *Harpe* had been observed by Matthew in 1880. As no organic remains had been found in the black slates of Monument settlement, the possibility remained that there might be an extension of another series of black slates which, on Eel river, a few miles to the eastward, contain Silurian forms of life. During the last season, remains of graptolites, apparently of Cambro-Silurian type, were found in the Monument settlement beds, and though, owing to the paucity of material and imperfect preservation, their age could not be definitely ascertained, their general aspect and the absence of the brachiopods which are found in the Silurian beds, seem to strengthen the previous conclusion that the beds in question are of Cambro-

Silurian or Cambrian age, and are a part of a belt of such rocks extending from the boundary of Maine to the headwaters of the Beccaguimic river. Careful search for confirmatory testimony of this theory was made in the bands of slates and quartzites south of Woodstock. This resulted in the finding of some interesting worm-tracks, to which Dr. Ami refers in the appendix.

Slates and quartzites.

Upon the southern side of the granite axis of York county, search was made among the slates and quartzites of Kingsclear, Prince William, Dumfries, etc., but nothing was found beyond those monograptoid forms previously discovered on Murray brook, which seem to denote the Silurian age of the rocks containing them. As it seemed desirable to ascertain definitely, if possible, the nature and age of the organic remains observed by Dr. Ells upon the south west Miramichi, the exposures upon this stream were examined as far above Boiestown as Rocky brook, that is to say, a breadth of about nine miles of Pre-Carboniferous rocks. These were found to consist mainly of quartzites and slates, the former being most conspicuous on the main stream, while the slates, often quite dark and pyritous, are best seen upon its tributaries. A prolonged search for fossils was unsuccessful, excepting at a spot about half a mile above Bird island. The strata here are unlike any others observed upon this river, in that though of a gray colour in the fossiliferous portions, they change somewhat abruptly, upon their strike, to a bright purple, thus recalling some of the strata upon the Nashwaak and its tributaries. The fossils in the gray portion of the rock are fairly numerous, but, except that they consist of strongly ribbed shells, probably of the genus *Orthes*, it is difficult to derive much information from them, as they are imperfectly preserved, much distorted and difficult to remove.

The cumulative evidence which these fossils afford as to the age of this great belt of slates and quartzites is important. When, many years ago, fossils of Siluro-Devonian age were found upon Rocky brook, a tributary of the Nashwaak, it was thought that the strata containing them must be simply a small outlier of such rocks enfolded in what were then supposed to be Cambro-Silurian slates. Since this view was embodied in the geological map published in 1886, graptolites of Silurian type have been found by the writer near Spring Hill, above Fredericton, and at other points, and although one cannot, from the occurrence of *Orthes* alone, predicate with certainty the age of the containing beds, it is much more probable that these are Silurian than Cambro-Silurian or Cambrian. In other words, large tracts of what were supposed to be of the latter horizon are now known to be more recent.

Di-prionidian forms.

The position of the fossiliferous strata upon the south-west Miramichi is very nearly upon the strike of the Rocky Brook beds, and both hold a similar position in relation to the granite, being separated therefrom by only a narrow belt, mostly of dark mica-schists. Both these and the slates and quartzites to the south have been followed, with little variation, from the Nashwaak to the Taxes river and thence to the south-west Miramichi while Prof. Ganong has recently observed similar mica-schists upon the head-waters of the Renous. The rocks in the vicinity of Bathurst, near the railway bridge over the Tattagouche river, contain graptolitic beds, from which a collection was made. The greater part was found to be too obscure for determination, but I was able to obtain a few specimens of definite character. These include di-prionidian forms, among which Matthew has recognized the following genera, *Diplograptus*, *Dicellograptus* and possibly *Dicranograptus* indicating an horizon about that of the Llandeilo formation of Wales.

It may be noticed that these beds and certain black graphitic slates, not yet known to be fossiliferous, occurring above the Grand falls of the Nipisiguit are all north of the central granitic axis which crosses the last named stream at the Pabineau falls. In relation to the granite, they therefore occupy positions similar to those of the Beccaguimic river, Benton and Monument settlement in Carleton county, and thus appear to indicate that a belt of Cambro-Silurian age is probably contiguous from the settlement last mentioned, on the frontier of Maine, all the way to the Bay des Chaleurs. In this case, no change is required in the general map of this part of the province, though the occurrence of fossiliferous Silurian strata on Eel river, as observed by Wilson, at Waterville, as observed by the writer, and on the right hand branch of the Tobique, as observed by McInnes, indicates that areas of more recent age may also occur.

In character, the quartzites of the Nigadoo falls, Carleton county, strongly resemble those found accompanying the black *Dictyonema* slates of Benton, in Carleton county.

ECONOMIC MINERALS.

The economic minerals which particularly received attention included ores of iron, manganese and copper, with such non-metallic substances as coal, petroleum and gypsum.

Iron.

Two localities in particular have in the last few years attracted attention as possible sources of this metal. The first is upon the left bank of the Nipisiguit river, one mile and a half above the Grand falls. Large beds of ore are exposed, their width, as revealed by numerous trial pits and trenches, being at least forty feet, while their length, as far as explored, is nearly two miles. They are strongly magnetic and, though obviously varying in the percentage of iron, are said to average 50%, the best being 58%. The ores are distinctly bedded, and with the associated rocks, which are light-weathering feldspathic slates, dip northward at high angles. Nothing was observed in connection with the beds to indicate their horizon, but, as black graphitic slates, which may be equivalents of the black fossiliferous slates of the Tattagouche river, occur about two miles and a half to the northward, they probably underlie these and are therefore Cambrian or Cambro-Silurian.

The removal of ore from this locality is at present impracticable, access being possible only by the river or rough wood roads through the forest.

Prospecting with magnetometer.

The second locality is in the district lying between the Lepreau river and New river, in Charlotte county. Here, too, the ore is magnetite, and in the Report for 1899 it was stated that veins of this material occur on the farm of John A. Wright, about two miles west of Lepreau village. Their greatest observed thickness was, however, only eight inches, and considering the great hardness of the enclosing hornblendic schists, it was not thought at that time that the ore, though a rich one (carrying, according to analysis made by Dr. Hoffmann, 66 per cent of metallic iron, with no titanic acid) could be profitably removed. Quite recently, however, an exploration of the ground for several miles around has been made with a magnetometer, under the direction of Axel Anderberg, a Swedish expert, with the result that much larger deposits appear to be indicated, especially at a point about two miles west of the openings upon the Wright property. The instrument used was a Thalen-Tiberg magnetometer, and in accordance with its indications, duly plotted from observations for vertical and horizontal magnetic intensity and declination, the probable location of the principal vein has been determined, and a shaft, about fifteen feet deep at the time of my visit, was being sunk thereon. As at the Wright farm. the enclosing rocks are hornblendic schists, and in the vicinity of the pit these are all so charged with magnetite as to readily affect the magnet. The course of the beds, with which the vein conforms, is about N. 70° E., and they dip south at an angle of about 80°. Drilling operations have also been undertaken as the result of magnetometer observations upon the Wright property, reaching a depth of about one hundred feet. The isodynamic curves in each case indicate a considerable body of ore, and though its quality is not indicated by the instrument, it may reasonably be assumed to be equal to that of

Wright property.

the veins which appear at the surface. One of these, eighteen inches thick, was analysed by Mr. Anderberg and gave the following result:—

Fe.	64·54	S.	·014	Mg.O	·85
Si.	6·65	$Al._2\ O._3$	1·59	Mn.	·19
P.	·023	Lime	·69		

Analysis of one sample of ore gave ·10 of titanic acid, an amount too small to affect the ore injuriously. The work now carried on is being conducted solely on the basis of the magnetometric observations, a method of exploitation quite new in this part of the world, but which, in Sweden and elsewhere, has been found to give very satisfactory results.

Similar ores, with similar associations, have been observed at New River and on the south shore of Deer island ,and it seems probable that the same method can be profitably employed at these places.

Manganese.

Manganese.—No new discoveries of importance relating to this metal have been made since the date of the Report of 1899. Some further attempts have, however, been made towards the development of deposits previously known. Thus, at the falls of the Tattagouche river in Gloucester county, some excavations have been made in the red manganiferous slates there exposed, revealing numerous veins of highly crystalline pyrolusite, but none of these, so far as the writer could ascertain, are of sufficient thickness to warrant profitable extraction. Considering, however, the area over which these veins have been observed, and the fact that the larger part of this is covered by superficial deposits, it is possible that thorough prospecting would disclose deposits of considerable extent and value.

At Dawson settlement in Albert county, the deposits consist of a remarkably fine quality of wad; expensive works were erected for briquetting, but this method has been found unsatisfactory and little has recently been done.

Copper.

Copper.—Of the three localities of interest in connection with this metal, only one could be visited by the writer. This was the property of the Intercolonial Copper Company, near Dorchester in Westmoreland county.

In the report of 1899 the ores of this locality were described as consisting of gray sandstones and conglomerates belonging to the lower part of the coal formation, through which copper is disseminated mainly in the form of copper glance or chalcocite but partly as chalcopyrite, malachite and azurite. The chalcocite is found both as small veins and scattered granules, but no distinct lode occurs. This, however, was not regarded as essential, the plan of working being to crush the entire mass of rock and then, by chemical and electrolytic processes, to extract whatever copper it contained, Since the date of the report referred to, extensive works have been constructed, the plant costing, it is said, over $600,000. This is sufficient proof of the faith of the authors of the enterprise in their undertaking, but since the death, about eighteen months ago, of the first manager, Mr. Philips, no work of any kind has been done.

Copper mining has been attempted on the Bay of Fundy shore in eastern St. John county. Ores of copper have long been known to occur in the Pre-Cambrian rocks of this coast and exploratory work has been carried on, especially in the vicinity of Goose creek, in the county named, and around Alma, in Albert county. At present, operations are confined to the vicinity of Goose creek where a tunnel, about five hundred feet in length, has been driven into the face of the cliffs which here form the shore. Small quantities of bornite, chalcopyrite and malachite have been removed. Transport difficulties and the dangerous wharfage constitute most serious drawbacks, the buildings and the ore having been more than once washed away by storms. It is said that the average of the ore is about eight per cent of metallic copper.

Coal.—The comparative scarcity of mineral fuel and the enhanced price resulting therefrom have not only proved a stimulus to the energetic working of known coal deposits, but have led to a reopening of the whole question of the productive capacity of the New Brunswick coal fields. Coal.

As to actual operations, these are at present practically confined to two distinct areas, viz: (1) that of the Grand lake district, and (2) that of Coal Branch in Kent county.

The most noticeable feature in the Grand lake district is the increased facilities for removal, owing to the completion of a railway from Norton in Kings county, a station on the Intercolonial railway, to Chipman, and its extension to Newcastle and Minto, the latter a new settlement and terminal in the very heart of the coal region. From this terminal, short branch lines radiate to most of the important coal fields. In addition to this, about the same amount as in former years is hauled from other pits to the shore of Grand lake, to be thence transported by wood boats to St. John or Fredericton. The coal removed by rail alone is, owing to less frequent handling, brought to market in better condition than that transported by both rail and lake.

All the mines are worked independently by vertical shafts from twenty-five to thirty feet in depth, the thickness of the seam varying from twenty to thirty-two inches, in the latter case usually including a shaly parting between twenty-six inches above and four inches below. The coal at the pit's mouth is worth about $2.00 per ton.

An interesting feature connected with the works at Minto, and confirming earlier observations, is that the diamond drill boring about one mile west of Minto station, passed completely through the coal formation at a depth of less than three hundred feet, the cores brought to the surface being bright glossy green and purple slates with quartz veins such as are elsewhere known to underlie the coal measures. There seems to be, therefore, no probability of any seam of coal being found below that now worked near the surface.

Coal Branch District, Kent County.—Though, as indicated by its name, the area traversed by Coal Branch, a tributary of the Richibucto river, has long been known to contain seams of coal, it is only recently that systematic mining has been undertaken. This was largely due, as at Grand lake, to the transport difficulties, but again as at Grand lake, the conditions have been wholly changed by the construction of a railway.

The works at Beersville are situated upon the left bank of Coal Branch, here forming a perpendicular bluff of one hundred and seventy-five feet, the seam being one hundred and twenty-five feet below the surface. In this seam two tunnels have been driven, one of them over one thousand feet in length, with numerous lateral levels. These are remarkable for their dryness and freedom from gas, neither pumping nor artificial ventilation being necessary. The roof of the galleries is surprisingly regular and firm, being a horizontal compact shale about two feet in thickness, while the floor is an under-clay about three feet thick. The shale contains numerous well-preserved fossils; above the shale are fine gray sandstones, well adapted for building purposes. The thickness of the seam is eighteen inches.

The works at Mt. Carlisle are on the right bank of Coal Branch, three miles above those at Beersville, but the situation is less favourable for work, and the seam is thinner, being only sixteen inches, while a pumping engine is required to keep the mine dry.

The Canadian mine, which gives employment to about fifty men, possesses coal essentially the same in character as that of the seams at Grand lake, and, considering the horizontal attitude of the beds at the two points and the general resemblance of their organic remains, it may well be supposed that they represent about the same horizon.

The coal is free burning, excellent for steam purposes and leaves very little ash.

Petroleum. Since 1859 oil has been known to exist in Albert and Westmoreland. At the time of the working of the Albert mines, petroleum was said to ooze in places from the bituminous shales which were the carriers of the material and, in connection with the same shales, oil was said to issue in a spring in the rear of St. Joseph's college near Memramcook. At Dover, inflammable gases were found to bubble through the water of brooks, and at one point small quantities of maltha or mineral pitch were observed. At that time the mineral albertite was usually known as Albert coal and commonly regarded as related to ordinary bituminous and cannel coals, but even then there were those who maintained that it was more nearly related to asphaltum and the group of the hydrocarbons. This latter view gradually gained ground until it became generally accepted that albertite was of the nature of an oxidized mineral oil. As a natural sequence of this belief and from the fact that the apparent supply of oil was so small, it was supposed that the greater part of any petroleum which may originally have existed in the region had, by oxidation, been converted into albertite. This view appeared to be confirmed by such random borings as were made prior to the year 1899, when an investigation of the field was undertaken under the advisory direction of Prof. N. S. Shaler of Harvard University. The supposition upon which these investigations were based was just the reverse of that previously entertained, or to the effect that only a portion of the original petroleum deposits had been converted into albertite, as the result of exposure and oxidation, while it might be the case that other large quantities, protected from such change by the superposition of impervious strata, had retained their primary form. Later results seem to show that this view had some substantial basis. At all events, drilling operations over considerable and widely separated areas have led to the obtaining of oil in quantities exceeding what was at one time thought probable. Petroleum.

The two most important areas at present being exploited are Dover and St. Joseph. At the latter place active operations were first begun, and ten or twelve wells are said to be regularly pumped. During the last winter, according to the statements of the manager, about 2,500 barrels of oil have been pumped. A factory with a capacity computed at 150 quarts per diem has been erected for the manufacture of nitro-glycerine.

At Dover about twenty wells have been opened, it is said, which have, in some instances, given a yield of from twenty-four barrels daily.

The oil is reported to come to the surface alternately with a very strong brine, from which it naturally separates in the tanks as the result of its lower specific gravity.

The crude oil is of a dark green colour, its composition being:—

	Per cent.
68 to 70 gravity naptha	5·5
Refined oil distillate	27
Wax distillate	37
Cylinder stocks	29·4
Loss	·008

The area of the property upon which active operations have been carried on is about twenty-four square miles, and lies between the tidal waters of the Petitcodiac and Memramcook rivers.

The finding of petroleum at Memramcook and Dover naturally suggests inquiry as to its possible occurrence elsewhere. It is reasonable to assume that, both oil and albertite being associated with the Albert shales, the distribution of the latter affords the best guide as to the regions which are most likely to yield the former. The distribution of these shales, in one belt at least, has been fully discussed and illustrated in an earlier report of 1876-77* in which they are shown to be recognizable and to contain veins of albertite at different points in Albert and Kings county as far westward as Apohaqui station, a distance from the Petitcodiac of over fifty miles, while at the old Albert mines, as already stated, oil was said to issue from the sides of the levels. Borings made on the western side of the Petitcodiac river in Albert county, three miles north of Hillsborough, are reported to have shown the existence, at two points, of oil-bearing sands. In an easterly direction it is probable that the bituminous oil-bearing shales which, between Memramcook and Dorchester, pass beneath the Millstone grit and higher members of the coal-formation, retain their character for some miles at least, and owing to the thicker covering may be more productive than the beds less deeply capped. A second belt, parallel with the above, is also indicated by exposures along the north side of Indian ridge, eight miles north of Moncton and sixteen miles north of Dover and Memramcook, but the shales so far observed at this point are less bituminous than those of the districts last named, and it is not known to what extent they underlie the extensive Carboniferous tract to the north. Borings near Coal Branch in Kent county, about midway between Beersville and Mt. Carlisle, are reported to have struck oil and gas at a very moderate depth. Should this report be confirmed, it would, by indicating the existence of oil-bearing

* Report of Progress. Geol. Surv. Can. 1876, p. 351 et. seq.

strata beneath the rocks of the great central coal-basin, increase enormously the area from which possible future supplies of petroleum in New Brunswick may be drawn.

Dolomite.—With the advent of the pulp industry in New Brunswick the source of supply for magnesian carbonates became an important question. At first these carbonates were brought, at considerable expense, from Ohio, but with the establishment of paper mills near St. John it became desirable to know whether a nearer source might not be obtained in connection with the limestones occurring so largely in the environs of that city. To determine this point, I was, in 1899, directed to make some investigations as to the occurrence of dolomites in the quarries near St. John, with the result that rock containing from 35 to 45 per cent of magnesian carbonate was found to be readily obtainable at several points. This fact was alluded to in my summary report of that year. It had not then, however, been put to the test of actual trial. It is gratifying now to report that the tests since made, both at Mispec and in Fairville, have been most successful, and that the material of this nature is now wholly drawn from their local sources, mainly from the quarries of Randolph and Baker at Randolph. Dolomite.

APPENDIX.

PRELIMINARY LIST OF THE FOSSILS COLLECTED BY PROFESSOR L. W. BAILEY FROM VARIOUS LOCALITIES IN THE PROVINCE OF NEW BRUNSWICK DURING 1904.

By H. M. Ami, Palæontological Division.

A.

Fossils from the black carbonaceous and graptolitic shales from near the railway bridge on the Tête à Gauche river, near Bathurst, Gloucester county, New Brunswick.

1. *Diplograptus foliaceus*, Murchison. Several fragments of the polypary of a diprionidian graptolite, which appears to be more closely related to this species than to any other known to me, occur in a rather imperfect condition.

2. *Diplograptus truncatus*, Lapworth, or a very nearly related form.

3. *? Lasiograptus, sp. indt.* Too badly preserved to identify with any degree of certainty.

4. *Climacograptus bicornis*, Hall. Three imperfect polyparies in the collection are referred to this species with but little doubt.

5. *Cryptograptus tricornis*, Carruthers. A number of very even-sided or parallel-margined fragments are seen, suggesting no other

than this well-known species, at times showing the free virgula, but in no instance displaying the distal extremity which is crucial.

6. *Dicellograptus sextans*, Hall. Several individuals.

7. *Dicellograptus anceps*, Nicholson, or a very closely related species.

8. *Orthograptus quadrimucronatus*, Hall. Two polyparies occur in the collection. I cannot distinguish these from typical examples occurring in other localities in Ontario and Quebec.

9. *? Didymograptus superstes*, Hall. This form is referred with considerable doubt to this species.

10. *Leptobolus, sp.* A minute round or orbicular brachiopod which appears to be referable to this well-known Ordovician genus.

Geological Horizon.

The above assemblage of forms suggests at once an Ordovician fauna belonging to one of those zones of graptolites occurring along the Saint Lawrence and the Hudson rivers. Similar forms from rocks of presumably the same age have also been found in Penobscot Co., Maine.*

These black and at times pyritiferous shales appear to be synchronous or homotaxial with the shales of Norman Kiln, near Albany, N.Y.; of the City of Quebec; of the north shore of the Island of Orleans; of the Marsouin river and of numerous other localities in the Gaspé peninsula. They find their equivalent in Europe in the Llandeilo rocks of Wales, the Moffatt shales of Scotland and the County Down shales of Ireland.

B.

Loc.—From a black indurated, carbonaceous and graptolitic shale from Monument Settlement, York county, New Brunswick.

Collector :—L. W. Bailey, 1904.

In this collection are two slabs of an indurated shale, one of which is evidently the counterpart of the other, on which two distinct but obscure graptolitic fragments occur.

1. *Diplograptus, sp.*, or other diprionidian graptolite.

Exhibits an imperfect portion of a polypary with ten hydrothecæ in the space of ten millimetres. The hydrothecae are inclined at an angle of about 50° to the axis of the polypary.

2. *Leptograptus* or *Monograptus, sp.*, Too obscure for identification.

* Amer. Journ. Sc., Vol. XL, p. 153, 1890. Ibid, Vol. XXII, p. 434, 1881.

Horizon.

It is impossible to state definitely to what horizon these shales may be assigned. Should the fragment resembling somewhat a Monograptus be truly referable to this genus, as future collections may reveal, the shales will fall naturally into the Silurian. A larger and better collection from this locality is desired.

C.

Note on a small collection of obscure fossil organic remains from above Lower Birch island, S. W. Miramichi river, New Brunswick collected by Prof. L. W. Bailey, 1904.

The fossils examined are all fragmentary and in a very poor state of preservation. They occur in what appears to be a rusty-weathering gray, glossy schistose rock which effervesces at times in cold hydrochloric acid. The precise geological horizon could not definitely be determined with the material at hand. It is most desirable to obtain from localities such as this, as complete a series of the organic remains as possible. These schists may be Silurian.

Amongst the forms which appear to be obscurely represented in the collection, the following are cited :—

1. *Orthis, sp. indt.*, possibly a *Rhipidomella R. hybrida,* Sowerby but too obscure to state with certainty.

2. *Rhynchonella, sp.*, a form which resembles the ribbing of *Wilsonia.*

3. *Homœospira, sp.*, too imperfect to identify at all clearly.

4. *Lingula, sp.*, a fragment of the test of a linguloid shell which may or may not be referable to this genus.

5. *Spirifer, sp.*, several costæ of a brachiopod which appear to point to this genus rather than to any other.

D.

Tapley's Mill, Woodstock, New Brunswick. Collected by Prof. L. W. Bailey, 1904.

In a drab and rusty-gray-weathering, glossy and indurated slate, are seen a number of tracks or trails of some organism, probably those of some annelid or other related form.

EUGYRICHNITES MINUTUS, N. G. AND N. SP.

A number of minute tortuous tracks or trails of worm-like organisms appear upon the surface of the slab from Tapley's Mill near

Woodstock. These are all probably made by the same creature whose slender body was dragged over the surface of the smooth fine-grained siliceous mudstone at the time when these slates were being deposited. They are very simple in structure, consisting for the most part of a linear trail across which a number of closely set parallel lines appear, varying in number from twenty-five to thirty, in ten millimetres. These tracks or trails are about one millimetre wide.

These ribbed trails are accompanied by others which appear to be quite smooth, but they are evidently merely covered over by the fine sediments of which the slate is composed.

Indications of burrows, one of which measures fully 1.25 millimetres across, also occur on the same slab,

At first sight, these minute tracks suggest the *Gyrichnites* tracks described by Dr. Whiteaves * from the Gaspé Sandstones, but they are evidently made by a very different organism.

It is impossible to determine from the material at hand to what geological horizon to refer the slates from Tapley's Mill.

These trails do not resemble any met with as yet from different geological horizons in Canada, and consequently a new designation is offered for the sake of reference.

NOTE.

In connection with the fossils from Locality A, it may not be uninteresting to note the species listed by an eminent authority on graptolites, in Britain.

List of species of graptolites determined by Professor Lapworth from the collection sent him by the writer some years ago, obtained along the Tête à Gauche river, Gloucester county, New Brunswick, by Dr. R. W. Ells :—

Lasiograptus mucronatus, Hall.

Climacograptus bicornis, H, with branch of *Dicranograptus.*

Cryptograptus tricornis, Carruthers.

Diplograptus aculeatus, Lapworth, or *D. Whitfieldi*, Hall.
" cf. *D. Whitfieldi*, Hall.
" allied to *D. quadrimucronatus* H.
" *foliaceus*, Murchison.
" sp.

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* Trans. Roy. Soc. Canada, Vol. 1, Sect. IV, 1882, p. 109, Art. XI, issued, 1883, plate XI.

The Counties of Cumberland, Hants, Kings and Annapolis, Nova Scotia.

By Mr. Hugh Fletcher.

Mr. Fletcher spent the winter of 1903-04 in compiling plans and sections from surveys made by himself and his assistants as recorded in the Summary Report for 1903 pages 160 to 174. He was assisted during the winter as well as in the field by Mr. M. H. McLeod and Mr. A. T. McKinnon. Introductory.

He left Ottawa on June 27, to continue fieldwork in Nova Scotia, and remained there until the end of the year. Early in the season Mr. McKinnon made a survey of the Joggins shore from Two Rivers, to Seaman Millbrook to fix more precisely the dip of the various strata of this great section. He also surveyed various branches of Little river and other small streams in the neighbourhood of Oxford. He examined a deposit of hematite ore occurring about half a mile south of Grand Pré railway station. A specimen of the ore was examined by Dr. Hoffmann. The deposit occurs in small veins at the contact of Triassic sandstone with dark gray shales and flags of the Horton series. For the greater part of the season, however, Mr. McKinnon was associated with Mr. M. H. McLeod in a survey along the great dike of the North mountain and the brooks from Ross Creek in Kings county to Parker cove in Annapolis county, a region wholly occupied by trap with small veins and masses of zeolites, amethyst, magnetite, native copper, &c. An amygdaloidal variety seems to underlie gray, more massive trap on the shore and in the brooks. The scenery of this shore is picturesque and has for many years continued to attract hundreds of summer tourists. From the low valley of Triassic rocks extending from the South mountain, the North mountain rises steeply as at Blomidon and the Lookoff, the ascent from the south being everywhere steep and short, while the descent northward to the Bay of Fundy is about four miles, both slope and escarpment showing frequent outcrops of trap. District examined. Iron ore. Coast from Scots bay to Annapolis basin.

At Morden (French Cross) this trap is full of large amygdules. On the Big Hollow road, between Sheffield mills and Baxter harbour, red Triassic shales and flags, with a low dip, sometimes towards the North mountain, sometimes away from it, are in contact with coarsely crystalline trap, succeeded by white-spotted amygdaloid: thence for a great part of the distance to the shore, amygdaloidal and other varieties in great sheets have a low undulating dip towards the shore, the structure being precisely similar to that of the same range described by Professor Bailey near Digby and at Blomidon*.

Baxter harbour.

At Baxter harbour, trap of various dark colours, fine in texture, not crystalline but in many parts globular, slopes gently seaward in thick sheets, broken by east and west joints and fissures containing quartz in veins and amygdules. This is a boat-harbour with a narrow gravel beach and rocky indentations, photographs of which are included in the collection of views entitled "The Evangeline Land." At Black Hole the trap is inclined to be basaltic and splintery.

Supposed fossils.

From Baxter harbour, eastward along the shore to Ross creek, the trap lies in sheets of variable thickness and includes beds of amygdaloid. Its contact with small patches of calcareous shale and sandstone shows the latter greatly altered and full of veins and druses of calcite and other minerals. The cylindrical and conical masses, irregular in size and shape, supposed by some observers to be fossils, are siliceous, and are, apparently, like veins of jasper and milky quartz in their mode of formation. One very persistent layer of jasper follows nearly the line of contact with the trap, but at certain points is separated from it by argillaceous shales; others follow the bedding of the shales, with which, in places, the trap is intimately associated in the same layers, both being decolourized. One end of a block of red altered sandstone consists of trap. In this vicinity is found beautiful black crystalline quartz in vugs or hollow barrel-shaped masses. Westward from Baxter harbour sheets of light gray trap form good productive soil as far as the millbrook, beyond which the trap is crumbly, jointed and globular in irregular layers, one of which contains small cylindrical concretions, gashes and minute veins of amethyst and milky quartz.

Sheets and rocky reefs of flaggy trap, in part amygdaloidal, crumbly and globular, usually gray and blackish, with red or chocolate patches, extend in cliffs for some distance. In the main mass of the amygdaloid the amygdules are generally small, but large vein-like aggregations of zeolites occur in the bedding-planes in which are also beds of red argillaceous shale not more than one inch in thickness.

A little further along the shore, a thick layer of dark massive trap, globular and in part crystalline, rests on and among reddish amygdaloid which is apparently horizontal, and includes veins of zeolites, there being no definite lines of separation between the different varieties.

Near Race point, amygdules are arranged in horizontal bands at short intervals apart. No basaltic or broadly crystalline trap is met

* Geol. Surv. of Can. Vol. IX. Pt. M. p. 24; and Geol. Surv. of Can. Summary Report for 1901, p. 214.

with, although blackish finely crystalline trap is cut by small joints and fissures.

At Halls harbour the reddish amygdaloid of the beach is overlaid by a bed of blackish and gray massive trap, so like that to the eastward that it might be a question whether it and the amygdaloid are not at the same horizon and in the same relation to each other all the way from Scots bay. Hall harbour.

Near Chipman brook, lenticular deposits of red marl in red amygdaloid have been used for paint: bands of zeolite also appear in the bedding. The road that runs from this point to the top of the mountain shows many outcrops of gray amygdaloid, dipping towards the sea. South of the summit and also on Blackrock mountain, small veins of magnetite, like those of Gerrish mountain, have been exploited. Magnetite. On the steep descent of the hill towards Cambridge station, the trap is succeeded by red clay-shales of the Trias, which give place further south to more sandy rocks. At Clarence, north of Bridgetown, the trap escarpment is also steep, and red Triassic sandstones and shales reach nearly to the summit, from which the land slopes several miles to the shore at Hampton, over large masses and sheets of globular, jointed trap, unlike the gray and blackish, coherent, crystalline variety of the escarpment which breaks along prismatic three to six-sided planes.

On the road from Granville ferry to Parker cove, a similar section is presented of Triassic sedimentary rocks succeeded by trap on a steep ascent, to the north of which lie nearly horizontal sheets of gray, fine, globular trap similar to that near Hampton. Westward from the cove, there are good exposures of this trap, in layers of various thickness, cut by minute veins or threads of jasper but no amygdaloid; similar traps are exposed eastward to Hampton. Contacts of igneous and sedimentary rocks.

At Rossway, on Digby neck, Triassic red sandstone and argillaceous shale are again found in nearly horizontal beds along the shore of St. Mary bay, at the foot of an escarpment that still follows the trap dike. The search made for coal here and in the Cambrian dark slate of Marshalltown was, of course, abortive.

In the prosecution of this survey, Dr. Poole and Mr. Fletcher, on October 26th made a section of 1516 feet of Silurian or Lower Devonian rocks which underlie Triassic sandstone in Messenger brook. The dip of these rocks nearest the contact is southerly, while upstream it is northerly, nearly vertical throughout but assumed to denote the syncline described as repeating the iron ores of the district. The strata Section of Messenger brook.

are* for the most part gray, but at the north and south ends of the section red and mottled slates are found, those lowest in the brook holding, according to Dr. Ami, *Fenestella.* Running nearly in the bedding is one of the greenish-gray dikes or layers of diorite so frequent among these rocks, at the contact of which with the gray slates, both above and below, there is an accumulation of whitish quartz. Near this dike, large fossil shells were collected by Dr. H. M. Ami.

Bore-holes at Abercrombie.

The bore-holes referred to last year were continued in 1904. That at Abercrombie‡ was lost at 1,900 feet, but another begun alongside had reached a depth of 2,135 feet in April 1905.

At Spicer cove.

The hole at Spicer cove† at a depth of about 898 feet, passed out of conglomerate into Devonian compact and granular splintery felsite and quartz-felsite, in which it was discontinued as hopeless at 944 feet. Farther away from this rim of the carboniferous basin, however, in the neighbourhood of East Apple river and Sand river, boring is perhaps more likely to be successful.

At Fullerton lake.

No change was observed in the material cut in the bore-hole north of Fullerton lake to 2,330 ft. but a seam of coal, said to be nine feet thick, is stated to have been cut at 2,350 ft.

A pumping examined on December 23, 1904, yielded chocolate-coloured, fine sand mixed with red clay. Progress was very slow because of the large quantity of water in the hole below the six-inch casing put in to a depth of 815 feet. This water was salt. Pebbles falling into the hole and removed by the pump consisted of bluish and whitish quartzites, red sandstone, felsite and other Devonian rocks, and one cannot fail to realize the enormous amount of denudation necessary to form conglomerates of such thickness.

At Springhill junction.

An interesting section of a drilling made by the Intercolonial railway at the water-tank immediately east of Springhill Junction station-house, was obtained from Mr. John U. Ross of Pictou. The position of the bore-hole will be readily understood by reference to the map of Springhill that faces page 392 of the Summary Report for 1902. An abstract of the section in descending order is as follows ;—

	Ft.	In.
1. Red argillaceous shale with three thin bands of reddish sandst...	273	0
2. Gray and reddish sandstone and argillaceous shale............	267	0
3. Conglomerate..	0	6
4. Gray coarse-grained sandstone..................................	85	0
5. Red argillaceous shale..	40	0
6. Gray sandstone and argillaceous shale in alternate layers......	53	0
Total depth of bore-hole............................	718	6

Sum. Rep. for 1902, p. 399 ; Vol. IX, Part M. pages 94 to 97 ; Acadian Geology, pages 563 and 571 ; Supplement 1891, page 20.

‡ Sum. Reps. for 1902, p. 391, and for 1903, p. 161.

† Sum. Rep. for 1903, p. 162 ; Trans. Min. Soc. of N. S., Vol. VIII, p. 125.

Mr. Isaac McNaughton's bore-holes, one mile and a half north of Trenton, Pictou county, are stated to be 660 and 875 feet deep, respectively*. Another, further south, recently bored by him a short distance south of Loudon brook, has reached a depth of 647 feet and cut black and blackish-gray argillaceous shale, full of ostracods and of spines, scales, teeth and coprolites of fishes. This resembles the black shale of Rear brook and Trenton‡ described by Mr. Henry Poole. It is associated with light-gray and whitish sandstone, generally fine, but also coarse and even conglomeratic, streaked with layers of carbonaceous or coaly matter. Among these are also beds of gray argillaceous shale with nodules and plates of ironstone; of red and green, purple and gray mottled marls, in part concretionary, spotted with concretions of pyrite; of crumbly fireclay, containing rootlets and reddish concretionary limestone-conglomerate. A section of these borings is promised by Mr. McNaughton.

North of Trenton.

Mr. Fletcher again spent a great part of his time in a further examination of the district referred to in the Summary Report for 1903, pages 163 to 167 and shown on map sheets 59, 60, 61, 62, which are now partly engraved and will soon be issued. No reference to this work need here be made, since it will be incorporated in these maps. In connection with it, discoveries of coal recently reported at Mount Pleasant, Beckwith and Roslin were investigated and found to be of no importance.

Surveys in Cumberland county.

On July 26 a visit was made to the galena deposit just inside the point of the sand bar at the mouth of the South pond of Aspy bay, § lately worked by Messrs. H. C. Corson, Fred. E. Carré and Captain Gordon. It lies on a little brook that flows into a saltwater marsh east of the house of Mr. Michael Fitzgerald, at the contact of a great mass of Lower Carboniferous limestone with Pre-Cambrian black gneiss and pegmatite-rocks, described in the report for 1882-84, page 19H, and page 52H, although this particular patch was omitted in colouring sheet No. 2. The mode of occurrence is like that of the ores described by Dr. Poole † in his paper on "A Mineralized Zone in Nova Scotia," which include the galena of Pleasant bay (sheet 3), Smithfield and Pembroke (sheets 36, 48 and 57).

Galena of Aspy bay.

The associated Carboniferous rocks extend from a spring on the shore west of Fitzgerald's house for about three quarters of a mile eastward, and are again met with in Piney brook and on the Ingonish

*Core Drilling in Nova Scotia, Mines Dep. of N. S., pages 40 and 41.

‡Trans. N. S. Inst. Sc. Vol. I, Part 1, page 39, 1863.

§ Sum. Rep. for 1903, page 173.

† Jour. Can. Min. Inst., Vol. 1, p. 227.

road. At Piney brook, a quarter of a mile west of the mine, the basal beds consist of gray, flaggy, calcareous grit and conglomerate passing upward into a limestone which holds a few large pebbles of pegmatite and gneiss; while, overlying the limestone east of the mine, there are thick bands of gray and red marl, sandstone, gypsum and limestone.

The ore deposit differs from that of Pleasant bay in having but little vein-stone, the galena occurring in lenticular plates and masses from one eighth of an inch to six inches in thickness, usually bedded near bluish-gray, soapy shales in the limestone, and mixed with pyrite in grains and botryoidal aggregations. The pyrite, on exposure, rusts and discolours the whole mass, but fine specimens of galena are obtainable.

The line of contact is nearly vertical, apparently faulted; the belt next the granite is crushed and in part composed of gossan derived from sulphides, perhaps originally segregated along fault-fissures. From other contacts in the neighbourhood no ore was obtained, although it is reported to have been found in some quantity on the Ingonish road.

A quantity of loose ore was found near the surface at the little brook mentioned above. The ore was followed by shallow pits now caved in. More recently, a well-timbered vertical shaft, 9 feet by 6 feet, has been sunk about forty feet, and from it a level, 7 feet by 4 feet, has been extended about twenty feet north-easterly along the granite, and a cross-cut of the same size driven ten feet into the limestone immediately east of the brook. From this excavation, about two tons of picked ore were taken, of which a large sample was sent to Dr. Hoffmann for analysis. By Mr. F. H. Mason, who made a report on the deposit, this is estimated to contain about thirty per cent of lead, representing not more than three per cent of lead for the total amount of rock mined. Mr. Mason concludes, also, that nothing has been found to warrant further development, but advises, if further development be undertaken, that the existing shaft be sunk to a depth of eighty or a hundred feet and that levels be then driven in both directions on the course of the vein. The cost of this work should not be, he thinks, more than ten dollars per foot for sinking and three dollars per foot for driving. A house for the men, a small boiler, engine and pump are at the mine.

Coal in Hants county.

Examinations were made in the district from South Maitland and Shubenacadie west, as far as Rawdon and Kennetcook Corner, in order to define more precisely the boundaries of rock formations on certain map-sheets now in the hands of the engraver. One of the small coal seams of this district, reopened lately in the Gore, yielded on analysis by Mr. F. H. Mason.

Moisture lost at 110°C	1.90
Volatile bituminous matter	23.90
Fixed carbon	49.40
Ash	24.80
	100.00
Sulphur	0.15

Evaporative power : one pound of dry coal will, upon complete combustion, evaporate 10.89 pounds of water.

The coal burns with a long luminous flame, gives a compact coke and leaves a gray ash.

The associated shales are, like those of Horton and Gaspereau, blackish and bluish-gray with occasional red layers. North of, and overlying, these shales is a great band of gray, coarse and fine sandstone, upon which several quarries were opened to procure building stone for the culverts and other structures of the Midland railway; this gray sandstone series is in turn overlaid by the Lower Carboniferous plaster and limestone formation of Kennetcook valley and the country to the northward. Quarries.

In November Mr. Fletcher visited the boring at Port Morien, made with one of the government calyx-drills to test the thickness of the coal seams underlying the Gowrie seam at present worked there. Boring at Morien mines.

At the same time he examined the Cape Breton Iron and Railway Co's. mine on the Tracy seam. This seam was traced by the late Mr. E. T. Moseley*, for six miles westward from the old workings at Mira bay. The present openings are about one mile and a half east of the Moseley pits and bore-holes and near the east end of Loon Lake (Map-sheet No. 135), a district now called Broughton. Two slopes are in operation and a third is soon to be begun, a quantity of coal has been extracted, and extensive surface works constructed. Three coal cutting machines are now in use in the pit. At one point, the coal was found to be about five feet eight inches in thickness with a small parting about a foot from the bottom; the quality is said to be excellent. The mine is to be connected with the Sydney and Louisburg railway by a branch line about two miles long, and large developments are to be carried out in 1905. A little work has also been done nearer Sydney at the old Cossitt pits. Broughton colliery. Cossitt mine.

During the summer of 1904, Mr. W. F. Jennison mined 500 tons of iron ore from the Greener-Ingraham area at the Barachois† and Barachois iron mine.

*Sum. Rep. for 1903, page 174. Trans. Min. Soc. of Nova Scotia, Vol. IV, page 26.

†Geol. Surv. of Can. Vol. IX, pt. A, p. 97.

shipped it to the Dominion Iron and Steel Company's works at Sydney. The shaft or pit from which this ore was taken was put down thirty feet, on the contact between the Carboniferous-conglomerate and Cambrian slates, and showed ore ten feet in width when the work was stopped. The average analysis of the 500 tons as given by the Dominion Iron and Steel Company was 44.43 per cent of iron, 16.10 silica. The low iron and high silica is said by Mr. Jennison to be due to the ore being mixed with slate from the wall. (Map Sheet No. 134).

Firebricks.

Reference has frequently been made to the fireclay of Coxheath * suitable for the manufacture of firebricks and pottery, as proved by the experiments of Dr. G. C. Hoffmann, in the laboratory of the Geological Survey, thirty years ago. During the past few months, some work has been done on this deposit by Mr. Graham Fraser, of the Dominion Iron and Steel Company; about 300 tons have been quarried, part of which has been ground and used to replace silica clay cement; and it is intended to have forty or fifty thousand bricks made for experimental purposes. Harbison and Walker have already made a barrel of bricks from this clay, and it is found that they are equal to the best imported silica bricks that are used in the open hearth practice.

Coal mining.

In Cumberland county, coal mining was vigorously prosecuted in 1904, and preparations are being made for still more extensive operations at most of the mines. The coal production of the Springhill collieries was 505,804 tons, the largest in the history of the company.

Londonderry iron mine.

The iron ores of Londonderry are again being mined and smelted. Mr. W. F. C. Parsons, M. E. who is at present in charge of the mines, and from whom most of this information was obtained, is confident that with a reasonable amount of new machinery, such as small compressors, air-drills &c, these mines, which, since 1849 have yielded about two million tons of ore, besides carbonates, could easily supply two furnaces instead of one. Two hundred men are employed in and about the mines. At the Old mountain, half a mile west of the works, on the right bank of Great Village river, and at the mines on Weatherby, Cook and Martin brooks and at the Cumberland road, extensive bodies of rich ore are being developed.

At Old mountain, two levels have been driven in brown ore and ankerite for a distance of half a mile, the ore in the bottom of these levels remaining unmined, although from the bottom of one of them a shaft in the ore is down seventy-five feet, the width of ore being twenty

* G. S. C. Rep. for 1873-74, p. 173; for 1875-76, pp. 373, 424 and 425; for 1876-77, pp. 416 and 456; Vol. VIII, 1895, Part A, page 110.

feet. At Weatherby brook, an adit level driven north 600 feet cuts two large veins of ankerite 40 feet and 12 feet thick respectively, and one of limonite. "Where the adit level cuts the limonite, drifts were worked on the ore east and west for about 400 feet in both directions. At a distance of about 200 feet to the west, a shaft is sunk for about 90 feet in ankerite and brown ore. At a point 80 feet down, levels were again driven east and west following the ore. In the west level the vein averages seven feet in thickness."

"The territory between Martin brook and Cumberland road mine, a distance of one mile, is known as West Mines. This territory, to the depth of 150 feet to number 6 level, contains a net-work of old levels cutting the veins in all directions. From these workings the bulk of the ore that supplied the furnace for about thirty years was taken. In several places the vein was over eighty feet in width, the most of which was limonite." By the sinking of the Jamme winze to the depth of 250 feet below number 6 level it has been proved that a vein of limonite, eighteen feet in width, still continues, so that there must exist a large body of ore below the old workings.

From Cumberland brook, an adit has been driven west 400 feet in ankerite and rich brown ore, in a vein eleven feet wide, ninety feet below an old level which followed the ore far into the mountain side.

These several workings are equipped with boilers, pumps, compressors, air-drills, hoisting engines, blacksmith-shop and other necessary buildings connected by telephone with the general office. The mines west of the works have a narrow-gauge railway for transporting ore to the furnace. There are about six miles of three foot gauge railway and ten miles of standard gauge, including the East mines branch and sidings. There are also four locomotives, flat cars, ore cars, etc.

Ore from Torbrook mines.

The Londonderry Iron Company also uses in its furnace hematite from Torbrook mines, taken from the Woodbury or number 2 shaft, 385 feet deep, on the Leckie bed. This shaft follows the ore at an angle of 80°, for about 300 feet, then flattens to about 45° at 370 feet, where the ore, eleven feet thick, is cut off by a small fault. From a level, about 300 feet down, a tunnel was driven northward 250 feet, about thirty feet west of the shaft, in gray flags or slates which break into brick-shaped pieces; while another cross-cut to the southward, fifty feet west of the Woodbury shaft, cut gray slates for 128 feet, then red. Only ore of low grade was found in these tunnels. The old machinery has been renovated; three small boilers and two compressors are at the mine; about fifty men are employed, and seventy tons of hematite are raised daily. The total quantity of ore taken from the Leckie mine to date is said to be about 150,000 tons.

Iron Ores of Torbrook and Nictaux.

Iron mines of Nictaux and Torbrook.

Judge Haliburton* in 1829 wrote that iron ore had long been known to exist in Annapolis county in great abundance and that efforts had been made to manufacture it at Nictaux. In the year 1825 the Annapolis Iron Mining Company was incorporated to manufacture hollow ware and bar iron. The company purchased a valuable and extensive bed of ore situated about three miles and a half from the mouth of the Moose river, another of equal importance at Nictaux, with one or two beds in other places. They selected the eastern bank of the mouth of Moose river as the site of their buildings, erected a large smelting furnace, stock house, coal house, stores, etc., manufactured a quantity of hollow ware of very superior quality, and laid the foundation of forges for making bar iron. The quality of the ore was regarded as fully ascertained, and the only part of the experiment to be decided was whether they could compete with the English ware, or whether the cost of manufacture would not exceed the value of the article when manufactured, a result depending upon the ecomony and skill with which the establishment was managed.

Description by Jackson and Alger.

In a paper on the Mineralogy and Geology of Nova Scotia, presented to the American Journal of Science in 1828 and 1831 by Jackson and Alger,† mention is made of this ore bed seen on Nictaux mountain. The width of the ore at the surface is said to be six feet and a few inches; increasing, apparently, as it deepens, it gives promise of an immense supply of this valuable mineral. It is covered by a stratum of ferruginous soil about two feet thick, on removing which the surface of the ore bed, being in some places quite smooth as if worn down by attrition, is seen curiously intersected by seams, some of which cross it transversely or nearly at right angles, and, when in open fissures, are filled up with a substance not unlike red ochre. They give the ore a tendency to separate into rhomboidal fragments, similar to those into which the slate itself often divides, and greatly facilitate the labour of raising it. The bed had been opened to a depth of eight or ten feet, and some hundred tons of the ore had been removed to the smelting furnace situated on the southern shore of Annapolis basin.

Fossil shells.

The character of the ore at this place differs in some respects from that of the Pictou county ore. From its very uniform slaty structure it is more easily broken up, and it abounds to a much greater extent with the casts of marine shells, the calcareous parts of which are sometimes still preserved.

*History of Nova Scotia p. 168. †p. 300.

Dikes and masses of granite and porphyry are described as inter cepting the strata of slate and the ore bed accompanying it, but it appears again in the vicinity of Clements, a distance of thirty miles, the last place along the range of the South mountain where it is known to appear.

Gesner's notes on the early working.

Dr. Abraham Gesner, in 1836, in his Geology and Mineralogy of Nova Scotia, states that the smelting furnace had at that time discontinued operations from causes not generally known, although the ore was said to yield about fifty per cent of good cast iron.

He also adds that the bed of iron ore at Nictaux is about six feet and a half wide and being divided into cubical masses and therefore easily broken up, will afford an immense quantity of metal at less expense than it can be procured at many other places. It has but a shallow covering of soil, a large proportion of which is the carbonate of iron. The walls of slate are distinctly separated from the metallic compound, and are not so much intermixed with the iron as those forming the sides of the bed at Clements. The ore, though very similar, is of a superior quality, and offers every inducement for working. At that time, excellent iron, manufactured at a smelting furnace and foundry erected near Clements, several years before was in use in Cornwallis. The ore, like that at Clements abounds in marine organic remains, and the impressions they have made in the ore and slate are extremely beautiful and distinct. It is argued that because the shells at Nictaux are as abundant in the iron ore as in the slate they are of contemporaneous origin.

Fossil shells.

About a mile and a half north-west from the spot where the ore has been exposed, the Nictaux falls come foaming down a narrow and tortuous channel worn out of the strata of slate. Were an iron foundry erected at the falls, it is improbable that it would be unprofitable. Only a mile and a half from the ore, the rapid river would supply a power more than sufficient for any machinery that might be required under the most extensive operations, and Dr. Gesner does not hesitate to declare that the mining and smelting of iron ore at Clements and Nictaux may be as profitably conducted as in any other part of the world.

In the Industrial Resources of Nova Scotia, he deplores, in 1849, the failure of an association formed for the smelting, casting and manufacture of iron near Clements, although both the ore and the iron produced from it proved to be unexceptionable; he adds: 'Another band of iron ore occurs in the Silurian rocks of Nictaux, which, like those of Clements, abound in the fossil shells and corals peculiar to the group. The ore at this place is six feet four inches in thickness and the outcrop is seen on the surface to the distance of half a mile. Nictaux falls. The falls of the Nictaux river offer an admirable site for machinery, and the forests through which the stream passes would maintain a furnace for a long period of time. Excellent iron was manufactured at this place in the early settlement of the country. Silurian fossils are found at New Canaan, southward of Kentville; and the ochres that usually accompany the iron were made into pigments at that village a few years since.' Dr. Gesner also foresaw that after the forests had disappeared the coal mines would offer a cheap supply of fuel; and he pointed out that the iron ores of Great Britain did not yield on an average more than 35 per cent of cast metal and that many of them are taken from the clay ironstone beds of the coal fields, scarcely exceeding a foot in thickness, and from great depths; that, moreover, the iron mines of Annapolis are on lands embraced by the old grants in which the coal, iron and other minerals were not reserved to the crown,

Quality of the ore.

The excellent quality of the ore thus highly spoken of so many years ago was corroborated by subsequent observers and it was shipped for many years to mix with the iron ore of Londonderry, to which, however, it is said by Dr. How* to be inferior.

This interesting mining district is situated among blooming orchards, cultivated fields and green meadows, is intersected by roads and is close to two railways and in the vicinity of two large water powers.

When the Nictaux works were in operation, limestone was imported from New Brunswick to a port on the Bay of Fundy and thence conveyed by land carriage some eleven miles to the furnace. Several thousand tons of iron ore were mined, chiefly from the bed of shell ore, but knowledge of the ores of the district was not confined to one bed; in

Report by Dr. Jackson.

1855, Dr. Jackson, State assayer for Massachusetts, wrote:—'One cannot fail to be surprised at the enormous quantities of ore which are already exposed by the numerous openings that have been made. There are several distinct and parallel beds of iron ores which we examined, from four to ten feet in width, extending certainly no less than five miles continuously. * * * The supply of iron ores at Nictaux is inexhaustible.' Dr. Hayes described, a short time before, the ores of Nictaux, and spoke of the magnetite on the west side of the river, of the less compact bright red ore of Little river, and the bog ore of the valley. While the two former are very dissimilar in appearance, there can be little doubt but that they and all the intermediate varieties, from the compact, strongly magnetic to the friable

*Trans. N. S. Inst. Sc., Vol. I, Part I, page 86.

fossiliferous red ore, are of the same geological age; the gradation from one variety to another being gradual and dependant on the distance from the seat of metamorphic action.

Mr. Mushet writing to Mr. C. Archibald, said :—"The shell ore is quite a novelty, and the magnetic character of some of the pieces contrasts strongly with the inert state of others to all appearance of similar composition. I have examined it and find that it is curiously comprised of magnetic and non-magnetic laminæ. The assay of the former gives 67¾ per cent, and the latter 54 per cent*.

Dawson's description of Nictaux ore.

Sir William Dawson† describes the Nictaux ore as a bed of highly fossiliferous peroxide of iron, from three to four and one half feet in thickness, the outcrop of which appears at several places in Nictaux and at Moose river with dark-coloured flags and slates dipping S. 30° E. at a very high angle beneath Triassic, red, coarse sandstone and extending from Canaan and Kentville, in Kings county, to Bear river in Digby county, a distance of seventy miles, but separated into two parts by granite. At Nictaux the ore is a peroxide of iron, containing 55·3 per cent of iron, laminated in structure, and full of fossil shells. At Moose river it is in the state of magnetic iron, but retains its character in other respects. This ore is thus of great value. Its distance from the coal fields, and the consequent necessity of smelting with charcoal, have been obstacles in the way of its commercial application.

"The fossils of the ironstone and the accompanying beds, as far as they can be identified, are *Spirifer arenosus*, *Strophodonta magnifica*, *Atrypa unguiformis*, *Strophomena depressa* and species of *Avicula*, *Bellerophon*, *Favosites* and *Zaphrentis*, etc. These, Professor Hall compares with the fauna of the Oriskany sandstone, and they seem to give indubitable testimony that the Nictaux iron ore is of Lower Devonian age.

This conclusion is, however, disputed by Dr. Honeyman in his notes on the geology of the rocks of this district.‡

How's description of Moose river and Nictaux ores.

Professor How‖ describes the ores of Moose river and Nictaux river as of the same nature as those in the slates of the East river of Pictou, consisting of conformable beds in the Lower Devonian slates, the iron ore at Clementsport being nine feet wide, in a magnetic

* H. S. Poole, Report of the Department of Mines for Nova Scotia, 1877, page 44.

† Canadian Naturalist, 1860, etc.; Acadian Geology, pages 499 and 526.

‡ Trans. N. S. Inst., Sc., Vol. IV., 1875-1878, pp, 337-362.

‖ Mineralogy of Nova Scotia, 1868.

condition, holding fossil shells, and yielding, in 1862, five tons of iron a day; that of Nictaux river has been in part rendered magnetic, the magnetism depending, he believes, on the state of aggregation and not on the chemical composition of the ore.

Previous operations at at Nictaux mines.

The Nictaux mines had been worked for many years and extensive works had, at great expense, been erected for smelting the ore. In 1855 a company of English capitalists continued operations on the ores of the shell bed, and in 1858 exported 744 tons of iron valued at $2,375, and in 1859, 1,125 tons valued at $14,790.‡ One shaft was opened close by the furnace, another about two miles to the eastward. The main supply of limestone came from St. John to Port George, ten miles away on the Bay shore. The pig iron had to be hauled to the same place for shipment. Charcoal was used instead of coal. These methods of operation proved so costly that these works, also, had to be closed.

About 1870, Messrs. Stearns and Page, the promoters of the railway from Middleton to Bridgewater, turned their attention to the magnetic ores of Cleveland on the west side of Nictaux river, from which a bed about eight feet thick was followed at intervals as far as Lawrencetown, six miles west of the river, where the strata are finally cut off by the granite.*

They took out leases of an extensive territory, intending to re-open the mines on the completion of their railway, which was projected to run along the deep valley of the Nictaux river, and by facilitating transportation would remove one of the chief obstacles to the success of the earlier blast furnaces. The old furnaces were in ruins, having been partly torn down by the people in the neighbourhood to obtain the bricks.† From the Cleveland areas a few experimental cargoes were shipped, and the ore was found to be of good quality. But their first plans miscarried, and it was not until many years later that the Nictaux and Atlantic was formally opened as the Nova Scotia Central Railway, which is now called the Halifax and South-western.

These early operations are referred to by Dr. H. S. Poole in his reports as Inspector of Mines and in an article by him on "Iron Making in Nova Scotia early in the Century".‖

Harrington's description of the ores.

The ores are described by Dr. B. J. Harrington § as fossiliferous hematites which have, in many cases, been more or less altered to

‡ Markland by R. R. McLeod, 1903, p. 198.

* Rep. of Dep. of Mines for N. S., 1877, p. 43; Middleton Outlook, June 14, 1895, and December 2, 1904.

† J. H. Bartlett, on the Manufacture of Iron in Nova Scotia, Trans. Amer. Inst. M. E., Vol. XIV, p. 537.

‖ Trans. Min. Soc. of N. S., Vol. II, p. 148.

§ Rep. Geol. Surv. for 1873-74, pp. 206, 210, 218.

magnetite, but which still hold numerous fossils of lower Devonian age. A massive, fine-grained, tough magnetite, breaking with sub-conchoidal fracture and resembling some of the Laurentian ores, sent to the laboratory of the Geological Survey for examination, held no fossils whatever, but, like the fossiliferous ores of the district, contained a large quantity of phosphorus.

In the autum of 1890, R. G. Leckie, Manager of the Londonderry Iron Company, revived the interest in mining in this district by securing a bed of excellent red hematite at Torbrook, about three and a half miles east of the Cleveland mines, and in the spring of 1891 a steam hoisting plant was erected, shafts opened and a railway laid to Wilmot, three miles distant, to join the Windsor and Annapolis, now the Dominion Atlantic railway. The ore was transported to Londonderry to mix with other ores, and the owner of the land having the right to the iron ore by the terms of the grant made to the original settlers by the British government, Messrs. Barss and Burns, S. Barteaux and John Banks drew large amounts of royalty. Red hematite at Torbrook.

As enumerated by Mr. R. G. E. Leckie, for some time manager of the mines, in his paper on the iron deposits at Torbrook,‡ the ore beds are four in number. No. 1 is that which has been worked at Torbrook mines and is locally known as the Leckie bed; its general strike is N. 40° E. and its dip, S. 40° E. < 70°—80°. It has an average thickness of six feet and is perfectly clean, there being no slate or stone between the north and south walls. These walls consist of two feet and eighteen inches respectively of a variegated talcose slate, white, bluish and pink in colour, the white and bluish slate predominating, interstratified among dark blue slates spotted with red iron stains. No. 1 bed.

It is noticeable that this bed of ore is entirely free from shells, while the overlying No. 2 bed, between sixty and a hundred feet south, and several beds of the surrounding slate, are highly fossiliferous.

No. 2 or the shell-ore bed, as it is called, is that which was worked by open cut for many years to supply the old furnace at Nictaux falls, It is perhaps identical with the shell bed worked at Moose river, although the connection has not been traced, on account of the disturbed condition of the intervening ground. The ore is a red hematite, metamorphosed at the western end into magnetite by its proximity to the igneous rocks. No. 2 bed.

‡ Trans. Min. Soc. of N. S., Vol. I, Part 3, p. 54.

No. 3 bed.

The outcrop of No. 3 bed appears halfway up the side of South mountain about a mile south of No. 2. It is the same in width and structure as No. 1, the only difference being that it is somewhat magnetic in character and has a darker or reddish brown streak. The dip is almost vertical or slightly inclined to the north-west, so that it has reasonably been assumed to be a repetition of No. 1 on the southern outcrop of a syncline, although as yet no bed corresponding to the shell-ore has been found north of it.

No. 4 bed.

No. 4 bed of Mr. Leckie's report has been opened on Messenger's property, almost on the Kings county line, and following the strike it would be farther up the mountain than No. 3, although the walls are composed of talcose slate like those of No. 1. It was opened and found to be of the following dimensions: Ore 2 feet; Slate 3 feet; Ore 1 foot.

Torbrook mines.

Active operations began, as already stated, in the spring of 1891 when ore was raised from two shafts (called No. 2 and No. 4), one of them worked bv back-stoping the ore, while the other was worked underhand. In the autumn two more shafts were opened (No. 3 and No. 5). No. 3 was worked underhand and No. 5 shaft by back-stoping. Four levels were driven in the ore cut by these shafts. The lower levels were still in good ore when the work was discontinued; in the two upper levels, going east, the ore is said to have been cut off by a small fault. A four-drum friction hoisting plant was put in during the winter of 1892 to hoist from Nos. 3, 4 and 5 shafts. No. 2 shaft had a separate engine and boiler having a capacity to hoist with steel skips of over a ton.

The mine was also equipped with an air-drill plant, by which the output was increased from twenty tons a day in the spring of '91 to seventy tons in the spring of '92, and in the fall to 130 tons. The equipment included locomotive boilers, two air compressors, running six machine drills, and five steam pumps. There were four shaft-houses, three engine-houses, two drying-houses, a blacksmith and carpenter shop, store-houses, dynamite magazine, office building and several dwelling houses. A Cornish plunger-pump was placed in No. 2 shaft. No. 4 and No. 5 shafts were kept dry by small steam Blake pumps. About one hundred men were employed. No. 4 or the Barteaux shaft is 335 feet east of No. 2 and 240 feet deep; No. 5 or the Leary shaft, 275 feet east of No. 4, is 112 feet deep, and the ground is stoped out for 160 feet to the east between the bottom level and the surface.

In a report accompanying that of Mr. Leckie, Mr. William Smaill gives analyses of the ore of the district, of which he enumerates two varieties: a highly fossiliferous hematite, known as shell-ore, rich in iron, but too high in phosphorus to be used in the manufacture of foundry iron; and the compact red hematite of Torbrook, somewhat siliceous, with a perfectly tabular cleavage.

In 1895 the main shaft was 350 feet deep,* and levels had been extended in the ore to a distance of 1,500 feet. The angle of inclination, about 80° at the surface, had flattened to 45° and the thickness of the bed of ore had increased from six to twelve feet. A large number of dwellings were erected in the neighbourhood, including a store, barber shop and photographic saloon, and a little village had grown up around the mines. Although only thirty-two miles from shipping at Annapolis by the Dominion Atlantic railway, another route of shipment was talked of, namely, by rail to Middleton, thence to Margaretville, eight miles distant on the Bay of Fundy—a harbour open all the year round—through a natural vault in the North mountain. But after 1896 the mines were closed for some years owing to the suspension of work at Londonderry, and because the Nova Scotia Steel Company drew its supply from Newfoundland; they were not opened again until 1903. When closed down, the mine was in good working order with a large amount of valuable ore in sight.

The production of iron ore from the Torbrook mines during these years† is estimated as follows: to 1891, 10,000 tons; 1892, 18,000 tons; 1893, 30,000 tons; 1894, 21,590 tons; 1895, 35,073 tons; 1896, 19,944 tons. Production

After operating for five years, and supplying Londonderry and Ferrona with 135,000 tons, the Torbrook mines, as already stated, were idle from 1896 to April, 1903, when they were reopened for the Londonderry Mining Company, under the superintendence of W. F. C. Parsons and the management of Mr. H. McI. Weir. The old plant was used after being renovated. The mine was pumped out and ore was raised from the No. 2 or Woodbury shaft. Part of the work was done by contract. Fifty men were employed; in 1903 nearly 5,000 tons of ore were mined, and the present output is about seventy tons a day.

Mr. Parsons states that the ore bed in the present workings varies considerably in size, and in places runs up to twelve feet in thickness, being apparently lenticular in form, the lenses pitching westerly at a low angle.

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* Rep. of Dept. of Mines for N.S., p. 53.
† Bell's Mining Manuals for 1893 to 1897.

Dr. Gilpin's report.

Dr. Edwin Gilpin, inspector of mines,* refers to the first attempts to manufacture iron early in the nineteenth century, when a few tons of bar iron were made in a Catalan forge at Nictaux; to the production, a few years later, of an excellent charcoal iron which was largely cast into kettles and stoves, and to other subsequent operations already described.

He maintains that in the Nictaux district the conditions resemble those of Germany, and that ores are presented suitable for the basic process, in addition to some that can be graded as Bessemer. Their contents run from 52 per cent to 62 per cent of iron, are low in sulphur and vary in phosphorus from .03 to 1·30 per cent. Two or more ore beds, varying in thickness from two to fifteen feet, have been traced continuously from the granite intrusions west of Nictaux river to the Kings county line, a distance of about five and a half miles, and perhaps extend still farther to the eastward, on both sides of a basin a mile wide and possibly repeated to the northward. They have been proved also to maintain their quality and size to a depth of 400 feet. Much is still needed, he adds, in the way of exploration to test their continuity and their economic value, by deeper shafts or tunnels and by analyses of the ore obtained from them. As to the quantity of ore, there can be no question; the amount available and easily mined above the water levels of the Torbrook and Nictaux rivers must be enormous. The question of the economic values of the ores must be a subject of extended investigation. Practical working has shown that the red hematites can furnish a foundry and forge pig. The magnetites are, with some exceptions, too phosphoric for this purpose. The ores are, as a rule, siliceous and in some cases manganiferous, but low in sulphur; they run high enough in iron and phosphorus, and low enough in sulphur, to answer for the basic process, and their large silica content would prove the principal obstacle to their use for this process. To meet these drawbacks it must be remembered, however, that the mining of these ores and their transportation would be cheaper than from almost any other iron ore district in Nova Scotia, and the preliminary outlay for machinery, drills, wire tramways, etc., would be reduced to a minimum by the facilities available for utilizing water power for generating electrical power.

Bailey's report.

Recent investigations of the geological structure of the Nictaux and Torbrook basin are given by Professor Bailey in his reports to the

* N. of Eng. Inst. M. E., 1876; Mines of N. S., 1880; Can. Soc. C. E., Vol. V., 1891; Trans. N. S. Inst. Sc. Vol. IX., 1894-98, p. 10, "On Steel Making in Nova Scotia;" Minerals of Nova Scotia, 1901.

Geological Survey* in which the fossils are referred, on the authority of Dr. Ami, some to the Silurian, some to a transitional series, and others to the Lower Oriskany.

On page 142 of Prof. Bailey's second report is given a list of the farms containing deposits of iron ore. These are shown on the map accompanying the present report.

Vigorous explorations, in charge of Mr. Francis Park, Major James L. Phinney and others, were carried on during the summer of 1900 by Messrs. S. M. Brookfield of Halifax, George E. Corbitt of Annapolis and others, records of which have been obtained for the Geological Survey through the kindness of these gentlemen.

Borings.

A bed, varying in thickness from six to ten feet, was traced westward from the Black river at the contact of the Triassic near the county line, and passing a short distance south of the Leckie bed is believed to represent the well known shell bed, the ore running from 33 to 55 p. c. of metallic iron. One of the Government calyx drills was used‡ to bore through the bed at a depth of 300 feet beside the Torbrook road near the Leckie mine. At this depth the ore bed is said to be about nine feet thick. A subsequent boring at Fletcher Wheelock's farm cut three beds of iron ore; and one, No. 5, on the S. McConnell farm, cut two beds on the steep north dip of the syncline, which seem to prove a thickening of both in depth.

Jennison's report.

Sufficient work was done, according to Mr. W. F. Jennison† by a series of bore-holes, test-pits and trenches to show that the ore beds are continuous as above stated, with the exception of small interruptions by faults, one of which on the east side of the Leckie workings, and another west of them, have been proved; and by dikes of diorite and granite which have partly metamorphosed the red hematite into magnetite.

Cost of mining.

The close proximity of the ores, both in the valley and on the South mountain, renders concentration of the mines and machinery possible, and reduces the cost to a minimum. With a production of 150 tons a day the cost of mining and shipping ore to Sydney is estimated by Mr. Jennison as follows:

* Vol. VI, 1892-93, Part Q. pp. 13-15; Vol. VII, Part A., p. 91; Vol. IX, Part M., 1898, pp. 91-111 and 140-143.

‡ D. Weatherbe, "Core Drilling in N. S.;" Trans. N. S., Inst. Sc. Vol. X. 1901, page 350.

† Nova Scotian, Halifax, 1903, p. 38; and a private report on Torbrook Iron District.

Mining and putting on cars	per ton	·75
Haulage by rail to Annapolis, 32½ miles	"	·25
Loading ship at Annapolis	"	·10
Freight to Sydney	"	1.00
		$2.10

Timber for all mining purposes is easily procurable. Mr. Jennison suggests the derivation of power to work the mines from the Nictaux river, which has a length of fourteen miles, is fed by several large lakes, has a fall of seventy feet in a distance of 3,750 feet and a flow during the dry season of 7,680 cubic feet per minute, which would give 500 horse power, during the dry time. The cost of installing electrical plant of this power and connecting it with the mines three and a half miles distant, he estimates at $25,000.

Quantity of ore.

Various estimates, all more or less vague, have been made of the approximate quantity of iron ore in this district. Dr. Gilpin estimates that every thousand feet longitudinal and 500 feet vertical of the northern beds worked out will produce 1,800,000 tons of ore—practically three years supply at 2,000 tons per day. His estimate to a depth of 800 feet for the district so far developed is not less than 300,000,000 tons.

Consequently, the small extent to which, so far, the ores of Nictaux and Torbrook, those of the East river of Pictou and other localities in Nova Scotia have been used, can only be explained, as suggested by Dr. Poole, by supposing that they are harder to smelt; that they are not so high in metallic iron as foreign ores or that they cost more to mine and deliver at the furnaces.

Explorations.

The following notes extracted from reports of the explorations made by Messrs. Park and Phinney will be readily understood by reference to the map which accompanies this report.

On the south side of the basin the dip is N. 48° W. $<$ 87° at the Messenger pit, but changes at the county line, being perhaps affected by the proximity of granite.

Section of ore bed.

On James L. Brown's farm, three beds have been opened, showing considerable magnetic attraction; in the centre bed the ore is similar to that of the Messenger pit. On I. J. Whitman's and James Jefferson's farms, there is found a broken ore of excellent quality, not so red as that of the Messenger pit. At Obadiah Brown's, the ore is also of good quality and contains no slate bands. The section of the ore bed on the Baker, McConnell and other farms is given in the following tabular form:

Pits.	Ore.	Slate.	Ore.	Slate.	Ore.	Slate.	Ore.	Slate.	Ore.	Slate.	Ore.	Total.
	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in	ft.in
Baker, No. 1........	0·10	2·10	4·0	2·6	0·7	1·6	2·3	3·3	0·6	....	....	18·3
" 2......	1·0	2·0	5·0	3·3	1·7	1·4	1·1	0·3	0·5	2·6	0·8	19·1
McConnell, No. 1...	0·8	2·6	5·0	2·6	1·2	1·5	1·10	3·0	0·4	....	....	18·5
" " 3...	1·2	2·10	4·10	2·9	1·0	1·6	1·7	3·0	0·2	....	....	18·10
" " 4...	1·8	2·8	4·0	3·6	1·0	1·3	1·6	3·9	0·4	....	....	19·8
Messenger pit	.....	.....	2·0	3·0	1·0	....	.....	....	....	....	....	......
Jas. L. Brown	.....	.....	2·9	2·8	3·1	....	....	....	....	....	....	.....

In McConnell No. 1 the ore of the large central layer is brown, while that on the sides is black. In this ore there are no shells, while shells are numerous in that of the Baker farm. The slates are hard and dark. On the H. P. Wheelock and M. and E. Armstrong lots, the ore is similar to that of the Baker No. 1 and the pits are all in line and on the same bed as far as Torbrook.

The most westerly of two pits on D. B. Armstrong's farm, at a depth of fifty feet, was still in surface soil; the other found ore similar to that of McConnell No. 4 pit, pushed about and broken by proximity to the granite.

The foregoing openings are on the south side of the syncline or basin; those now to be described are on the north side. No ore has been found in the bed of the Nictaux river, where it is probably covered by drift, for the line of the ore from Martin's to Ward's, on the east side would strike, if produced, the beds of the Cleveland mines on the west side of the river.

On William Ward's farm, the old workings are being extended to obtain iron ore for the furnaces at Londonderry. Ward's property.

An old shaft, sunk fifty years ago or more by the smelting company that operated at Nictaux falls, was cleaned out, the timbers being found in a good state of preservation. Three and a half feet of ore is already in sight. The company intend to haul the ore to Nictaux station for shipment.

E. Martin property.

The shell bed, averaging three feet in thickness, has been traced from Ward's for 2,800 feet without a break to Edward Martin's, where there seems to be an offset to the south about three hundred feet, beyond which it has been traced across the Hoffman and Holland farms and halfway over Stanley Brown's, with the exception of a few feet of offset on H. P. Wheelock's farm. The average thickness of the iron ore is six feet, with 52 per cent of iron. The old trenches on the shell-ore bed are about eight feet in depth and they have a total length of nearly a mile. At the break on the shell-ore at Martin's and also at J. Allen's, two other beds of magnetic ore are opened to the north of it. The first, at sixty feet from the shell-ore, is two feet eight inches wide; the other, sixty feet farther or 120 feet north of the shell-ore bed, is three feet six inches wide and runs to DeLacy Foster's and Albert Wheelock's (Benjamin Wheelock No. 1 of Honeyman's report) where the dip is 87° to the south-eastward. A bed of hematite, called the Park bed, probably the equivalent of the Leckie bed, was also opened on Martin's farm and runs parallel with the shell-ore as far as Eliakim Wheelock's east line; its average thickness is four feet five inches and its composition is about 50 per cent of iron.

Page and Stearns property.

After leaving Foster's no ore bed is found until we come to the Page and Stearns lot, where a bed of red hematite two feet nine inches in thickness was opened. On the banks of the Black river, to the eastward, there appear to be three beds of iron ore, the Spinney bed, ten feet thick, and two beds north of it, three feet four inches to five feet two inches, and two to three feet wide respectively. The ore of the Spinney bed is not as good as that of some of the other beds; it yields only 33 per cent of iron.

The ore of the Leckie mine was lost both going east and west. Trenches have been dug in search of it both north and south, but it has not been found, unless represented by the inferior ore of the five foot bed north of the Spinney bed. A cross-trench was dug to the rock from the road near J. Goucher's line for about 3,000 feet north to the river; a great deal of money was spent in this neighbourhood in exploration.

Fletcher Wheelock property.

On the Fletcher Wheelock farm a shaft was sunk fifty feet on a bed about nine feet thick without partings between the walls and yielding about 48 per cent of metallic iron. On this farm, also, No. 4 borehole was drilled to a depth of 635 feet from a point about forty feet south of the hanging wall of the shell bed.

North of the ore bed at Albert Wheelock's there is a band of diorite with white quartz along its contact with the slates. From the edge of this diorite, on the M. Hoffman lot, a cross-cut was extended southerly; it cut three beds, very white and full of shells, but containing some excellent iron ore. Ore was taken from both the shell bed and the Leckie bed on the George Holland farm.

Stanley Brown property

Where opened half way across the Stanley Brown lot, east of the private road, the shell bed is found to be a mass of shells with very little iron, whereas the Leckie bed, uncovered in two places, shows three feet of good ore.

On the Annie Parker (Deacon Feltch) lot the ore was not found, being covered by a boarsback of drifted sand and gravel, and on W. R. Neily's it was found only as drift, and is perhaps interrupted by a belt of greenish gray diorite.

From the Barss and Burns and from the Samuel Barteaux (Samuel Wheelock of Honeyman) areas, most of the ore shipped from the Torbrook mines has been obtained. The Leckie bed was only eighteen inches thick at the surface, but increased greatly in depth.

E. M. Barteaux property.

On the E. M. Barteaux farm, from the Parker line, a costeaning trench was cut close along the east side of the Torbrook road for 2000 feet, under the direction of Captain Park. In red slates on the line of the other ores, it cut three beds of low-grade iron, one of which was six feet thick. Borehole No. 2 was close to and in line with this cross-cut or tunnel, and to a depth of 111 feet cut red shales, dipping at an angle of 85° to 87°. Borehole No. 3 was drilled twelve feet north of the preceding, in red shales dipping at an angle of 83°, to a depth of 228 feet, and bored to a total depth of 330 feet. All the rocks here seem to be red and to differ from those of the iron mines, yet a bed resembling the shell-ore is opened at the river to the eastward, and another, supposed to be the Leckie bed, is present in the bed of the river.

On the Hatt and Eaton lots, pits were opened on what was supposed to be the shell bed, eleven feet wide beneath fifteen feet of surface. The ore is soft and impure, similar to that in the river to the eastward. At Peleg Spinney's, the eastern pit shows eighteen feet of clean ore and seven feet of mixed red slate and ore, twenty-five feet in all, the south side being the better. It was opened also across the river, and seems to be in lenticular masses or beds of compact and pisolitic hematite. On the David Banks lot, on the bank of the river, in the first bed north of the Spinney bed, there is five feet of soft, low-grade ore, and on Mrs. Spicer's, three feet of hard ore.

Other properties.

On T. B. Messenger's lot, a small brook shows gray and red slates well exposed for a breadth of 1516 feet from a point a short distance above their contact with the Triassic sandstone of the valley, the red slates being above and below the gray, the latter occupying a considerable breadth in the centre. As already stated, these slates appear to lie in a syncline; but it has also been suggested that the structure may be anticlinal, and further examination is required to determine the thickness of the ore-bearing belt of this district and the relation of the red strata of the Torbrook road to the gray beds of Torbrook mine. It is supposed by Major Phinney and others that this belt extends to the northward of the outcrops above described. In the brook which runs into Nictaux river, three-quarters of a mile below the falls, the Foster pit was sunk thirty feet on iron ore containing 34.45 per cent of iron and 10.55 per cent of manganese. The ore is hard and does not break like the Torbrook ores. At the same place a trench was dug for 1,000 feet across a mass of broken red slates.

Loose ore is reported to have been found, also, on the farms of E. Pierce (A. B. Parker), A. S. Banks and George Holland; and samples of limonite in the drift on the Frank Woodbury property.

Analyses.

The following analyses, collected from different sources stated in the table, will serve to show the character of the Nictaux and Torbrook iron ores:

ANALYSES of Iron Ores of Nictaux and Torbrook, Annapolis County, N.S.

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Peroxide of iron	.... 69·17	71·85	26·39	....	....	75·80	48·34	....	....	....	74·63	86·74	84·29	....	....	....	....
Protoxide of iron	....	....	....	....	....	....	21·76	....	....	....	....	....	....	....	....	....	....
Protoxide of manganese	....	0·28	12·74	....	....	0·65	0·40	....	0·86	....	....	....	....	....	3·02	Heavy trace	....
Alumina	....	3·59	....	....	....	4·19	1·62	....	5·53	....	....	....	....	....	5·00	....	....
Lime	....	2·30	....	....	....	6·30	4·01	....	2·70	....	....	....	....	....	....	....	....
Magnesia	....	1·00	....	....	....	....	0·60	....	0·41	....	....	....	....	....	....	....	....
Phosphoric acid	1·82	....	....	....	....	....	3·08	....	....	....	3·80	0·399	....	0·427	....	0·414	....
Sulphuric acid	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0·57	0·196	....
Titanic acid	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Insoluble matter	18·94	18·13	33·50	11·64	....	8·26	18·95	18·56	13·30	17·21	11·00	10·28	12·87	....	26·50	10·12	....
Metallic iron	50·09	50·27	....	59·11	53·14	53·06	50·77	52·22	55·49	57·99	52·24	60·72	59·00	61·38	47·50	55·74	56·45
Phosphorus	0·05	....	....	0·17	0·172	2·65	....	....	0·23	0·18	1·66	0·17	....	0·18	....	0·18	....
Sulphur	0·79	....	....	0·09	....	0·20	0·08	....	0 08	0·04	....	....	....	....	0·23	0·08	....
Manganese	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

NICTAUX—1, Geological Survey Report for 1873-74, page 210; 2, Geological Survey Report, Vol. V., Part P., page 179; 3 do, page 180; 4 and 5, Gilpin's N.S. Mines and Mineral Lands, 1880, page 58; 6, "Shell ore," William Smaill in Trans. Min. Soc. of N. S., Vol. I., Part 3, page 62; 7, do, page 59, a magnetite; 8, Average of four magnetites from the Heatly, Baker and McConnell (2 samples) farms at Nictaux and Cleveland, Geological Survey Report, Vol. XIII., Part R., page 29, 1900; 9, Average of three samples of magnetite from Cleveland; 10, Average of two samples of hematite from Cleveland; 9 and 10, from Department of Mines for N. S., page 61, 1875.

TORBROOK.—11 to 17, Geological Survey Report, Vol. V., Part P., pages 179 and 180.

ANALYSES OF Iron Ores of Nictaux and Torbrook.—*Continued.*

Sample No.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Peroxide of iron	...	...	...	...	...	49·52	...	79·42	...	...	...	...	...	...	...	...	...
Protoxide of iron	...	...	...	...	...	27·09	...	...	...	...	...	...	...	...	...	...	...
Protoxide of manganese	...	...	...	...	...	0·80	...	0·38	...	...	...	...	...	...	...	...	...
Alumina	...	...	...	3·14	...	1·90	...	5·08	...	...	...	...	...	...	...	...	...
Lime	...	...	...	2·16	4·50	7·00	...	1·90	...	...	...	...	...	...	...	...	...
Magnesia	...	...	...	...	...	1·80	...	0·35	...	...	...	...	...	...	...	...	...
Phosphoric acid	...	...	...	...	0·30	...	...	...	...	...	...	...	...	...	...	...	...
Sulphuric acid	...	...	...	0·11	...	...	...	...	...	...	...	...	...	...	...	...	...
Titanic acid	...	...	...	...	...	...	...	...	...	...	0·144	...	...	...	...	...	...
Insoluble matter	...	...	17·21	5·93	9·50	13·48	10·22	12·00	11·56	10·39	10·87	14·16	10·35	7·97	9·41	...	...
Metallic iron	56·00	58·05	57·93	59·86	60·00	...	59·76	55·60	54·71	42·30	54·84	53·10	55·40	54·28	52·40	50·76	54·87
Phosphorus	...	0·193	0·16	...	0·13	Trace	...	0.43	0·669	0 396	1·452	0·704	1·037	0·53	1·861	...	...
Sulphur	...	...	0·036	...	...	Trace	...	0·11	0·007	0·015	0·015	0·025	0·114	0·028	0·030	...	...
Manganese	...	...	...	...	...	...	...	...	...	0·52	0·41	0·24	0·26	0·28	0·23	...	...

TORBROOK—18, Geological Survey Report, Vol. V., Part P., pages 179 and 180; 19 and 20, Gilpin's Mines and Mineral Lands, 1800, page 58; 21 and 22, Geological Survey Report, Vol. X., Part S., page 98; 23 and 24, R. G. E. Leckie in Trans. Min. Soc. of Nova Scotia, Vol. I., Part 3, page 53; 25, do., page 61; 26 to 32, Ores from the Armstrong and other farms on the South mountain, Report by Dr. E. Gilpin, 1901; 33, average of 10 samples, ranging from 46·60 to 55 per cent of metallic iron, from the Spinney, Martin, H. P. Wheelock, F. Wheelock, Holland and Allen farms; see map also Geological Survey Report, Vol. IX., Part M., page 142; 34, McConnell farm on the southern side; 33 and 34 are also from Gilpin's Report, 1901.

Gold Fields of Nova Scotia.

By Mr. E. Rodolphe Faribault.

Mr. Faribault was engaged in office work from October 12, 1903, until June 15, 1904. The greater part of this time was spent in plotting the surveys, made by him the previous summer, of gold mining districts in the counties of Guysborough, Halifax, Hants, Lunenburg and Queens and in revising the plotting of surveys, made by his assistants, of the granite region lying to the north of St. Margarets bay, as detailed in the Summary Report for 1903, pages 174 to 186. Office work by M. Faribault.

Much of his time was also taken up, as usual, in correspondence, especially in answering letters from persons seeking information and advice on the gold fields of Nova Scotia, which are attracting more and more attention from scientists and capitalists, at home and abroad.

The plan and section of the gold district of Gold River, surveyed in 1901, and those of Isaac Harbour and Cochran Hill, surveyed in 1902, have been published.

The plan of Wine Harbour gold district is now being engraved, while that of Harrigan Cove and Miller Lake were completed for publication and only require to be traced for engraving. Plans and maps.

Mr. Owen O'Sullivan, of this department, was engaged some four months during the winter in compiling from the plotting sheets onto the one-mile to an inch map the topography and geology of the region extending from Halifax north to Rawdon and west to Newport, Mount Uniacke, Pockwock lake and the head of St. Margarets bay. The compilation of the surveys made for several years past in the counties of Halifax, Hants, Lunenburg and Queens is still in arrears, but it is now progressing more rapidly and will soon be completed for publication.

A special report on the gold fields of Eastern Nova Scotia is well advanced and will be ready for publication next year. It will include the plans of twenty-five of the most important gold districts situated in the counties of Guysborough, Halifax and Hants; several transverse sections of the saddle-vein formation of different gold mines; a general map of the gold-bearing rocks of the province, showing the location of the gold mining districts from Canso to Yarmouth, Report on gold fields of eastern N.S.

and the granite areas; a geological and structural map of the gold-bearing rocks of the eastern part of the province, from Isaac Harbour to Mount Uniacke, and a selection of photographs illustrating the mines in operation and the structure of the gold-bearing quartz veins.

On the field-work accomplished in the Nova Scotian gold fields during the summer of 1904, Mr. Faribault reports as follows:

In accordance with your instructions, I left Ottawa on June 15, 1904, for Bridgewater, Nova Scotia, to resume last season's surveys in connection with the mapping of the gold-bearing series of the western part of the province and to continue the study of the structural geology of the gold-mining districts which are being operated. I returned from the field to Ottawa on October 6.

Assistance.

I was again ably assisted in the field the whole summer by Mr. James McG. Cruickshank, who has now been my assistant for seventeen seasons, and by Mr. W. H. Prest, from June 15 until September 30. The latter's experience as a practical prospector and miner was especially valuable and useful in some of the districts surveyed.

Acknowledgments.

In the performance of my field-work, I have received much information and assistance from miners and others, and I wish to offer, especially, my acknowledgments to the following persons: Hon. A. Drysdale, Commissioner of Public Works and Mines; Dr. E. Gilpin, Deputy Commissioner of Mines; D'Arcy Weatherbe and Geo. A. Hall, of the Department of Mines; Harry Piers, Curator Provincial Museum; Dr. H. S. Poole, F. H. Mason, Prof. J. Ed. Woodman, Geo. E. Francklyn, Fred. P. Ronnan and Joseph H. Austin of Halifax; G. J. Partington, Isaac's Harbour North; Harold Playter, Goldboro; S. R. Heakes and M. McGrath, Wine Harbour; Geo. W. Stuart, Truro; G. H. Gillespie, Ecum Secum Bridge; W. H. Boak, Harrigan Cove; L. W. Getchell, Caribou Gold Mines; Edwin L. Foster, Clam Harbour; L. F. S. Holland, Cow Bay; Jas. A. Crease, Mount Uniacke Gold Mines; T. N. Baker, Montague Gold Mines; Peter Dunbrack, Dartmouth; E. Percy Brown, H. S. Badger, Dr. D. Stewart, Chas. F. Hall and N. C. Owen of Bridgewater; Thos. W. Moore and J. Lacey, Leipsigate Gold Mines, Bridgewater; R. R. McLeod, Brookfield, Queens County; Sam. Sutherland, Malaga Gold Mines; W. L. Libbey, Stanley Cole, N. C. Crowe and Geo. G. King, Brookfield Mines; Marland L. Pratt, Boston, Mass., and S. L. Kingsley, Bar Harbour, Me.

Surveys.

The greater part of the season's work consisted in making detail surveys of the gold-mining districts of Leipsigate in Lunenburg county, Malaga and Brookfield in Queens county and Clam Harbour in Halifax county. The surveys of these districts were for the most part plotted in the field, and since my return to the office, the plans of Leipsigate and Clam Harbour have been completed, while those of Malaga and Brookfield are not quite finished. Several districts already surveyed have also been re-examined and a few new gold discoveries have been visited, in the counties of Guysborough, Halifax, Hants, Lunenburg and Queens, at the request of persons asking for information on the progress of developments recently made. Valuable data have thus been collected which will be useful to bring my final report up to date.

Progress was also made, especially by my assistants, in the general mapping of the country surrounding Leipsigate, Malaga and Brookfield mines and these surveys have since been plotted and are ready for compilation on the one-mile to an inch map. These surveys have now been extended as far west as Vogler Cove, Lapland, Buckfield and Cameron Landing thence north to Brookfield, New Germany, Dalhousie road, New Ross road and the Gaspereau lakes, where our work joins Mr. Fletcher's from the north.

It would not be judicious to report on the gold districts of Malaga and Brookfield before the plans are fully completed, and, besides, it is probable that additional data and surveys will be required to work out satisfactorily the structural geology, and arrive at more precise conclusions regarding the location and extent of the zones of special enrichment and their relation to the structure of the rocks. The following reports on Leipsigate and Clam Harbour are given subject to revision. Malaga and Brookfield district.

LEIPSIGATE GOLD DISTRICT.

The gold mining district of Leipsigate, sometimes called Millipsigate, is situated in Lunenburg county, at a distance of six miles and a half west of Bridgewater, a flourishing town and lumbering centre at the head of navigation on La Have river, and three miles north of the new line of the Halifax and South-western railway completed last summer. Leipsigate takes its name from Leipsigate lake, a beautiful sheet of water 11,800 feet long, east and west, by 4,000 feet wide, situated 225 feet above sea level on the headwaters of Petite Rivière, and surrounded by a comparatively level country. Leipsigate district.

Gold-bearing veins have been discovered at several places around the lake over an area extending about three miles long and one mile and a half wide. A detailed survey of the area has been made, a plan compiled on the scale of 500 feet to one inch is completed for publication and a full report is given therewith of the structure of the district.

Rocks.

The rocks of the district mostly comprise beds of gray and greenish-gray, hard, altered quartzose sandstone, locally called 'whin', between which are intercalated bands of bluish and greenish-gray, argillaceous slates, and they form part of the lower and most productive division of the gold-bearing series. Natural rock exposures are sufficiently numerous in most parts of the district to work out the structure with some degree of accuracy, especially with the aid of the surface developments which have been made.

Structure.

A close study of the rock structure from the plan shows that, since their deposition on a sea bottom, the whole thickness of the strata has been subjected to a powerful north and south pressure which has lifted and bent them up into a broad anticlinal fold, the top of which has since been truncated by erosion and planed down to the present level, exposing the uptilted edges of strata which were originally at least 17,000 feet below the surface.

Anticlinal fold.

The fold has the shape of a long elliptical dome, the two axes of which are in the ratio of about one to six. The centre of the dome occurs at the western extremity of the district, 2,000 feet west of Leipsigate lake, about area 57, block 2, and is well exposed on a rocky knoll situated between two hay marshes on Caribou brook.

The anticlinal axis runs N. 64° E. magnetic, through Leipsigate lake, at the eastern extremity of which it follows the outlet, while at the west end it passes 400 feet north of the inlet from Caribou lake. Thus, the rocks on the north side of the lake dip north, at angles increasing gradually from 30° to 55° from the horizontal as we recede from the axis, and on the south side they dip south at angles increasing from 25° to 50°. The angle formed, therefore, by the two legs of the fold is about 75° and the axis plane of the fold is about vertical.

Horizon of rocks.

The slates of the upper division of the gold-bearing rocks are met with about 9,900 feet north and south of the anticline and the horizon of the lower strata brought up by this huge upheaval is about 6,500 feet below the base of the upper slate division, which gives a total erosion of some 17,000 feet of known measures. The horizon corresponds approximately with that of the gold district of Gold River, which is situated fourteen miles farther east and probably on a north branch of the same anticlinal fold.

On the eastern pitch of the anticlinal dome the strata curve and dip easterly in concentric circles at angles increasing gradually from the dome eastward and reaching 30° at the outlet of the lake; while, on the western pitch, they curve and dip westerly at lower angles and are apparently disturbed by a series of left-hand faults. Pitch of anticline.

The only important fault located in the district probably follows a depression between Weagle hill and the Micmac mine and runs in a north-westerly direction towards Bird island, giving a right-hand horizontal displacement of some 400 feet to the Micmac fissure vein. There may also possibly be a corresponding left-hand fault following the swamp immediately east of the Crank shaft and Jackpot mines, running in a north-easterly direction towards South Duck cove and the pond above the dam; but it has not yet been proved. Faults.

All the gold-bearing veins so far discovered occur on the eastern pitch of the dome, the centre of which appears to be the western limit of the mining district. The productive veins may be conveniently divided into three classes: 1° the interbedded veins or 'main leads,' following fractures along slate belts intercalated between heavy beds of whin; 2° cross-veins cutting the strata at various angles but of little extent and 3° true-fissure veins cutting the strata but of considerable extent. In this district, interbedded veins do not attain the development in size, length and richness that is generally found in the eastern districts of the province. Several of them have been prospected, and mining operations have been attempted on a few, but generally with limited success. This is due to the fact that the structure of the fold is not propitious to the formation of large main leads. The anticlinal fold is much broader than in anyone of the eastern districts; the angle formed by the dip of the north and south legs of the fold is over 75°; the folding has been gradual with no sharp flexure; hence there has been but little or no parting along the planes of stratification caused by the sliding of one bed upon another and no fracture for the formation of important main leads. In a few cases, however, rich ore-shoots have been found at the intersection of angling veins with main leads, such as the rich pay-streak operated at the Bluff mine to a depth of 255 feet and that at the Black Hawk mine, 265 feet deep. But in these cases the main lead and the cross-vein do not appear to carry any gold outside of the shoot. The main leads occur more especially along two well-defined zones, beginning at the centre of the dome, on area 57, block 2, and diverging in a north-easterly and south-easterly direction on both sides of the anticlinal arch. Interbedded veins.

The north-eastern zone is especially well defined. It follows the northern side of the lake and extends to Ernst's Washing lead, a Mineralized zones.

distance of 10,000 feet from the centre of the dome. The following main leads have been opened along this zone, from west to east:—The Gow lead, worked for several years by the Black Hawk mining company to a depth of 265 feet and for 450 feet in length, on a narrow ore-shoot, pitching west at an angle of 38°, formed at the intersection of a cross-vein with the main lead; the Green lead opened down to 42 feet; Deal's belt of leads, prospected; Birch Brook lead, worked 55 feet deep and 300 feet in length; Garfinkel belt of large leads, developed on the surface and on one of which a shaft was sunk to a depth of 48 feet; the Boulder Hill, McKinnon, Jim Deal, Rusty, Butterfield (32 feet deep), Fox-den and a few other small leads have been a little prospected; the Ernst Washing lead (50 feet deep), from $\frac{1}{8}$ to one inch thick, in a metalliferous slate belt carries a large quantity of gold, and the gold extracted by cradle-washings from the drift lying immediately south of the vein is also derived no doubt from this vein. Much good ground is still completely undeveloped along this zone, more especially between the Black Hawk and the Birch brook leads and beyond as far east as the Boulder hill where a great many large blocks of quartz have been observed, strewn over the surface.

The south-eastern zone of main leads is not so well defined as the foregoing, but it follows in a general way the southern side of the lake and extends probably about the same distance eastward from the centre of the dome. The principal leads opened along this zone are the Pelton (60 feet) Stillwater, Twin, Waterman (48 feet,) Aulenback (40 feet,) Point (90 feet,) Bluff (255 feet,) Quigley (20 feet,) Rose (40 feet,) Johnson (10 feet,) Island (20 feet,) Joe Zink (10 feet,) Greenwood and Lacey (20 feet deep.) The rich pay-streak worked to a depth of 255 feet on the Bluff lead, is a well defined ore-shoot, 8 feet long measured horizontally, formed at the intersection of angling veins or 'angulars' from the north-west with a small main lead and reported to be still as good at that depth as it was above. Rich ore was mined 40 feet deep on the western end of the Rose lead, where it is cut off by a small fault on the eastern edge of a swamp, and gold values were developed at a few other points along its course for a length of 1,300 feet.

Cross veins and angulars.

The district presents a great number of quartz veins following planes of fractures of limited extent cutting the strata at different angles. Many of them attain several feet in thickness, but they are composed for the most part of barren, white quartz. Some, however, have been observed on the north side of the lake to include bands holding metalliferous sulphides which are undoubtedly gold-bearing. These have been located on the plan with explanatory notes, and they should be well prospected along their course for pay-ore, which might be found to occur in shoots at th ir intersection with certain slate belts generally holding seams of quartz.

A great number of cross veins occur at the eastern end of the district, about the outlet of the lake. They all strike at right angles to the anticline and parallel with the strata, but dip westerly at angles of 50° to 70°, or about a right angle, and in a direction opposite to the dip of the strata. Similar veins have been observed on the pitching arch of folds in the eastern districts. They do not appear to carry any gold, but probably form part of the main system of channels through which the ascending solution came up.

Small angling veins or 'angulars,' branching off from or running into main leads and sometimes causing enrichments in the form of ore-shoots, have already been referred to in the case of the Bluff and Black Hawk mines. They are generally barren of gold, but they appear to be the smaller ramifications of the main channels conveying the solution into main leads where a deviation or a check to the flowage produced a concentration of minerals by precipitation.

One fissure vein, however, the Leipsigate, owing to its permanency and size and the uniformity of its ore values, has made the district famous. In many respects it is probably the most typical true-fissure vein in the province, and gives promise of being one of the best producers. It is situated in the most southerly part of the district, some 1200 feet south of the lake, and has been traced for 9000 feet, of which 4350 feet have already been opened in three different sections, which are described here separately. Fissure veins.

The western section of the Leipsigate fissure is situated to the west of Mud lake, at a distance of 3200 feet south of the anticline. It has been opened for 800 feet along its course by two shafts, the Duffy shaft, ninety-five feet, and the Dr. Cowie shaft, twenty-five feet deep. The course of the vein here is N. 83° 30′ E., magnetic, and it dips north at an angle of 50° towards the anticline, while the strata strike N. 54° E. and dip south at an angle of 49°. The width of the vein varies from a few inches up to two feet, and appears to be made up by small angling veins coming from the north-west and dipping north-east at angles averaging 48°. Western section.

The intersection of the fissure with strata as well as with the angulars is thus pitching east, and, according to the general rule in this as well as other fissure veins in the province, the ore-shoots should also pitch eastward; therefore, developments in depth may meet with good results in that direction.

The fissure vein has not been traced to the westward of the Cowie shaft, but it undoubtedly extends much further in that direction, probably along a low swampy depression running due west to the eastern end of Caribou lake, at the outlet of which a vein, eighteen inches thick, was observed to run N. 41° W., magnetic, and dip south at an angle of 60°.

Towards the east, from the Duffy to the Gilmour shaft, a distance of 800 feet, the fissure vein is also concealed by low swampy ground and Mud lake. A small fault probably occurs between the two shafts, which would account for the change in direction of the vein at both places, but the horizontal displacement is apparently of but little extent.

Middle section.

From the Gilmour shaft eastward, the middle section of the fissure vein has been traced in a straight line for 2,000 feet, bearing N. 64° 45′ E. magnetic, and it dips north at an angle of 70° at the surface, decreasing to 55° at a depth of 180 feet in the Gilmour shaft.

The first mining operations on this part of the vein were undertaken in 1886 by a German party from Minneapolis and Duluth, under the name of the Duluth and Nova Scotia Mining company, but extravagant and unskilful management soon caused the mine to close.

Scotia Company's workings.

In 1901 the Scotia Mining and Development company acquired the old "German" property, so called, and extensive developments have since been made under the management of Messrs. N. C. Crowe and E. Percy Brown, proving the permanency and value of the vein. Two main shafts, 780 feet apart, have been sunk on the dip of the vein. The Gilmour shaft at the west end of the property is 180 feet deep and, at the 100-foot level, drifts have been driven 100 feet west and 320 feet east, developing four distinct and well-defined ore-shoots reported to average 24 inches of crushing material, and pitching east at an angle of 17°. The old German shaft was sunk 130 feet and drifts were driven 180 feet west and 325 feet east at the 110-foot level. The data obtained from these developments show that the ore also lies in shoots dipping east at a low angle.

Ore-shoots.

It has been observed that the ore-shoots occur at the intersection of the vein with certain strata of soft rock which are apparently more favourable to fracturing, infiltration and deposition of gold. This important feature already observed in several other fissure veins deserves much attention in mining. These intersections are necessarily continuous for great lengths and a succession of them probably recurs in depth; it should therefore follow that the ore-shoots are quite extensive in length and that those already developed are likely to be underlaid by a succession of others. This should encourage developments to a much greater depth.

The opening farther east on the Scotia property is fifteen feet deep, on area 402, block 5, 100 feet east of the Bear Trap road; it showed the vein to be six inches thick. From this opening eastward, for 2,930 feet to the Micmac main shaft, the country is low, swampy and flooded by several runs of the Menamkeak stream, preventing the tracing of the fissure vein between those two points.

Some rich float found at the north end of Weagle hill came no doubt from this part of the vein, but it is reported that several attempts to cut it have proved unsuccessful. Some local miners, however, expressed the opinion that it was probably cut some years ago on the north side of the brook, about the north end of area 442, block 4.

This undeveloped portion of the vein, which is for the most part held under the name of David McKay, of Bridgewater, offers undoubtedly a promising field for development. Good prospects.

In producing the course of the vein from either side, we find that there should be a left-hand fault giving a horizontal displacement of possibly 400 feet, measured at right angles to the vein. It is important to determine the exact location and extent of this fault in order to locate the vein. Judging from the surface features and the position of the float to the south of the vein, the fault probably runs N. 30° W. along a depression lying east of Weagle hill and Bird island, and 250 feet west of Weagle's store.

Some rich float from a ten-inch vein was also found on the south end of Weagle hill, half a mile south of the fissure vein, but a shaft sunk several years ago by Germans to a depth of ninety feet in the glacial drift forming the hill, did not reach bedrock, and it is possible that this float may have drifted thus far south from the fissure vein.

The eastern section of the fissure veins has been developed for a length of 1,600 feet, 1,200 feet of which is situated on the property of the Mimac Mining Company and the rest on that of the Leipsigate Mining Company, called the Jackpot mine. The eastern extension of Eastern section.

the vein, which is as yet undeveloped, is mostly situated on the property of N. C. Owen *et al*, of Bridgewater.

Micmac mine. Extensive and profitable mining has been done on the Micmac property since 1897, first by Messrs. Cashon and Hines, and since April 15, 1900, by the Micmac Mining Company, under the management of Mr. T. W. Moore. This is the only mine worked at present in Leipsigate district. It is well equipped for economical and limited operations and is furnished with a fifteen-stamp mill and a cyanide plant recently erected and successfully operated by Mr. H. S. Badger*

At the Micmac mine the main shaft has reached a depth of 500 feet, and the workings extend 435 feet west and 360 feet east of the shaft; the mill shaft, 670 feet further east, is 180 feet deep, and operations extend ninety feet west and seventy feet east, while the Crank shaft is but fifty feet deep, with no development. Jackpot mine. On the Jackpot mine, operations have attained 260 feet deep on the west shaft and 226 feet on the east shaft, to the east of which a prospecting pit, sunk seventy-five feet deep on the edge of a swamp, is the most easterly opening on the vein. Some developments were made on the Jackpot mine, last summer, by the Leipsigate Mining Company who contemplate resuming operations next spring.

Structure of vein. The western portion of the vein operated by the Micmac company has a general course of N. 57° E. magnetic, for the first 700 feet, and dips north at an angle of 70° to 60°, after which it divides into two branches: the Crank shaft vein running N. 53° E., and dipping north angle 70°, and the Jackpot vein curving gradually northward until it runs N. 21° E. to the edge of a swamp where it is concealed. As the strata strike N. 45° E., and dip south angle 45°, their intersections with the Micmac portion of the vein, as well as with the Crank shaft vein, pitch eastward at a low angle while with the Jackpot vein, they pitch westward.

As far as developments have gone in the Micmac mine, to the west of the main shaft, the pay-ore lies in a series of shoots or chimneys, at the intersections of the vein with certain strata, averaging twenty-five feet in height and several inches thick, pitching east at an angle of 7° and occurring at intervals of ten to twenty feet, much in the same manner as in the old German mine above referred to. But to the east of the main shaft the pay-ore occurs in irregular bodies with a tendency to pitch westward at about 75°, and probably coincides with the branching off of the main fissure, which occurs at the eastern end of the workings.

*Summary Report, Geol. Survey, Can., 1903, pp. 183-184.

The recurrence of the ore-shoots in regular and close succession and the uniformity of the ore values have thus been proved in actual practice at the Micmac mine to the depth of 500 feet and in systematic developments at the old "German" mine to a depth of 180 feet. Such favourable conditions are, perhaps, not met with in any other known fissure vein in the province, and they should encourage the companies to rapidly push their developments to greater depth and establish payable and permanent mines.

Permanency ore-shoots.

Good ore has been found also on the north branch of the fissure to a depth of 260 feet in the Jackpot mine and to 180 feet at the Mill shaft, in more or less regular shoots or patches, pitching west between 45° and 75°. These are probably formed by angling veins branching off from the main vein in an easterly direction.

The Crank shaft, fifty feet deep, proves the south branch of the fissure to be a strong vein, reaching seven feet in thickness, and showing metalliferous sulphides which should justify further developments. It is possible that this might be the most important branch of the fissure to the eastward, but the vein is unfortunately concealed by a swamp immediately east of the shaft, preventing surface examination in that direction.

It is important to draw attention to the fact that the fissure vein dips towards the anticlinal fold, and that, although it occurs over one half of a mile to the south of it, there is little doubt that it forms part of the system of fractures running up the axial plane of the fold through which the ascending mineralized solutions passed and were deposited at the most favourable places. This is another strong point in favour of the possibilities of deep mining in the fissure vein.

Important relation of fissure to anticline.

The production of the Micmac mine for the year 1904 was ;

	oz.	dwt.
From the ten-stamp mill 4,074 tons ore crushed.........	1,825	19
From the cyanide plant 3,044⅗ tons sands treated........	535	3
Total......................................	2,361	2

According to the returns received at the Department of Mines of Nova Scotia, the total production of Leipsigate district until January 1st, 1905, was :—27,702 tons crushed, for 9,454 oz. 8 dwt. 7 grains gold.

Values.

CLAM HARBOUR GOLD DISTRICT.

This new district is situated on the Atlantic coast, in Halifax county, forty-seven miles east of the city of Halifax, by the post road. A few days were spent in making a hurried survey of the district, and

Clam Harbour district.

a plan on the scale of 250 feet to one inch has since been compiled. It shows the general structure of the strata and gold bearing veins, and the probable zones of special enrichment along which prospecting should be prosecuted.

The strata have been folded into two anticlinal folds about 500 feet apart and into one intervening synclinal fold, running east and west, magnetic, slightly converging towards the west and pitching to the eastward.

A small fault runs at right angles to the folding and gives a right hand displacement of some ninety feet at the south anticline, decreasing to but a few feet at the north anticline.

The gold bearing quartz veins met with are of two kinds—the bedded veins or 'main leads,' following slate belts interlocked between heavy beds of quartzite or 'whin,' and the cross veins intersecting the strata, generally in a north-easterly and south-westerly direction.

Main leads.

The main leads are the most important and persistent veins. They appear to carry all the payable ore deposits.

The cross veins do not appear to contain gold in payable quantity, but their intersections with main leads often determine important ore-shoots, generally short horizontally, but probably of great extent and uniform values in depth. Thus the ore-shoots worked down to 122 feet at No. 1 shaft, just north of the engine house, and the shoot worked to sixty feet, east of the forge, are formed by the intersection of a cross-vein with main leads. This cross-vein is a good 'feeder,' and other pay-shoots may be looked for at its intersection with other main leads.

Saddle veins along three lines.

The most important fact brought out by the surface developments is, that all the main leads, so far opened up on the apex of the folds, have proved auriferous, and all the pay values discovered are confined to these lines. From this fact and from the knowledge gained in the study of similar districts in the province, we may safely conclude that the axes of the three folds form three well-defined and distinct zones of special enrichment. It is, then, most desirable that systematic developments be made along the apex of the three folds, and more especially the anticlines on the surface and in depth, which will undoubtedly open up a great number of ore-shoots, all pitching east and probably extending to great depths.

CYANIDE PROCESS FOR THE EXTRACTION OF GOLD.*

Progress has been made in saving the refractory portion of the gold contained in the tailings. Cyaniding.

It is now about four years since the first commercial cyanide plant was erected in the province, and, unfortunately, both that and the plant that succeeded it at Isaacs Harbour proved failures from a financial standpoint. Since that time, however, a plant with a capacity of about 50 tons per 24 hours, was erected by Mr. H. S. Badger, at the mine of the Micmac Mining company at Leipsigate, which has now been running profitably for some two years.

A duplicate of that plant, installed last summer, under the supervision of Mr. H. S. Badger, at Brookfield, also appears to be successful. Experiments have recently been conducted at the Boston-Richardson mine at Isaacs Harbour, with the object of installing there a plant, which, as the mill contains sixty stamps, will doubtless be larger in capacity than the two last named.

It is probable that many mines in the province could profitably erect small cyanide plants for the treatment of their tailings, which numerous assays, covering a number of years, have shown to be valuable.

DEEP GOLD MINING.

The following is an extract from Mr. D'Arcy Weatherbe's annual report on the gold mines of Nova Scotia, ending September 30, 1904.† D'Arcy Weatherbe's report.

"At the annual meeting of the Nova Scotia Mining Society last winter, the question of gold mining was very thoroughly gone into during discussion, and many valuable interchanges of opinion regarding important points in connection therewith were given.

"The Government, anticipating a special discussion on the question of *deep mining*, on which they had legislated during the previous session, employed Mr. Faribault of the Geological Survey, to make a special report on the subject, which was gone into very fully. One direct result of this discussion was the amendment of the above legislation, so that aid to a deep shaft would be given by the Government to the whole sinking, from the surface to a depth of 2000 feet, instead of requiring the miner to do the first 500 feet of work at his own expense, as provided by the first Act. This amendment brought

*Rep. Dept. of Mines, N.S., 1904, p. 54.
†Report Dept. of Mines, N.S., 1904, p. 47.

forth several bona-fide applications for the aid almost immediately. In some of the districts to which these applications applied, Mr. Faribault's services were again used in reporting on their suitability. The districts where this aid was asked include Isaacs Harbour, Malaga, Caribou and Sherbrooke.

"It should be particularly mentioned, that the past season has marked a stage in Nova Scotia gold mining not before reached, two mines having attained vertical depths of 1000 feet or over, and at both places, Brookfield and Caribou, (over 100 miles apart), was gold found, presumably, in paying quantities.

"Although the returns for the past season, and more noticeably for the present season, are smaller than usual, this does not necessarily show a falling off in the industry. In fact it might rather tend to prove the suggestion that the day of the small miner and tributor are rapidly drawing to a close, the rich and small leads and chimneys being to a large extent exhausted to the depth considered profitable by small scale work.

"During the winter one of the largest producing districts, Sherbrooke, was practically closed by being cut off from fuel-supply on account of navigation closing earlier than usual.

"On the other hand large scale operations, preparatory, it is hoped, to an output of gold, larger in an increasing proportion, are in progress at several districts, and in one or two practically new localities prospecting of an intelligent character is being done."

On the Meteorite which fell near the Village of Shelburne, township of Melancthon, Ontario, in August 1904.

By Mr. Robert A. A. Johnston.

Shelburne meteorite.

In accordance with instructions received on September 16, last to proceed to Shelburne in the county of Dufferin, Ontario, to investigate the reported fall of a meteorite near that place, I left Ottawa the same evening by C. P. R., arriving at Shelburne the following day, and proceeded to the office of Mr. R. L. Mortimer, editor and proprietor of the Shelburne Free Press, who at once volunteered all the information he had regarding the fall, and furnished me with a number of newspaper notices concerning it: he further generously offered to accompany me to the scene of the fall, an offer I readily accepted. For these and many other courtesies extended to me by this gentleman during my visit, I here record my grateful thanks. Pursuant to arrangement, I proceeded with Mr. Mortimer to the home of Mr. John Shields, east half of lot 8, concession 2, township of Melancthon.

Shield's statement.

Mr. Shields said that at about eight o'clock in the evening of Saturday, August 13, while he and several of his family, along with some friends, were engaged in conversation in his dining-room, they were suddenly disturbed by a heavy crashing noise such as would be occasioned by the collapse of a building ; this was immediately followed by a dull concussion like that of a heavy solid body striking the ground. An examination of the premises was immediately made to ascertain the cause of the disturbance, and it was noticed that the east end of the north wall of the house and the underside of the adjacent veranda roof were bespattered with mud, while the floor of the veranda was strewn with moist earth : further search resulted in the finding of a small excavation in the soil about two feet from the veranda with a small heap of fresh earth piled up between the excavation and the veranda. Some hours after, the loose earth, which partially filled the excavation, was removed, and at a depth of eighteen inches, Mr. Shields came upon the rock fragment which forms the subject of the first portion of this notice. When this fragment was removed, it was found that a partly charred bur *(Arctium)* had been buried beneath it, while a few charred leaves were picked up around the excavation. At the time of my visit, the excavation in the soil, as well as the mud-marks on the wall and veranda, were, for all practical purposes, in the same condition as at the time of the occurrences which have just been related, so that I was enabled to to take accurate notes regarding the effects produced by the fall. The excavation had a diameter of about twelve inches and, as stated before, a depth of approximately eighteen inches ; the sides of the excavation did not vary sensibly from the perpendicular, showing that the stone must have approached the surface of the earth at a very high angle. The major portion of the soil which had been displaced, formed a small heap to the south-east, or between the excavation and the veranda ; the remainder had been thrown beyond this in the same direction, much of it on the veranda floor and some of it over the wall of the house and the underside of the veranda roof. The mud-markings on the wall were confined to a well-defined section, about four feet across, at a distance of eight feet from the excavation ; the veranda roof, at the line where it comes in contact with the wall of the house, has a vertical height of about twelve feet from the ground, and, at this point, the markings were most abundant ; they were gener-

Shield's specimen.

ally from three to four inches across, indicating to what a comparatively slight extent the soil had been desintegrated. The fragment was found to weigh twelve pounds and a half (5·7 kilos); it is in the form of an irregular, angular block measuring 9x4x3½ inches and is marked by the pittings and corrugations characteristic of a large number of meteoritic bodies; exteriorly, it is coated with a smooth varnish-like glaze which, for the most part, is slightly lustrous and of a velvet-black colour; on one side of the specimen, however, the glaze has a brownish colour and is so thin that the texture of the underlying material is but faintly hidden beneath it; this side of the specimen does not appear to have been subjected to the friction of the atmosphere during as protracted a period as has the rest of the surface of the mass, and suggests that the fragment under discussion is a detached portion of a still larger mass, the separation having taken place at a comparatively low level of the earth's atmosphere. The glaze is furrowed in places by small cracks resulting, no doubt, from the sudden cooling of the surface after its first contact with the earth.

Texture.

A small piece had broken off one corner of the stone, and the surface thus exposed afforded the only available means of examining the real texture of the materials composing the mass. It has a chondritic structure, and mainly consists of a rather friable, moderately fine-grained, dark greenish gray silicate which is probably olivine; this is seen to inclose what looks like veinules of a bronze-yellow, rather brittle mineral having a metallic lustre and one well-marked cleavage; this mineral is probably meteoric pyrrhotite or troilite. No further detailed examination of the stone could be made as Mr. Shields was averse to having the specimen further desintegrated and was likewise disinclined to dispose of it either in whole or in part.

T. Johnston's statement.

From Mr. Shields' place I proceeded to the farm of Mr. Thomas Johnston, west half of lot 10, concession 2, of the township of Melancton, where, it was reported, a second meteorite had been found. Mr Mr. George Johnston, who was one of the actual observers of the phenomena attending the descent of the meteorite on the evening previously mentioned, was of the opinion that some peculiar object had fallen in the oatfield to the south of his house; not caring, however, to destroy any of his crop, Mr. Johnston deferred making any search until the grain was being harvested, on August 30, when he instituted a sharp watch from his seat on the binder for any unusual conditions of the soil. He was rewarded by finding, near the foot of a low crescent-shaped elevation, a small excavation rather more than a foot across, with a small heap of earth piled up alongside. He at once called Mr. William Fleming, who was working in another portion of the field, who examined the spot with the result that a meteorite weighing twenty-eight pounds was found at a depth of about two feet from the surface. The sides of the hole were, to all appearance, perpendicular, but, as in the case of the "Shields" occurrence, the earth was thrown toward the south-east, showing conclusively that the bodies under discussion approached the surface of the earth from a north-westerly direction. A few days previous to my visit, Mr. Johnston had disposed of this specimen, for $200, to Mr. J. F. Gardner, a district superintendent of the Bell Telephone Company.

The remainder of the afternoon, until train-time, was spent in collecting whatever information was obtainable regarding the circumstances of the fall and then I returned to Toronto whither, I was given to understand, the "Johnston" specimen had been sent. I found, however, that M. Gardner was away from home and it was only after much difficulty and repeated inquiries that I was enabled, through the courtesy of an officer of the Bell Telephone Company, to obtain a view of the specimen and to make some notes regarding its size and appearance. It is, roughly speaking, a ploughshare-shaped mass measuring $11\frac{1}{2}$ x 9 x $6\frac{1}{2}$ inches and is enveloped in a black varnish-like coating of the same character as that observed in the "Shields" specimen; some portions of its surface are marked by the usual depressions and corrugations. Particular attention was paid to the possibility of there being a surface which might accord with the evidently newer surface observed on the "Shields" specimen, but in this respect I was unsuccessful; it might, however, be possible to correlate the two specimens in this respect, could they be examined side by side. Mr. Gardner has since sold this specimen for two hundred and seventy six dollars to Dr. Leon H. Borgstrom whose intention it is, I believe, to add this meteorite to the collection of the University of Helsingfors, Finland. A cast of this specimen, obtained from Dr. Borgstrom, has been placed in the museum of the Geological Survey Department.

Johnston specimen.

The "Shields" and "Johnston" specimens both belong to the class of meteorites known, under the British Museum system of classification, as the aerolites or meteorites, which consist, principally, of stony matter: until such time as they have been subjected to critical examination, this is as much as can definitely be stated regarding their character.

The impressions created in the minds of different persons who observed any of the phenomena attending the fall bear a very close relation, varying only in the details such as might be expected from differences of direction or distance from the occurrence. In the neighbourhood of the village of Shelburne, two distinct detonations were heard, described by some as resembling the firing of heavy ordnance in the distance, by others as loud drum-beats; these were followed by a series of musical vibrations lasting several seconds.

Phenomena.

Mrs. Craven, who witnessed the fall from the front door of her residence in Shelburne, says that previous to the detonations she observed the object shooting through the air at a rapid rate, emitting sparks in its path and followed by a tail like that of a comet. At the time of the fall—about half an hour after sunset—the northern sky is described as being of a fiery-red colour while that to the westward was hidden by a dense black cloud. At the village of Tara, which lies about fifty miles in an almost direct north-west line from Shelburne, in the county of Bruce, the meteor was observed passing in a south-easterly direction almost directly overhead, and it was thought by some that it had fallen close at hand; indeed, it was even reported that a fragment had been picked up near there, but of this I have been unable to obtain any authentic confirmation, and it is doubtful whether any specimens of the fall have been found there. At Kincardine, about seventy miles a little to the north-west of Shelburne, it was seen as a brilliant object traversing the sky, leaving a shower of sparks behind. As seen from different points in the Muskoka lake country, the flight of this body afforded a magnificent spectacle. Mrs. R. R. Bongard of Toronto, who was at the time particularly well situated for observing the fall from an island near the middle of Lake Joseph—approximately eighty miles in a north-easterly direction from Shelburne—says that it was of surpassing brilliancy and a bright yellow colour. By some, it was thought to have fallen near-by; the observed time and direction, however, leave no doubt as to its identity with the Shelburne fall.

Descriptions of a number of Canadian meteorites are to be found in different scientific journals but in addition to these and the two specimens noted above, a number of others (concerning which there is no available literature) are in the hands of private individuals.

A small amount of information has been collected, chiefly from private individuals, regarding observed phenomena which it is difficult to account for in any other way than by the fall of meteoric bodies. It has been found impracticable to make a satisfactory compilation of this information in time for the present report, but as soon as all the material can be collected for the purpose, a separate report, dealing with Canadian meteorites in general, will be issued.

Chemistry and Mineralogy.

By Dr. G. C. Hoffmann.

Reporting on the work done in these branches of the Survey's operations, Dr. Hoffmann says :—

'Conformably with the practice of former years, the work carried out in the chemical laboratory during the past year has been of a purely technical character, that is to say, it has been almost exclusively confined to the examination and analysis of such ores and minerals, etc., etc., as were considered likely to prove of more or less economic value and importance. Succintly stated, it embraced :—

Fossil Fuel.

'1. Analyses of several varieties of fossil fuel from various parts of the Dominion, namely of—Lignite, from certain seams not far from La Roche Percée, on the Souris river and from the vicinity of Halbrite, in the district of Assiniboia; from a seam on Knee Hillcreek, Red Deer river, in the district of Alberta, North-west Territory; from a seam on Coal creek, a tributary of the Yukon, Yukon territory nd from a seam in the vicinity of Enderby, Yale district, in the province of British Columbia. Of lignitic coal, from a seam on the Souris river, in the vicinity of La Roche Percée, in the district of Assiniboia, and from a seam on a branch of Ruby creek—a tributary of Indian river, Yukon Territory. Of coal, from Debert river, Colchester county, and from the land of A. McLean, between McLelland brook and Vale colliery, Pictou county, in the province of Nova Scotia; from the Bailey and C. W. Wetmore lot, two miles north-westerly of Flowers cove, Grand lake, Queens county, in the province of New Brunswick; from a seam on the north side of the North Fork of the Old Man river, in the district of Alberta, as likewise from a seam not far from Morley, also in the district of Alberta; and from Miller's workings on the Lewes river, Yukon Territory. Of anthracitic coal, from the fourth seam at the Canmore mine, and from number one seam of the Canmore mine, also from a seam in the mountain on the east branch of Kananaskis river, and from a seam on Sheep creek, in the district of Alberta, North-west Territory. Of semi-anthracite, from the Canadian Pacific Railway tunnels, Cascade mountain, and from the south branch of Sheep creek, in the district of Alberta, North-west Territory.

Copper ore.

'2. Analyses, partial, of samples of copper-ore from, among other localities,—La Tête, county of Charlotte, in the province of New

Brunswick; from Oxford township, Sherbrooke county, in the province of Quebec; from mining location No. 2,961, R. 455, in the district of Thunder bay, and from the township of Spragge, district of Algoma, in the province of Ontario.

Iron ore.

'3. Analyses, more or less complete, of several varieties of iron-ore namely of—A clay iron-stone from Collins gulch, Tulameen river district of Yale, province of British Columbia. Hematite, from a point about half a mile south of Grand Pré railway station, Kings county, in the province of New Brunswick, and from the Rocky mountains, south of Blairmore, in the district of Alberta, North-west Territory. Magnetite, from the twenty-seventh lot of the fourth concession of the township of North Crosby, Lanark county, in the province of Ontario; from the eastern slope of the Rocky mountains, near Pincher creek, in the district of Alberta, North-west Territory; and from a locality not far from Enderby, district of Yale, in the province of British Columbia.

Nickel and cobalt.

'4. Analyses, in regard to nickel and cobalt content, of numerous samples of arsenopyrite, pyrrhotite, pyrite, etc., of which among the many, may be mentioned—arsenopyrite from a vein not far from Hope, in the district of Yale, province of British Columbia. Pyrrohotite, from the west half of the tenth lot of the fourth concession of the township of Olden, Frontenac county, in the province of Ontario, and from near Ingall station on the line of the Canadian Pacific Railway, about thirty miles west of Keenora, (formerly Rat Portage) in the district of Rainy river, Ontario.

Limestones.

'5. Analyses of limestones (in continuation of the series of analyses of such stones already carried out, in connection with an inquiry into their individual merits for structural purposes, for the manufacture of lime, or of hydraulic cement, or for metallurgical purposes, etc.), including,—limestone, from three miles east of Brookfield station on the line of the Intercolonial Railway, Colchester county, province of Nova Scotia; from the fifth lot of the fourth range, and from the eighth lot of the fourth range, of the township of Grenville, Argenteuil county; from the immediate vicinity of Phillipsburg, in the township of St. Armand, Missisquoi county, and from the thirteenth lot of the first range of the township of Litchfield, Pontiac county, in the province of Quebec; from Marble cove, on the north-east shore of Texada island, strait of Georgia, province of British Columbia. Of the foregoing limestones, that from the vicinity of Brookfield affords, when burnt, an excellent lime; that from the immediate vicinity of Phillipsburg, takes a good polish and is well fitted for purposes of decoration, and when burnt it affords a very white and pure lime; that from the township of Litchfield is now extensively employed for the manufacture of lime; and that from Marble cove, where it occurs in almost unlimited quantity, is useful for ordinary purposes of construction, and taking a good polish is also well adapted for use as a marble; it likewise affords an excellent material for the manufacture of lime.

'6. The examination of samples of clay, from a very great number of localities, in regard to their suitability for the manufacture of bricks, ordinary building bricks or fire-bricks, tiles, sewer-pipes, terra-cotta, stone-ware, etc., some of the localities being—The vicinity of Baddeck, Victoria county, province of Nova Scotia; Dutch Valley road, Upper corner, Sussex, in the province of New Brunswick; from a boring two miles east of 'The Brook' village, township of Clarence, Russell county, and from the farm of M. F. Boyd, north of the town of St. Mary's, on the Stratford and St. Mary's road, Perth county, in the province of Ontario; from a deposit occurring on section 1 or 2, or both, of township 24, range 1, west of the 5th initial meridian, district of Alberta, North-west Territory; and from the vicinity of Enderby, Yale district, in the provinoe of British Columbia; et cetera. Clays.

'7. Analyses of natural waters—with the object of ascertaining their suitability for economic or technical purposes, or possible value from a medicinal point of view, from, among others, the following localities—a spring at Brook village, about seven miles south-east of the town of Mabou, Inverness county, and from a well in Granville centre, Annapolis county, in the province of Nova Scotia; from an artesian well on the east end of cadastral lot No. 52, in the first concession of the parish of St. Johns, seigniory of Longueil, St. Johns county, and from a boring on the east part of the Richelieu river on lot 86, first concession, in the parish of St. Athanase, seigniory of Bleury, Iberville county, in the province of Quebec; from the 'How' spring, on the fifteenth lot of concession B of the township of Fitzroy, Carleton county, and from an artesian well in Courtright, on the eighth lot of Front street, or Front concession, township of Moore, Lambton county, in the province of Ontario; from the workings of the coal mine at Hant, in the district of Alberta, North-west Territory; and from a hot spring near the city of Vancouver, district of New Westminster, in the province of British Columbia. Natural waters.

'8. Miscellaneous examinations, such as the examination and, in most instances, partial analysis of samples of—Argillaceous shale; pyroschists; graphitic schists; carbonaceous shale; bog-manganese: iron-ochres; marls; silts, &c. Miscellaneous.

Yukon gold.

'Some very noteworthy observations have been made, in the course of examining material obtained by Mr. Keele, from the riffles of sluice-boxes, in the course of placer gold-mining on Highet creek, a remote tributary of the Stewart, and at Dublin gulch, on Haggart creek, a tributary of the McQuesten, which also flows into the Stewart, Yukon Territory. The material from the first mentioned locality was found to contain small irregular-shaped fragments of native bismuth with, in some instances, a little attached native gold, and small water worn nodules of an association of scheelite (calcium tungstate) with a little quartz; whilst that from Dublin gulch consisted very largely of more or less rounded grains of scheelite with a few intermixed particles of quartz and of hematite and a little native gold. Again, in a sample of gold-washings from the Lippy claim, Eldorado creek, in the Yukon district, which was sent for examination, aggregations of native gold with embedded particles of native lead were found. Scheelite, it may be observed, is a not unimportant source of tungsten, a metal employed in the manufacture of what is known as tungsten steel, its presence much increasing the hardness and tenacity of steel and otherwise generally improving its properties. As a result, this mineral is, when found in any quantity, of considerable commercial value. Until quite recently it had been met with, and that only in small, or comparatively small, quantities, at but two localities in Canada, one in the province of Quebec and the other in that of Nova Scotia, but since then it has been found, and that, it is said, in some quantity, at the Meteor mine, Springer creek, in the West Kootenay district, and on Hardscrabble creek, Cariboo district, in the province of British Columbia, specimens from both localities having been received by the writer for identification.

Tungsten.

Statistics.

'The number of mineral specimens received during the period covered by this report for identification or the obtaining of information in regard to their economic value, amounted to six hundred and one. Of these, a large number were brought by visitors, to whom the desired information was communicated at the time of their calling, or failing that—owing to a more than mere cursory examination being necessary or when a partial or even complete analysis was considered desirable—it was subsequently conveyed to them by letter, whilst that sought for in regard to those sent from a distance was also, necessarily, communicated by mail.

'The number of letters personally written, in connection with the work just referred to, and which were mostly of the nature of reports embodying the results of the examination or analysis, as the case might be, amounted to three hundred and four, whilst the number of those received amounted to one hundred and six.

I have been very ably assisted by Mr. F. G. Wait in the general work of the laboratory. His close application to the same has enabled him to carry out a number of water analyses, several analyses of limestones and dolomites, some more or less partial analyses of iron ores, copper ores and manganese ores; also many determinations of nickel in various minerals, and, in addition, a great variety of miscellaneous examinations.

The additions to the mineralogical and lithological section of the Museum during the past year embraced:—

A.—Duplicates of specimens which were sent to the laboratory for examination.

Indurated clay, from the property of T. H. Patrick, Souris river, section 10, township 7, range 20, west of the principal meridian, province of Manitoba. Specimens examined.

Anthracitic coal, from seam No. 4, north-west quarter of section 29, township 24, range 10, west of the fifth initial meridian, district of Alberta, North-west Territory.

Graphitic shale, from Victoria county, province of Nova Scotia.

Coal, from a seam on the North Forks of the Old Man river, section 35, township 10, range 3, west of the fifth initial meridian, district of Alberta, North-west Territory.

Hematite, from the property of Mr. Patrick Flynn, lot 23 B., range 6, of the township of Templeton, Ottawa county, province of Quebec.

Magnetite, from lot 27, concession 4, of the township of North Crosby, Lanark county, province of Ontario.

Lignites, from Knee Hill creek, a tributary of the Red Deer, district of Alberta, North-west Territory.

Clay from Okanagan Landing, Yale district, province of British Columbia.

B.—Collected by Members of the Staff Engaged in Field-work in Connection with the Survey.

Ami, Dr. H. M:—

Paving blocks of Nepean sandstone, Bishop's quarries, Carleton county, province of Ontario.

Barlow. Dr. A. E. :—

A large mass of nickel ore, consisting of niccolite through which is distributed a small quantity of native silver, a very little smaltite, and a small quantity of gangue, in part stained and coated with annabergite. From the vicinity of Haileybury, district of Nipissing, province of Ontario.

Brock, Prof. R. W. :—

(a) Arsenopyrite, holding some free gold, in a gangue of quartz. From the Lucky Jack claim, Poplar creek, West Kootenay district, province of British Columbia.

(b) An association of quartz with some talcose schist, carrying a small quantity of sphalerite, very small quantities of tetrahedrite, chalcopyrite, pyrite and galena, and a very little native silver. From the Spyglass claim, Poplar creek, West Kootenay district, province of British Columbia.

(c) Quartz carrying somewhat small quantities of galena and tetrahedrite, a small quantity of sphalerite, and a very little pyrite. From the Lucky Boy mine, Tour creek, West Kootenay district, province of British Columbia.

(d) An association of tetrahedrite and galena with a small quantity of pyrite, through which is distributed a little gangue. From the Silver Cup mine, South fork of Lardeau creek, West Kootenay district, province of British Columbia.

(*e.*) An association of sphalerite with very small quantities of galena, pyrite and chalcopyrite. From the Mother Lode claim, Poplar creek, West Kootenay district, province of British Columbia.

(*f.*) A cavernous, rust-stained quartz, carrying very small quantities of pyrite and chalcopyrite and a little free gold. From the Eva mine, Lexington mountain, half a mile north of the town of Camborne, West Kootenay district, province of British Columbia.

(*g.*) An association of arsenopyrite and pyrite in a gangue composed of quartz with a little feldspar. From the Hardy group, Lardeau river, West Kootenay district, province of British Columbia.

(*h.*) Fine masses of a yellowish-white, greenish-yellow and yellowish-green, subtranslucent to translucent, calcite having a fine-columnar, radiated and concentric structure. From the

Black Prince claim, Gainer creek, a tributary of the south fork of Lardeau creek, Trout lake, West Kootenay district, province of British Columbia.

Dowling, D. B., B.A. Sc.:—

(*a.*) Semi-anthracite, from C. P. R. tunnels, Cascade mountain, section 19, township 26, range 11 west of the 5th initial meridian, district of Alberta, North-west Territory.

(*b.*) Anthracitic coal, from pinch out north-west of slope, bottom of No. 1 seam, at the Canmore mine, section 29, township 24, range 10 west of the 5th initial meridian, district of Alberta, North-west Territory.

(*c.*) Anthracitic coal, from a vertical seam high up the mountain, on the east branch of Kananaskis river, a tributary of the Bow, five miles below the head of Elbow river, section 33, township 19, range 8 west of the 5th initial meridian, district of Alberta, North-west Territory.

(*d.*) Semi-anthracite, from the Costigan seam, forks of Panther river, section 33, township 30, range 11 west of the fifth initial meridian, district of Alberta, North-west Territory.

(*e.*) Anthracitic coal, from the five foot seven inch Costigan seam, Panther river, post B, section 1, township 31, range 12 west of the fifth initial meridian, district of Alberta, North-west Territory.

(*f.*) Anthracitic coal, from lower seam, three feet six inches thick, Panther river, post B, section, township, range, &c., same as given under "*e.*"

(*g.*) Anthracitic coal, from three foot six inch seam, Panther river, post D, section, township, range, &c., same as given under "*e.*"

(*h.*) Semi-anthracite, from the two foot seam, section 8, township 30, range 12 west of the 5th initial meridian, district of Alberta, North-west Territory.

(*i.*) Semi-anthracite, from the five foot seam, Panther river, post D, section, township, range, &c., same as given under "*h.*"

(*j.*) Coal, from a five foot seam, head of Snow creek, between Panther and Red Deer rivers, district of Alberta, North-west Territory.

Ells, Dr. R. W.:—

(*a.*) Coal, from tunnel on lower seam at Coal Gully, Yale district, province of British Columbia.

(*b.*) Coal, from lot 1267, on creek running into Quilchena creek, Yale district, province of British Columbia.

(*c.*) Coal, from southerly outcrop of seam on Coldwater river, Yale district, province of British Columbia.

Faribault, E. R., B.A.:—

(*a.*) An association of quartz with some chloritic schist, carrying small quantities of pyrrhotite, pyrite, sphalerite, galena and arsenopyrite and some native gold. From the property of the Plough Lead Mining Co., Wine Harbour, Guysborough Co., province of Nova Scotia.

(*b.*) An intimate association of hydrated peroxides of iron and manganese—so-called Van Dyke paint or "Umber"—from what is known as the Paint mine, Chester Basin, Lunenburg Co., province of Nova Scotia.

(*c.*) A slightly ferruginous and manganiferous dolomitic limestone, from the so-called Paint mine, Chester Basin, Lunenburg Co., province of Nova Scotia.

(*d.*) An association of quartz, feldspar and mica, with a little scapolite and trifling quantities of fluorite and of chlorite, and small quantities of molybdenite. From vein in granite, right bank of Larder river, one mile south of Old Dalhousie road, New Ross, Lunenburg county, province of Nova Scotia.

(*e.*) An association of quartz, feldspar and mica, with small quantities of calcite and fluorite, holding a little molybdenite and sphalerite, and some particles of chalcopyrite and pyrite. From vein in granite on Caraway island, in Lake Ramsay, Lunenburg county, province of Nova Scotia.

(*f.*) An association of quartz with some chloritic schist, carrying small quantities of chalcopyrite and pyrite, somewhat less of galena, a little sphalerite, and very small quantities of native gold. From the Borden Lead, West Lake mine, Mount Uniacke Hants county, province of Nova Scotia.

(*g.*) Crystals of smoky quartz and mica, from a vein in granite, at top of hill just west of Joe Bill brook, one mile west of Sefferensville P.O., Lunenburg county, Nova Scotia.

(*h.*) An association of quartz with a little chloritic schist, and a very small quantity of calcite, carrying a somewhat large quantity of mispickel, a small quantity of galena, a little chalcopyrite, and a very small quantity of sphalerite and of pyrrhotite. From the Baltimore-Nova Scotia Mining Company's Caribou mines, Halifax county, province of Nova Scotia.

(i.) Limonite, from prospecting pit on vein in granite, two miles north-east of north end of Wallaback lake, New Ross, Lunenburg county, province of Nova Scotia. From surface.

(j.) An association of specular iron and manganite, from prospecting pit referred to under *(i.)* From a depth of six feet.

(k.) A crystal of almandite, from head of Sherbrooke lake, Lunenburg county, province of Nova Scotia.

Johnston, R. A. A. :—

(a.) Copper, native, two large masses of, from the Sovereign claim in Aspen Grove camp, at the head of Otter creek, Yale district, province of British Columbia.

(b.) Chalcedony, three large masses and two smaller fragments of, from the Maggie claim in Aspen Grove camp, at the head of Otter creek, Yale district, province of British Columbia.

(c.) Idocrase, from Charley's Cove, north-west side of Frye's island, Charlotte county, province of New Brunswick.

Keele, Joseph, B. A. Sc. :—

(a.) Gold, native, filiform and nuggety, from Highet creek, a remote tributary of the Stewart, Yukon Territory.

(b.) Concentrates, obtained in the course of placer gold-mining on Highet creek, a remote tributary of Stewart river, Yukon Territory.

(c.) Concentrates, obtained in the course of placer gold mining on Duncan creek, Yukon Territory.

(d.) Concentrates, obtained in the course of placer gold mining at Dublin gulch, on Haggart creek, a tributary of the McQuesten, Yukon Territory.

McConnell, R. G., B.A.:—

(*a.*) Lignitic coal, from a seam on a branch of Ruby creek, a tributary of Indian river, about seven miles up from its mouth, Yukon district, North-west Territory.

(*b.*) Lignite, from a seam on Coal creek, a tributary of the Yukon, eleven miles and three-quarters up from its mouth, Yukon Territory.

(*c.*) Coal, from Miller's workings on the Lewes, about twenty miles above Five-Finger rapids, Yukon Territory.

McKinnon, A. T.:—

Hematite, from about half a mile south of Grand Pré railway station, Kings county, province of Nova Scotia.

Willimott, C. W.:—

(*a.*) Asbestus (fibrous serpentine, chrysotile), from Johnson's mine, on the twenty-seventh lot of the sixth range of the township of Thetford, Megantic Co., province of Quebec.

(*b.*) Idem, dressed.

(*Received as presentations.*)

Archibald, Sheriff, and Jas. A. Crease, per E. R. Faribault, B.A. Sc. (Survey), a sample of ore from the Borden lead, West Lake mine, Mount Uniacke, Hants Co., province of Nova Scotia.

Deville, E., Surveyor General, Ottawa:—

(*a.*) Gypsum, var. alabaster, from the south-east quarter of section 14, township 33, range 8 west of the first meridian, province of Manitoba.

(*b.*) Gypsum, var. selenite, from the south-west quarter of section 4, township 33, range 8 west of the 1st meridian, province of Manitoba.

(*c.*) Gypsum, white, fine-granular, massive, from the south-west quarter of section 23, township 33, range 8 west of the first meridian, province of Manitoba.

(*d.*) Gypsum, brownish-white, somewhat fine-granular, massive, from the north-east quarter of section 3, township 33, range 8 west of the 1st meridian, province of Manitoba.

(*e.*) Limestone, very fine-granular, almost compact, from the Narrows of Lake Manitoba, province of Manitoba.

(*f.*) Selenite, from the mud banks on the Simonette river where it is crossed by the sixth meridian, district of Alberta, North-west Territory.

Lonergan, Daniel, per E. R. Faribault (Survey):—

Almandite, crystal of, from head of Sherbrooke lake, Lunenburg Co., province of Nova Scotia.

Lordley, Capt., Chester, Lunenburg Co., Nova Scotia:—

Infusorial earth, from Sabody pond, east side of Middle river, two miles above the bridge, Chester, Lunenburg Co., province of Nova Scotia.

Mitchell, W. D., New Denver, B.C.:—

(*a.*) Galena, from the Queen Bess mine, Silver mountain, West Kootenay district, B.C.

(*b.*) Galena and tetrahedrite, association of, in a quartzose gangue, from a claim on Goat mountain, West Kootenay district, B.C.

(*c.*) Galena, from the Idaho mine, West Kootenay district, B.C.

(*d.*) Galena and tetrahedrite, in a gangue of quartz, from the Sligo vein, Capella group, Goat mountain, West Kootenay district, B.C.

(*e.*) Tetrahedrite, pyrite and a little sphalerite, in a gangue of quartz, from the Kintora claim, Mollie Hughes group, West Kootenay district, B.C.

(*f.*) Galena, from a claim on Blind Springs hill, Blind Springs mining district, Mono Co., Cal., U.S.A.

(*g.*) Bournonite, from same claim as specimen "*f.*"

(*h.*) Silver, native, in a quartzo-feldspathic gangue, from the same claim as the two preceding specimens; and the following from the Bosun mine, near New Denver, West Kootenay district, B.C.:

(*i.*) Galena, fine-granular, almost compact, massive.

(*j.*) Galena, very fine-crystalline, massive.

(*k.*) Galena, fine-granular, massive, with which is associated a little sphalerite, chalcopyrite and a trifling quantity of ruby-silver.

(*l.*) Sphalerite, with a little disseminated pyrite.

(*m.*) Galena, cleavable, somewhat coarse-crystalline.

(*n.*) Galena, very fine-granular, massive, locally known as "steel ore."

(*o.*) Pyrite, an association of, with sphalerite.

(*p.*) Galena, very fine-crystalline, almost compact, locally known as "wavy galena."

(*q.*) Galena, very fine-crystalline-massive, through which is distributed a little chalcopyrite.

Nattress, Rev, Thomas, B.A., Amherstburg, Ontario, per J. F. Whiteaves (survey):—

The following, obtained in the course of excavating the bed of the Detroit river at Amherstburg, Essex county, Ontario:—

(*a.*) Celestite, large, isolated, more or less perfect, tabular crystals of—two specimens.

(*b.*) Celestite, bluish, crystal aggregates—nine specimens.

(*c.*) Calcite, var. dog-tooth spar, of a yellowish-brown colour—four specimens.

(*d.*) Dolomite, with inclusions of bituminous matter.

(*e.*) Quartzite, white, compact, with some attached celesite.

Smith, F. B., inspector of mines, Calgary, N.W.T. :—

Iron rail, part of, from workings of the coal mine at Harts, Alberta, N.W.T., illustrating the action of the mine water on same.

Soues, F., gold commissioner, Clinton, B.C. :—

(*a.*) Agate-jasper, from Big Bar, on the Fraser river, Lillooet district, province of British Columbia.

(*b.*) Scheelite, from Hardscrabble creek, Cariboo district, province of British Columbia.

Spencer, Dr. D., Ottawa, Canada :—

Peat briquettes, from the Newington peat works, township of Osnabruck, Stormont county, Ontario.

Thomlinson, William, mining agent, New Denver, B.C. :—

Scheelite, from the Meteor mine, Springer creek, West Kootenay district, province of British Columbia.

Mineral educational collections.

Mr. C. W. Wilimott was engaged during the early part of the year in carrying out a lengthy series of experiments with ochres, clays and certain other minerals, with a view of demonstrating their utility as mineral paints. This accomplished, his time was mainly occupied in making up collections of minerals and rocks for distribution to various Canadian educational institutions. The following is a list of those to which such collections have been sent :—

		Specimens.
Collegiate Institute, Galt, Ont.,	consisting of	26
Toronto University, Toronto, Ont.	"	20
Collegiate Institute, Ingersoll, Ont.	"	100
High school, Petrolia, Ont.	"	100
Convent school, Sydney Mines, N.S.	"	75
Aberdeen school, St. John, N.B.	"	75
Convent, Whitney Pier, Sydney, N.S.	"	75
High school, Campbellford, Ont.	"	100
Huron Institute, Collingwood, Ont.	"	100
High school, Sydenham, Ont.	"	100
Col. Inst., Harbord street, Toronto, Ont.	"	100
High school, Keenora, Ont.	"	100
Central school, Chatham, Ont.	"	75
Lachine academy, Lachine, Que.	"	100
McDonald school, Middleton, N.S.	"	75

Collections has also been supplied to :—

Rev. J. D. Borthwick, Montreal, Q., consisting of	....	37
A. C. Bell, M.P., New Glasgow, N.S.	"	52
C. F. Speipper, Trout lake, B.C.	"	45
Can. Commercial agent, Paris, France	"	62
Le Figaro, Paris. France	"	75
Chronicle Reference Library, Halifax, N.S.	"	75
Total number of specimens		1,567

He has also, at intervals, visited, for the purpose of procuring further material for the making up of such collections, the townships of Hull, Wakefield, Buckingham, Villeneuve and Egan, in Ottawa county, province of Quebec, of Ross and Bromley in Renfrew county, that of Bancroft in Hastings county, and those of Calvin and Cameron in the district of Nipissing, in the province of Ontario.

'While so engaged, he collected :—

Serpentine limestone	some	200 lbs.
Jasper	"	150 "
Albite	"	200 "
Microcline	"	200 "
Quartz	"	100 "
Fluorite, in calcite	"	100 "
Amazon stone	"	400 "
Limestone	"	150 "
Molybdenite, in the gangue	"	250 "
Molybdenite, pure	"	35 "
Shellmarl	"	100 "
Serpentine	"	50 "

'The results of Mr. Willimott's experiments in connection with mineral pigments—above referred to, have been incorporated by him, together with some observations on mineral occurrences, which he made while engaged in collecting minerals, in a separate report—see, page 229.

Mapping and Engraving.

Mr. C. O. Senécal, Geographer and Chief Draughtsman.

Mr. C. O. Senécal, reports as follows :—

"I have the honour to present, herewith, a summary of the work accomplished under my supervision during the past calendar year :—

Mr. L. N. Richard prepared the colour copy of the Haliburton sheet for the lithographer and part of the engraver's copy of a geological map of the island of Montreal and vicinity. He has also drawn a map of the southern part of the province of Quebec for photolithographic reproduction. He made reductions of astronomical observations, various computations, and tested field instruments, etc. Assignment of work.

Mr. Richard was on sick leave from April 2 to June 27. From August 18 to the end of September he was on field duty and spent the remainder of the year in plotting his surveys.

Mr. J. A. Robert spent the greater part of his time on the compilation of Mr. H. Fletcher's map of Nova Scotia, covering sheets Nos. 64, 65, 66, 73, 74, 75, 83 and 84. He traced, for engraving, sheets Nos. 65 and 74; prepared the colour copy of six Cumberland county sheets, and attended to the revision and correction of Nova Scotia map proofs. He was also on field duty from August 20 to end of September, and has since been occupied in calculations of latitude and departure.

Mr. O. E. Prud'homme compiled the map of Southern Quebec; made additions to the eastern sheet of the Dominion Map and to the Lake Nipigon sheets Nos. 11 and 17 of the Northern Ontario series, from recent surveys. He prepared the colour copy for the geological and topographical editions of the Klondike map; the relief copy in crayon-shading of the map of Boundary Creek mining district, B. C., and copies for photolithographic reproduction of the Winisk river map; of a sketch map of the Lardeau mining district, B. C.; of a sketch map showing Cretaceous rocks of Alberta district, and of a geological section of Doliver mine, N.S. He also lettered the Perth sheet (No. 119, Ont.) and the map of Lake Temagami iron ranges.

Mr. V. Perrin compiled the Winisk river map, and completed the Ignace sheet, No. 5, North-western Ontario series. He has in hand the compilation of Mr. McInnes' recent surveys of the Headwaters of Winisk river.

Mr. James McGee was, on January 12th, appointed general assistant and type-writer. It is with regret that I have to report his premature death which occured on May 12th, from injuries he had sustained in an accident. He was replaced by his brother Mr. J. J. McGee, jr., who reported himself for duty on 1st of June. Mr. McGee was on field work from August 20th to the end of October.

Mr F. O'Farrell was appointed as draughtsman on October 24th and was instructed to assist Mr. E. R. Faribault in the compilation of this officer's surveys of Halifax and Hants counties, Nova Scotia.

Mr. P. Frèreault traced, for engraving, the Ottawa and Cornwall geological sheet, Ontario series; the map of Elsie and Murray mines, Sudbury mining district, Ont. and additions to map of Boundary Creek mining district, B. C. He also prepared, for photolithography, a map of North-western Ontario; a sketch map of the vicinity of the Klondike; a section of West Lake mine, N.S., and made several zinc-cut drawings for various reports. Mr. Frèreault was on sick leave from October 14, to November 24.

Messrs. W. J. Wilson, J. Keele, O. O'Sullivan and J. F. E. Johnston having been transferred to the field staff, contributed only a small portion of their time to mapping work. Mr. Keele compiled the map of Elsie and Murray mines, Ont.; a sketch map of the vicinity of the Klondike, a map of Lake Temagami iron ranges, and partly prepared the copies of the same for engraving and lithographing. M. O'Sullivan devoted some time to the compilation of the Nova Scotia map-sheets of Halifax county. He is at present preparing a preliminary map of the west coast of James bay, to accompany his summary report 1904.

Mr. Wilson finished the construction of his preliminary map of North-western Ontario.

Mapping by field-officers.

The following maps were compiled by field-officers from their respective surveys:—

Continuation of the mapping of the Lardeau mining district, B. C., on the 2-mile scale, by Mr. W. H. Boyd.

Costigan coal-field, Alberta, 40 chains to one inch, with sections and perspective view, by Mr. D. B. Dowling.

A contour geological map of Yamaska mountain, Que., scale 20 chains to one inch by Dr. G. A. Young.

Plans of the following gold districts of Nova Scotia by Mr. E. R. Faribault:—

Miller lake, Halifax, county,	Scale,	500 ft.	to 1 inch.
Clam Harbour, " "	"	250 ft.	"
Malaga, Queens county.......	"	250 ft.	"
Brookfield, county...........	"	250 ft.	"
Leipsigate, Lunenburg county,	"	500 ft.	"

A geological map of Arctic Canada on the scale of 50 miles to 1 inch, showing the cruise made by the *Neptune* in 1903-4 under the command of Mr. A. P. Low, is also under construction by Mr. C. F. King. This interesting map is expected to be placed, shortly, in the engraver's hands.

Routine work.

The routine work of correcting map proofs, making sun-prints, tracings, lists of repairs of instruments, projections, etc., was divided among the staff and attended to.

Base-lines in Nova Scotia.

Having received instructions to make an accurate transit and chain survey of the Dominion Atlantic railway and of the Halifax and South-western railway of Nova Scotia for the purpose of locating and tying in the detailed surveys of Messrs. H. Fletcher and E. R. Faribault, extending in Kings, Annapolis and Lunenburg counties, I left for the field on August 19, accompanied by Mr. L. N. Richard as transit man and Messrs. J. A. Robert and J. J. McGee, jr., as chainmen. Traverse lines checked by careful azimuth observations, were run between Port George and Bridgewater—thus connecting opposite coasts of Nova Scotia—and between Middleton junction and Hantsport, tying with my survey of 1902 on the Kings—Hants county line. From the data of these traverses, the geographical position of the following points, depending upon the latitude and longitude of Hantsport and Bridgewater, as given on Admiralty charts Nos. 353 and 342, was computed.

Locality.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Hantsport station, D.A.Ry..................	45 4 5	64 10 40
Kentville " "	45 4 40	64 29 54
Middleton " "	44 56 33	65 4 20
Port George, P. O	45 0 4	65 9 28
New Germany station, H. & S.W.Ry...........	44 32 43	64 43 26
Bridgewater " " "	44 22 44	64 30 57

Geographic board.

The meetings of the Geographic Board have been regularly attended, and lists of place-names covering maps under construction have been submitted.

Accompanying maps.

The following eight maps, illustrating part of the progress made in the field last summer, accompany the present Summary Report and Part A., Annual Report, Vol. XVI :—

No. 889.—Exploration from Lac Seul to Severn lake, Keewatin, scale, 35 miles to 1 inch.

No. 890.—Coal basins of Nicola river valley, B.C., scale, 80 chains to 1 inch.

No. 891.—Duncan Creek mining district, Yukon, scale 6 miles to 1 inch.

No. 892.—Costigan coal-field, Alberta, scale, 40 chains to 1 inch.

No. 894.—Kluane mining district, Yukon, scale, 6 miles to 1 inch.

No. 895.—West coast of James bay, Keewatin, scale, 16 miles to 1 inch.

No. 897.—Nictaux and Torbrook iron district, N.S., scale, 25 chains to 1 inch.

No. 898.—Bruce Mines and Debarats district, Ontario, scale, 1 mile to 1 inch.

Besides the above mentioned maps, there are at present twenty-four in various stages of progress in the hands of the King's Printer, including the Bancroft and Haliburton (Ont.), the Klondike and the Boundary Creek (B.C.) maps, the editions of which are expected at an early date. Of that number, eight new geological sheets of the systematic series of Nova Scotia were sent for engraving on copper. Maps in progress.

The examination and repairing of field-instruments was, as usual, attended to, and the following new instruments were purchased:— Field-instruments.

One Bridges-Lee Photo-theodolite, from L. Casella, London, Eng.

One 8-inch graduated circle for transit No. 5, from W. & L. E. Gurley, Troy, N.Y.

One Ross-Zeiss copying lens, series vii a, $6\frac{1}{2}$ x $8\frac{1}{2}$, from Ross, London, England.

One camera, 5 x 7 without lens, No. 19, from R. F. Smith, Montreal, Que.

Two cameras, 4 x 5, Nos. 27 and 29, from W. J. Topley, Ottawa, Ont.

One 50-foot steel tape, No. 21, from Department of Stationery, Ottawa.

Three 66-foot Chesterman tapes Nos. 5, 11 and 34, from Department of Stationery, Ottawa.

Two pocket compasses Nos. 41 and 42 from McDougall Hardware Co., Ottawa.

The number of letters, memoranda, specification sheets, etc., relating to map-work, was 264 sent and 160 received. Correspondence.

Maps published.

The following is a list of maps, plans and diagrams which have been received from the King's Printer during the past calendar year :—

Catalogue number.	Description.	Area in sq. miles.
792	British Columbia—West Kootenay geological sheet, Scale, 4 miles to 1 inch.	6,400
853	British Columbia—Sketch map of Lardeau and Trout Lake mineral belts, West Kootenay district, Scale 8 miles to 1 inch.	
842	Athabaska district—Map of Peace and Athabaska rivers, scale 32 miles to 1 inch.	
845	Alberta district—Sketch map of Cretaceous coal-bearing rocks, scale 2 miles to 1 inch.	
846	Keewatin—Map of Winisk river, scale 16 miles to 1 inch.	
820	Ontario—Geological map of Sudbury mining region, (Sudbury map,) scale, 1 mile to 1 inch	208
824 et 825	Ontario—Geological map of vicinity of Copper Cliff, Sudbury mining district, in two sheets, scale 400 feet to 1 inch	abt. 8½
864	Ontario—Geological map of Elsie and Murray mine, Sudbury mining district, scale 400 feet to 1 inch	1½
852	Ontario—Geological map of North-east Arm and Vermilion iron ranges, Lake Temagami, scale 40 chains to 1 inch.	
789	Ontario—Perth geological sheet, (No. 119,) scale 4 miles to 1 inch	3,456
847	Ontario—Preliminary map of the north-western part of the province, north of Lake Superior, scale 16 miles to 1 inch.	
848	Quebec—Plan of recent landslide on Lièvre river, near Buckingham, scale 12 chains to 1 inch.	
875	Quebec—Map of city of Montreal and vicinity showing location of wells, scale 3,000 feet to 1 inch.	
876	Quebec—Graphic diagrams showing the relations of groups of wells in the city of Montreal and vicinity.	
866	Quebec—Map of the older copper-bearing rocks of Southern Quebec.	
833	Nova Scotia—Geological map of Pictou coalfield, scale 25 chains to 1 inch	66
826	Nova Scotia—Apple river geological sheet, (Nos. 100 & 101); Scale 1 mile to 1 inch	473
832	Nova Scotia—Plan and section of Isaac Harbour Gold district, scale 500 feet to 1 inch.	
843	Nova Scotia—Plan and section of Cochran Hill gold district, scale 500 feet to 1 inch.	
844	Nova Scotia—Plan and section of Gold River gold district, scale 250 feet to 1 inch.	
849	Nova Scotia—Sections of West Lake mine, Mount Uniacke gold district.	
850	Nova Scotia—Transverse section of Doliver mine, Upper Isaac Harbour gold district.	
	Also eight diagrams to illustrate the mineral production of Canada and several zinc-cuts to accompany various reports.	

Palæontology and Zoology.

By Dr. J. F. Whiteaves.

Dr. Whiteaves reports that the study of the fossils of the Silurian rocks of the Winisk river (Keewatin), collected by Mr. W. McInnes in the summer season of 1903, which was commenced late in the fall of that year, has been completed as far as practicable, and that a list of the species represented therein has been prepared for publication in Mr. McInnes' report.

Three parts of the third volume of "Palæozoic Fossils" have already been published by this Survey, and it is intended that the fourth part shall consist of a descriptive and illustrated report on the fossils of the Silurian (Upper Silurian) rocks of Keewatin, Manitoba and Saskatchewan now in its Museum. A considerable portion of the letter press of this report, embracing all that refers to fossils of Keewatin, has been written during the year.

A preliminary examination has been made of the fossils of the palæozoic rocks of the Kabinakagami, Little Current, Nagagami and Drowning rivers, in Northern Ontario, collected by Messrs. W. J. Wilson and O. O'Sullivan in 1903. At one locality on the Little Current river the fossil fauna has rather a "Hudson river" facies, but everywhere else on these rivers where fossils were collected the rocks appear to be of Silurian (Upper Silurian) age.

In 1901 Dr. H. M. Ami collected some fine specimens of a species of *Trocholites* from the Trenton limestone at the Natural Steps, on the Montmorency river, in the province of Quebec. A study of these specimens has led to a recent revision of the Canadian species of that genus and to a reconsideration of the geological horizons indicated by each. The conclusions arrived at on these points are embodied in a paper published in the "Ottawa Naturalist" for April, 1904, and entitled "The Canadian species of Trocholites."

Another paper, entitled "Description of a new genus and species of rugose corals from the Silurian rocks of Manitoba," and based upon specimens collected by Mr. J. B. Tyrrell in 1897, was published in the same journal for September, 1904.

Twenty-four collections of fossils have been sent to the writer during the year, and nineteen of these have been examined and studied. Four of these collections are from the neighbourhood of Ottawa, forwarded by Mr. Walter R. Billings; one collection is from the Utica shale or slate at Collingwood, Ont., sent by the Rev. Thos. Nattress; five, not yet critically examined, are from the bed of the Detroit river at Amherstburg, also sent by the Rev. Thos. Nattress; one is from the carboniferous rocks at Nevada, consigned by Mr. W. F. Ferrier; the remaining thirteen are from the Cretaceous rocks at various localities on Vancouver island, sent by Miss Wilson and Mr. Walter Harvey. Some specimens of exceptional interest in these collections have been acquired for the Museum of the Survey, and the rest have been named and returned. Two of those presented by Mr. Billings have been described by the writer and figured in a paper recently contributed to the "American Geologist" entitled "Notes on some siphuncles of Canadian Endoceratidæ, with descriptions of two supposed new species of *Nanno*." And, the two crinoids and five of the best heart urchins referred to in another paper by the writer, published in the "American Journal of Science" for October, 1904, entitled "*Uintacrinus* and *Hemiaster* in the Vancouver Cretaceous," were presented by Miss Wilson and Mr. Harvey.

A number of fossils from the Vancouver Cretaceous which were loaned by the Provincial Museum at Victoria and by Mr. Harvey during the preparation of Mesozoic Fossils, vol. I, part 5, have been named and returned.

In zoology, the extensive series of land and water shells collected last summer by Mr. McInnes at various localities in Keewatin have been examined and studied. It has been found to consist of numerous specimens of seven species of land shells and of twenty-five species of fresh-water shells, a list of which has been prepared for publication in Mr. McInnes' report. Small collections of land and fresh-water shells from Keewatin, British Columbia, and the Yukon territory, as well as a number of foreign shells, have been named for Mr. O'Sullivan, Dr. Fletcher, Mr. Keele and the St. Laurent convent near Montreal.

At the request of Professor Verrill, who is engaged in the preparation of an illustrated monograph of the recent echinodermata of the Pacific coast of North America, which is to form one of the volumes to be published by the Harriman Alaska Expedition, nearly the whole of the Survey's large and important collection of starfishes and brittle stars from the seaboard of British Columbia, has been sent to him for examination and study.

A "Bibliography of Canadian Zoology for the year 1903, exclusive of Entomology" has been prepared for publication in the Transactions of the Royal Society of Canada for 1904.

Three short zoological papers have been published in the "Ottawa Naturalist" during the year. One of these records the discovery by Dr. Bell, in 1885, of a living colony of a common European land-snail *(Helicigona arbustorum)* on grassy slopes facing the sea, near the narrows of St. John's harbour, Newfoundland. This seems to be the first instance of this species being found, in a living state, on the American side of the Atlantic. The second paper entitled "A White Pelican at Manotick," is descriptive of a fine adult female of the American white pelican *(Pelecanus erythrohynchus)* shot last May on the Rideau river at Manotick, fourteen miles south of Ottawa. The specimen is now in the Museum of the Survey. The third paper is a short note on the recent acquisition, by the Provincial Museum at Halifax, of an adult male of the brown pelican *(Pelecanus fuscus)* shot at Louisburg, Cape Breton island, also in May last.

During Dr. Bell's absence from Ottawa, for about six weeks last summer, the duties of acting deputy head and director have been performed by the writer.

The number of official letters received and answered in 1904, has been about as usual.

The following specimens have been received either from members of the staff, or from employees of the department in 1904 :—

Ells, Dr. R. W. :—

Seventy-five specimens of fossil plants from the brown shales at Quilchena creek, Nicola river valley, Yale district, B.C. About fifty fossils, including three ammonites, from shales on the top of the mountain north of the Nicola river, three miles west of Nicola lake, B.C. Sixteen fossils from carbonaceous shales at Coal gully, Nicola coal basin, B.C.

Chalmers, Dr. R. W. :—

Six fossil fresh-water shells from the clays of the Lake St. John district at Roberval, P.Q.

McConnell, R. G. :—

Five fossils from the Kluane mining district, Yukon territory.

Low, A, P. :—

A collection of fossils, from the Silurian limestone of North Devon island. Collections of fossils from Silurian limestones, Southampton island, Hudson bay, six complete specimens of musk-ox including four males, one female and one young male. Specimens of arctic wolf, fox, lemming, marmot and hare. Specimens of birds breeding in the arctic, together with many rare birds eggs :—including those of the Snow Goose, Whistling Swan, Parasitic and Long-tailed Jaeger, Arctic Tern, Sabine Gull, Glaucous Gull, Herring Gull, American and King Eider, Red Phalarope, and Leash Sandpiper.

A large collection of marine and fresh-water invertebrates from Fullerton, Hudson bay and Port Burwell.

Ami, Dr. H. M. :—

About 500 fossils from the Silurian rocks along the Arisaig shore, Antigonish co., N.S.

About 300 fossils from South mountain, Messenger brook, and the valley of the Torbrook, Annapolis co., N.S.

Fifty specimens of Ostracoderms, &c., from McArras brook, Antigonish co., N.S.

Several slabs and fragments of fossil plants from St. Andrews, N.B.

About 300 fossils from Silurian and Devonian rocks at St. Helen's island, near Montreal.

Pleistocene fossils from Peel St., Montreal.

About 150 Trenton fossils from the Montmorency and Ferrée rivers, Montmorency co., P.Q.

Numerous fossils from the Trenton, Utica and other formations near Ottawa.

About fifty fragments of pottery and bones from the right bank of the South Nation river, near Casselman, Ont.

Lambe, L. M. :—

A large collection of vertebrate remains from the Cypress hills, in south-western Assiniboia.

McInnes, W. :—

A large collection of land and fresh water-shells from Keewatin.

Wilson, W. J. :—

A few fossils from near the mouth of the Pagwachuan river, Kenogami river basin, Algoma district, Ont., and a few fresh, water shells from Northern Ontario. Five chipped flints, from O'Sullivan lake, Thunder bay district, Ont.

Bailey, Prof. L. W. :—

Forty specimens of graptolites from the Cambro-Silurian slates at Tête à Gauche river, Gloucester co., N.B.

Two slabs of Carboniferous shale from Gunn's mine, Minto, Sunbury co., N.B.

Two slabs of shale, with obscure fossils, from Tapley's mills, Woodstock, N.B.

Two slabs of graptolitic shales, from Monument settlement, York co., N.B.

About twenty specimens of obscure fossils from Lower Birch island, S. W. Miramichi river, N.B.

Keele, Joseph :—

Specimens of fresh-water shells from small lakes in the valley of the Stewart river, Yukon territory.

Dowling, D. B. :—

About 100 fossils from the Devono-Carboniferous of the Rocky mountains in Canada.

Spreadborough, W. :—

Ninety skins of birds and seventy-two of small mammals, from the vicinity of Fernie and Elks, B.C. Specimens of marine, land, and fresh-water shells, from several localities in or near James bay.

The additions to the palæontological, zoological, archæological, and ethnological collections in the Museum during 1904,* and from other sources, are as follows.

By presentation :—

(*A.—Palæontology.*)

Springer, Hon. Frank, East Las Vegas, New Mexico :—

Slab of Niobrara chalk from Logan Co., Kansas, showing at least six fine and nearly perfect specimens of *Uintacrinus socialis*, Grinnell, on one of its weathered surfaces, and three separate specimens of that species, from the same formation and locality.

* In last year Summary Report, page 203, line 21 from the top, the additions to the Museum for 1903 are inadvertently incorrectly stated to be those "for 1902."

Harvey, Walter, Crofton, B.C. :—

Specimen of *Uintacrinus* from the Cretaceous shales on the north bank of the Cowichan river, below Menzies creek, Vancouver island; and one from similar shales at Vesuvius bay, Salt Spring island. Specimen of *Hemiaster Vancouverensis*, from the Cretaceous shales at Shopland, V.I.

Wilson, Miss. M. E., Duncan's, V. I.:—

Type of *Hemiaster Vancouverensis*, W., from the north side of the Cowichan river, V.I., near the mouth of Menzies creek; and two specimens of the same species, from the west slope of Mount Tzonhalem, V.I., from shale pits on the Maple Bay road.

Narraway, J. E., Ottawa :

Specimen of *Beatricea*, recently collected at Stony mountain, Manitoba, by E. J. Adams.

Fawcett, G. H., Ottawa :—

Specimen of *Corbicula occidentalis*, from the Little Bow river, near the mouth of Long Coulee.

Crawley, F. A., Wolfville, N.S.; per Dr. Ami :—

A fossil from the iron ore beds of the Torbrook valley, Annapolis valley, N.S.

Leckie, Major J. E., Torbrook Mines, Annapolis, N.S.; per Dr. Ami :—

Two slabs of fossiliferous iron ore (hematite) from the Torbrook mine.

Phinney, Capt. James, Middleton, Annapolis Co., N.S.; per Dr. Ami :—

Specimen of ore from the bore-hole on the Fletcher Wheelock property (ninety-eight feet from the surface), South mountain, Annapolis co.

Grant, H. H., New Glasgow, Pictou co., N.S.; per Dr. Ami :—

Specimen of core from the bore-hole on Rear brook, west bank of the East river of Pictou, near New Glasgow.

(B.—Zoology.)

Tyrrell, J. B., Dawson City, Y.T. .—

Male, female and lamb of *Ovis Dalli*, from the Yukon territory.

Latchford, Hon. F. R., Ottawa :—

Four fine specimens of *Arca incongrua*, Say, from Ste. Augustine, Florida.

Labarthe, J., Trail, B.C. :—

Set of nine eggs of the Cinnamon Teal ; nest of three eggs of the Black-winged Stilt ; both from Salt Lake county, Utah.

Stewart, Jas., Grande Prairie, B.C. :—

Numerous specimens of a small *Pisidium* from Grande Prairie.

Brodie, Dr. W., Toronto :—

Four specimens of *Vitrea cellaria* from Toronto, and three specimens of two species of *Sphœrium* from Midland, Ont.

Tufts, R. W., Wolfville, N.S. :—

Set of six eggs of the Purple Finch *(Carpodacus purpureus)* from Wolfville.

Walker, Miss Mary E., Buffalo, N.Y. :—

One specimen of *Vallonia pavula*, Sterki, and two specimens of *Pisidium Danielsi*, Sterki, from Oxley, Ont.

Weston, T. C., Quebec City :—

Specimen of *Hygromia rufescens* (an introduced British snail) from a garden in Quebec.

Young, Rev. C. J. Madoc, Ont. :—

Nest and set of seven eggs of the Golden-crowned Kinglet *(Regulus satrapa)* from North Frontenac.

Raine, Walter, Toronto :—

Photographs of the nest and eggs of the loon (1), American Merganser (1), Double-crested Cormorant (2), Herring Gull (1), and Black Tern (1), from Lake Winnepegosis ; and of the American robin (1), and Prairie horned Lark (1), from Kew Beach, Toronto.

Beaupre, Edwin, Kingston, Ont. :—

Two photographs of the nesting place of the Least Bittern, at Collins lake, Frontenac county, and one photograph of the nest and eggs of the Florida Gallinule, at the same lake ; also a photograph of the nesting place and eggs of a Black Duck in an old crow's nest in an elm tree on Wolfe island, near Kingston.

(G.—Archæology and Ethnology.)

His Excellency the Earl of Minto (per Dr. R. Bell) :—

A birch bark box.

Armstrong, R. E., St. Andrews, N.B. :—

Stone skin scraper, found a mile and a half above St. Andrews, in the valley of the St. Croix river.

By purchase :—

From D. H. Price, Aylmer, Ont. :—

"A large collection of Indian relics, mostly from the country on the north side of Lake Erie, which was inhabited by the Tobacco nation, at the advent of Europeans."—R. Bell.

From Walter Harvey, Crofton, V.I. :—

An unusually perfect specimen of a fossil crab, in a cretaceous nodule, picked up on the beach at Victoria, B.C.

From John Flann, jr., Manotick, Ont. :—

A fine adult female of the American White Pelican, shot at Manotick.

From R. W. Tufts, Wolfville, N.S. :—

Set of three eggs of the olive-sided flycatcher *(Cantapus borealis)* from Wolfville.

From F. Landsberg, Victoria, B. C. :—

Large cup-shaped sponge from the coast of British Columbia, near Bella Bella, brought up from a depth of 300 fathoms.

Vertebrate Palæontology.

By Mr. Lawrence M. Lambe.

(Vertebrate Palæontologist.)

Monograph issued.

The monograph on *Dryptosaurus incrassatus* referred to in the Summary Report for 1903 as being then more than half completed, was ready for the press in the early part of this year and has now been printed and issued. This monograph, based on the skulls and certain other parts of the skeletons of two individuals of one of the largest known species of carnivorous dinosaur, forms part III of volume III (quarto) of Contributions to Canadian Palæontology and consists of twenty-seven pages of text illustrated by text figures and eight photogravure plates. The above dinosaurian remains are from the Edmonton series of the Cretaceous of the Red Deer river district in Alberta.

Other reports issued.

With a view to summarizing our knowledge to date of all fossil vertebrate species known from Canada, a paper was prepared during the first half of this year and presented in June last at the annual meeting of the Royal Society of Canada, for publication. This paper consists of four parts, (i) a summary of the progress of our knowledge of fossil vertebrate species since 1841, (ii) an enumeration of species according to their geological age, (iii) an enumeration of species arranged zoologically, and (iv) a bibliography of the more important references to these species. The lists are a convenient index to the study of vertebrate palæontology in Canada and will, it is hoped, prove of use to advanced students generally.

The results of a further study of the posterior crests of the Ceratopsia (horned dinosaurs) of the Belly river series, as exemplified by material from Red Deer river, Alberta, have been published in the form of illustrated papers entitled 'On the squamoso-parietal crest of two species of horned dinosaurs from the Crètaceous of Alberta', Ottawa Naturalist, vol. XVIII, and 'On the squamoso-parietal crest of the horned dinosaurs *Centrosaurus apertus* and *Monoclonius canadensis*', Transactions of the Royal Society of Canada, volume X. These reports were issued in July and December respectively; in the latter the new genus *Centrosaurus* is proposed.

Additional information regarding the structure and probable habits of the remarkable dinosaur *Ornithomimus altus* from the Belly river series of Red Deer river, Alberta, was published in the Ottawa Naturalist, vol. XVIII, in a paper on 'The grasping power of the manus of *Ornithomimus altus*, Lambe' (date of issue, May 10.)

Although part II of vol. III (quarto) of Contributions to Canadian Palæontology covers in a general way most of the remains of vertebrates obtained from the Belly river series of the North-west Territory, there is still much valuable material included in these collections that needs further study. As a single instance, from the Reptilia alone of this interesting fauna, some time has been given during the past year to the study of excellently preserved specimens of parts of the head of the crocodile *Bottosaurus perrugosus*, Cope, as yet very imperfectly known. Much additional light is thrown on the structure of the head of this animal by the Belly river series fossils, on which an illustrated descriptive paper, partly completed, is now in hand.

Field work in Cypres hills.

The Oligocene beds of the Cypress hills, in Assiniboia, discovered during the summer of 1883 by Mr. R. G. McConnell, may be looked upon as probably the most promising collecting ground so far discovered for early Tertiary mammals in the west. Collections from this locality made by Messrs. McConnell and Weston were reported on by Professor E. D. Cope in 1891 in a paper entitled "The species from the Oligocene or Lower Miocene beds of the Cypress Hills," constituting the first part of vol. III (quarto) of Contributions to Canadian Palæontology. It being thought desirable to make further collections of fossil vertebrate remains from the Cypress hills, and acting under instructions, more than a month during the past summer was devoted to field work in this region.

Leaving Ottawa on 2nd July by the Canadian Pacific Railway, a start was made by waggon from Maple creek, Assiniboia. Mr. Justin S. De Lury, of Manilla, Ont., meeting me at North Bay, accompanied me as field assistant, and fulfilled the duties entrusted to him in a most creditable manner.

To reach the head waters of the north fork of Swift Current creek, where previous collections had been made and where the best palæontological results were expected, a course due south was taken as far as Hay lake, from which point Bone coulée, almost due east, was reached without difficulty. In Bone coulée, about nine miles west of the eastern escarpment of the Cypress hills, the head waters of the north fork of Swift Current creek and a creek flowing south (named Fairwell creek, by Mr. McConnell but known as Frenchman creek by the ranchmen in this district) flow within a few hundreds yards of each other in opposite directions, the former in a north-easterly direction, the latter at first almost due south, the sources of the creeks being in two neighbouring coulées tributary to Bone coulée on the west.

Oligocene deposits examined.

The exposures of the Oligocene deposits were examined along the eastern escarpment of the hills as well as on the southern slope in the vicinity of Frenchman (White Mud) river as far west as the mouth of the locally called Frenchman creek, also in the valley of this creek northward to Bone coulée and for some miles along the upper reaches of the north fork of Swift Current creek. Little success attended the examination of the eastern and southern escarpments. The greater part of the collection was made in Bone coulée, with its numerous tributary coulées, and in its southern extension for a few miles along Frenchman creek. Here the grass-covered slopes are broken by numerous small and isolated weathered outcrops that at first do not appear very promising from a palæontological standpoint. A careful and close search, however, reveals an abundance of, for the most part, mammalian remains. Mammalian remains.

The most prolific beds are composed of a fine conglomerate that, on disintegration, has freed the enclosed fossils. Associated beds of coarse sand, of a rich brown colour, also yielded some very promising remains. Very few fossils were found in the coarser conglomerates, and none at all in the beds of loose pebbles.

The generally fragmentary and disassociated nature of the remains at this locality detracts much from their value as definite horizon markers. Many of the specimens clearly show that they had been broken and often worn prior to being deposited in the beds where they were found. Some excellently preserved jaws with continuous series of teeth were obtained, with many separate and well preserved teeth, but bones of the feet were in all cases disassociated.

The geology of the Cypress hills is discussed by Mr. McConnell in his report of 1885* where the newest deposits, capping the hills, are referred to as of Miocene age. Cope, in his memoir of 1891 on the Cypress hills collections of 1883-84, qualifies this to a certain extent and describes these beds as of Oligocene or Lower Miocene age. Matthew has assigned them to a more definite horizon at the bottom of the Oligocene, expressing the opinion that they are probably of approximately the same age as the Titanotherium beds at Pipestone springs, Montana. This opinion appears to be borne out by the list of species from Pipestone springs published by Dr. Matthew in 1903**, and the collections from the Cypress hills in the possession of this Survey. It is probable that the later Oreodon beds are represented wholly or in part. Whether the equivalent of the uppermost division of the Oligocene (Protoceras beds) is present has yet to be ascertained.

The collection of last summer is a large one and some time was spent in preparing it for a preliminary study that has occupied the closing months of the year.

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* Report on the Cypress hills, Wood mountain and adjacent country, &c. by R. G. McConnell. Part C. annual report, 1885. Geological and Natural History Survey of Canada.

** The fauna of the Titanotherium beds at Pipestone Springs, Montana. Bulletin American Museum of Natural History, vol. xix, article vi, 1903.

The specimens require careful study and comparison with types before anything but a tentative opinion, regarding the affinities of the forms included in the collection, can be given.

The following provisional faunal list is the result of a preliminary study of last summer's collection:—

PISCES.

Fishes.

Actinopterygian fishes of at least two families viz: Amiidæ and Siluridæ. Represented by vertebræ, scales, and pectoral and dorsal fin spines.

REPTILIA.

CHELONIA.

Reptiles.

A number of species indicated by parts of the shell. About five species are represented of which two can be readily identified with *Trionyx leucopotamicus*, Cope and the species from the Cypress hills doubtfully referred by Cope to *Stylemys nebrascensis*, Leidy.

SQUAMATA.

Lacertilian remains in the form of lower jaws with teeth, and dermal plates. Probably referable to Cope's species *Peltosaurus granulosus* from the White river beds of north-eastern Colorado.

Ophidian vertebræ, of probably one species.

CROCODILIA.

Represented by teeth, deeply pitted scutes, and vertebræ. Dr. F. B. Loomis has in the last number of the American Journal of Science (vol. xviii, No. 108, December 1904), in an interesting paper entitled "Two new river reptiles from the Titanothere beds," described a new species of crocodile (C. prenasalis) and a new species of Chrysemys (C. inornata) from South Dakota.

Cope in his report on the Cypress hills collection of 1883-4** describes two species of *Amia*, one species of *Rhœas*, two of *Amiurus*, one of *Trionyx* and refers to a previously known species of *Stylemys* (as above).

Lizards, snakes and crocodiles are now for the first time added to the Oligocene fauna of the Cypress hills.

**1891. On vertebrata from the Tertiary and Cretaceous rocks of the North-west Territory. "The species from the Oligocene or Lower Miocene beds of the Cypress hills," Geol. Surv. of Canada, Contr. to Can. Palæon, vol. iii (quarto) part I.

MAMMALIA.

UNGULATA.

ARTIODACTYLA.

Hyopotamus.

This genus is represented by an upper second molar tooth that may prove to belong to *H. brachyrhynchus*, O. and W., an Oligocene (White river) species described from South Dakota. The genus has not been hitherto recorded from the Canadian west. Mammals.

Elotherium.

Parts of lower jaws with molar teeth, collected last summer, are referred to *E. coarctatum*, Cope described originally from the Cypress hills in 1891, from an incomplete left mandibular ramus holding all the molar and premolar teeth. Two upper premolars, presumbly the third and fourth, and a posterior upper molar are tentatively referred to the same species.

Agriochœrus.

Oreodon.

Numerous teeth indicating a species of *Agriochœrus* possibly *A. antiquus*, Leidy and a species of *Oreodon (? O. culbertsonii*, Leidy). These forms have been known from the Western States but not from Canada.

Leptomeryx.

Hypertragulus.

Additional material is included in the collection of 1904 of Cope's Cypress hills species, *Leptomeryx esulcatus*, *L. mammifer*, *L. semicinctus* and *Hypertragulus transversus.* It is probable that the list of Tragulidæ will be augmented on further study of the material on hand.

PERISSODACTYLA.

Mesohippus.

An increased knowledge of the structure of the teeth of *Mesohippus westoni* is afforded by an unworn upper molar. The type specimens of this interesting and primitive form consist of an imperfect upper molar and two lower molars, the latter not free from injury, so that any information throwing light on the tooth structure is most acceptable.

Another species of *Mesohippus* approaching closely to *M. bairdi* (Leidy) in tooth pattern, but apparently specifically distinct, is indicated by well-preserved upper molars. This species is new to the Cypress hills fauna.

Hyracodon.

The maxillæ of an *Hyracodon* with the full premolar-molar series of teeth preserved was secured last summer. The specimen appears to be referable to a species distinct from *H. nebrascensis*, Leidy already known from the Oligocene of the Cypress hills.

Aceratherium.

Fragments of jaws probably belonging to the two species *A. mite*, Cope and *A. occidentale* (Leidy) already known from this locality.

Titanotherium.

An unusually perfect lower jaw of a Titanothere showing a complete set of teeth in the left ramus viz: three incisors, the canine, four premolars and three molars. In the right ramus are the three incisors, the canine and the second and third premolars. The alveolus of the first premolar is preserved. Nothing remains of the teeth behind the third premolar. The presence of three incisors is of interest and may be regarded as a primitive character.

RODENTIA.

Ischyromys.

A species, represented by a single tooth from the lower jaw (? p. 4), is referred for the present to *I. typus*, Leidy.

Steneofiber.

Part of a left mandibular ramus of small size holding the ? second molar tooth is regarded as referable to a species of *Steneofiber* distinct from *S. nebrascensis*, Leidy. The alveolus of the third molar is preserved, as well as parts of those of the first and last molars. The antero-posterior diameter of the second molar is slightly over two mm.

A small molariform tooth of doubtful affinity is mentioned here as worthy of notice*. It is singular in exhibiting a large number of small lakes, about twenty, in the slightly worn surface of the crown.

Palæolagus.

Represented by separate teeth. A mandible from the Cypress hills has been already referred to *P. turgidus* by Cope, the author of the species. Matthew is of the opinion that *P. haydeni*, Leidy, and *P.*

* Since this paragraph was written Dr. W. D Matthew's genus *Entypomys* has been established (Notice of two new genera of mammals from the Oligocene of South Dakota, Bull. Am. Mus. of Nat. Hist., vol. xxi., article iii., Feb. 14, 1905). The Cypress Hills tooth is probably referable to this new genus.

turgidus are distinctive of the Oreodon beds and has recorded two species *P. temnodon*, Douglass, and *P. brachyodon*, Matthew, from the Titanotherium beds of Pipestone springs, Montana. It is possible that one or both of these last two species are represented in the collection of this year.

Of the rodents *Palæolagus* was the only genus known from the Cypress hills up to the present time.

CARNIVORA.

Creodonta.

Hemipsalodon grandis, Cope.

A separate lower canine of large size of this species; imperfect above. Total length of specimen 112 mm; length restored about 132 mm. (about $5\frac{2}{10}$ inches). Greatest antero-posterior diameter, slightly above mid-length, 42 mm.; transverse diameter, slightly above mid-length, 30 mm.

The type specimen, consisting of a right mandibular ramus, was described by Cope from the Cypress hills, in 1891. In this specimen, the canine, broken off close to the edge of the alveolus, agrees in general size with the tooth discovered last summer. The robustness of the jaw and the size of the teeth demonstrate in a particularly forcible manner the great strength of this, the largest of the Creodonta.

Fissipedia (Carnivora Vera.)

Amphicyon.

Separate teeth representing apparently a number of forms belonging to the Canidæ. Part of a right maxilla, holding the fourth premolar and showing the alveoli of the third premolar and of the first, second and third molars, indicates a species of *Amphicyon*.

Dinictis..

This genus of the Felidæ is indicated by a few well-preserved teeth belonging to a species thought to be hitherto undescribed.

INSECTIVORA.

Mesodectes.

Separate upper molars of a species that is for the present referred to *Mesodectes* or *Ictops*.

The animals inhabiting our western country during Oligocene times are thus seen to have belonged to a variety of groups. That the number of individuals in some of the groups was large is evident from the abundance of the fossil remains of some forms. Some of the groups have since become extinct, others have undergone great changes and are with difficulty recognized in their descendants of the present day whilst a few now exist with but slight differences of form and structure.

The fishes belonged to the family of Amiidæ from which is descended the modern Bowfish or Mud-fish notably primitive in its structure, and the Siluridæ resembling the cat-fishes of to-day.

The reptiles included certain species of land and water tortoises, and river turtles, besides small lizards and snakes as well as crocodiles.

The greater proportion of the animals, however, were mammals some of which, such as the Titanotheres, approached the elephants in size.

Chalicotherium represents a distinct order and had a curious assemblage of characters amongst which were notably the possession of clawed feet, and teeth suggestive of the Perissodactyls. *C. bilobatum* described by Cope from the Cypress hills collection of 1883-4 has not been recognized as yet in the collection of last summer.

The Ungulata or herbivorous hoofed mammals were numerous and some of them evidently existed in large herds.

The Artiodactyls or even-toed Ungulates are well represented by their fossil remains. *Elotherium* was a pig-like animal of large size distantly related to the Pig and to the Hippopotamus. *Hyopotamus* was also an early ally of the true pigs (Suidæ) with teeth tending to approach the form of tooth characteristic of the higher Artiodactyls that chew the cud (ruminants). *Agriochœrus* and *Oreodon* belong to the family of Oreodontidæ, animals not larger than sheep, the typical members of which have been called by Leidy ruminating hogs. *Agriochœrus* closely resembled *Hyopotamus. Leptomeryx*, and allied genera, included animals of small size from which the deer of a later geological age are supposed to be descended. *Hypertragulus* is another form of extinct Traguloid.

Early horses, etc.

The Perissodactyls or odd-toed Ungulates consisted of early horses, primitive rhinoceroses, and titanotheres. The horses were represented by a form very similar to *Mesohippus bairdi* and a smaller species *M. westoni. M. bairdi* was of about the size of a peccary and had three toes. *Hyracodon* was a running type of rhinoceros with teeth nearly resembling those of some of the early horses. *Aceratherium* included species of hornless rhinoceroses of small size and with light limbs. The Titanotheres were huge animals, with limbs shorter than those of an elephant, and bore a pair of horns set transversely in advance of the eyes.

The Rodents are represented by the following genera :—*Ischyromys* belonging to the Squirrel family, *Steneofiber* a small form of early beaver and *Palæolagus* antecedent to later hares and rabbits. Rodents.

The flesh-eating animals belonged to the Creodonta and to the true terrestrial carnivora of the families of Canidæ (Dogs) and Felidæ (Cats). The Creodonta constituted a primitive group of flesh eaters. *Hemipsalodon grandis* is the largest of this group and was an animal of powerful build. According to Cope its jaw was "more robust than that of any existing carnivore". *Amphicyon* is a genus belonging to the Canidæ. *Dinictis* included early forms of the cat tribe. Flesh eaters.

The Insectivores are revealed to us by the teeth of a small animal belonging to the genus *Mesodectes*. This order has not been previously known from our Oligocene rocks. Insect eaters.

Twenty-five vertebrate species in all have hitherto constituted the Oligocene fauna of the Cypress hills; with the increased knowledge gained from this year's collection this number is now raised to about forty.

It is proposed to fully describe the Oligocene fauna of the Cypress hills in a forthcoming illustrated memoir to form part IV of volume III (quarto) of Contributions to Canadian Palæontology.

Official correspondence connected with work in hand, and proof reading, whilst reports were being printed, have been attended to as in past years.

THE LIBRARY.

By Dr. John Thorburn, Librarian.

During the past year, from January 2 to December 31, 1904, there were distributed 13,307 publications of the Geological Survey, comprising reports, special reports and maps. Of these, 8,235 were distributed in Canada; the remainder, 5,072, in foreign countries, as exchanges to universities, scientific and literary institutions and to a number of individuals engaged in scientific pursuits.

The sale of reports and maps during the year amounted to $642.71. A large number of our earlier reports and maps are now out of print and can no longer be supplied.

There were received by the library, as donations or exchanges, 3,197 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets and maps. The publications purchased during the year were 139. Forty-six scientific periodicals were subscribed for. The number of letters received in connection with the work in the library was 2,684, besides 3,137 acknowledgments from exchanges and individuals for publications sent to them. The number of letters sent from the library was 2,083, besides 798 acknowledgments for publications received. There are now in the library about 14,000 volumes, besides a large number of pamphlets. The number of volumes bound during the year was 126.

I have been greatly helped in my duties as librarian by my able assistant, Mrs. T. Alexander.

NOTE.—The books in the library are open for consultation during office hours, by persons wishing to obtain information in regard to scientific subjects.

MINES SECTION.

In regard to the operation of the mines section during 1905, Mr. E. D. Ingall reports as follows:

Owing to my absence on sick leave for four months, during the early part of the year, and subsequently for four months on geological field-work, the carrying on of the general work of the section devolved upon Mr. John McLeish assisted by Mrs. W. Sparks.

The preliminary summary of the mineral production of Canada for 1903 was issued February 23, 1903, and during the summer the preparation of the annual report for 1903, giving statistical and other details regarding the various mineral industries, was completed.

The collection of general data regarding the economic minerals of the country and their discovery and development; the answering of many inquiries along these lines, and all the other work of a similar nature devolving upon the section, have been carried on as well as the small staff and means of disposal would permit.

It is inevitable that in collecting technical data regarding our mineral deposits and industries, mostly by circulars and correspondence, the personal acquaintanceship with mining districts, &c., which is so necessary a pre-requisite to the accomplishment of good work, should need renewing from time to time, and field investigation will be needed next season in several directions. With so large a territory as that presented by the whole Dominion, and, so few of the mineral industries carried on in any well organized and regular way, it becomes quite a problem to keep in touch with them, so as to have always on hand reliable and detailed information to meet, without the expenditure of large sums of money annually, the constant public demand. In the United States the equivalent branch of their geological survey department absorbs amounts varying from $25,000 to $50,000 yearly.

The following pages present a summary of the progress, &c., of the various mineral industries during 1904, as completely and accurately as the data, so far available, will permit.

As usual it will be followed later by the annual report in which more complete and revised information will be given.

SUMMARY OF THE MINERAL PRODUCTION OF CANADA IN 1904.

(Subject to Revision.)

PRODUCT.		Quantity. (a)	Value. (a)
METALLIC.			$
Copper (b)	Lbs.	42,970,594	5,510,119
Gold, Yukon	$10,337,000		
" All other	6,063,000	....	16,400,000
Iron ore (exports)	Tons.	168,828	401,738
* Pig iron from Canadian ore	"	68,297	901,880
Lead (c)	Lbs.	38,000,000	1,637,420
Nickel (d)	"	10,547,883	4,219,153
Silver (e)	Oz.	3,718,668	2,127,859
Zinc (i)	Lbs.	477,568	24,356
Total metallic		....	31,222,525
NON-METALLIC.			
Arsenic (exports)	Tons.	73	6,900
Asbestus	"	35,635	1,167,238
Asbestic	"	13,011	13,006
Chromite	"	6,074	67,146
Coal	"	7,509,860	14,599,090
Coke (f)	"	543,557	1,884,219
Corundum	"	919	101,050
Feldspar	"	11,083	21,166
Graphite	"	452	11,760
Grindstones	"	4,509	42,782
Gypsum	"	340,761	372,924
Limestone for flux	"	200,646	176,973
Manganese ore (exports)	"	123	2,706
Mica	"	....	152,170
Mineral pigments—			
Barytes	Tons.	1,382	3,702
Ochres	"	3,925	24,995
Mineral waters		....	80,000
Moulding sand	Tons.	3,423	6,790
Natural gas (g)		....	247,370
Petroleum (h)	Brls.	552,575	984,310
Phosphate	Tons.	917	4,590
Pyrites	"	33,039	94,797
Salt	"	68,777	318,628
Talc	"	840	1,875
Tripolite	"	320	6,400

* The total production of Pig iron in Canada in 1904 from Canadian and imported ores amounted to 303,454 tons valued at $3,582,001, of which it is estimated 68,297 ons valued at $901,880 should be attributed to Canadian ore and 235,157 tons valued at $2,680,121 to the ore imported.

Summary of the Mineral Production of Canada in 1904—*Concluded.*

Product.	Quantity. (a.)	Value. (a.)
Structural Materials and Clay Products.		$
* Cement, natural rock.......Brls.	56,814	49,397
" Portland........ "	850,358	1,197,992
Flagstone........	....	6,720
Granite........	....	100,000
Pottery........	....	200,000
Sands and gravels (exports).......Tons.	399,809	129,803
Sewer pipe........	....	378,894
Slate........	....	23,247
Terra-cotta, pressed brick, &c........	....	400,000
Tiles........	....	275,000
Building material, including bricks, building stone, lime, &c........	....	5,667,000
Total structural materials and clay products..	....	8,428,053
" all other non-metallic........	....	20,392,587
Total non-metallic........	....	28,820,640
" metallic........	....	31,222,525
Estimated value of mineral products not returned........	....	300,000
Total 1904........	....	60,343,165
1903 total........	....	62,600,434
1902 "	....	63,885,999
1901 "	....	66,339,158
1900 "	....	64,618,268
1899 "	....	49,584,027
1898 "	....	38,697,021
1897 "	....	28,661,430
1896 "	....	22,584,513
1895 "	....	20,648,964
1894 "	....	19,931,158
1893 "	....	20,035,082
1892 "	....	16,623,417
1891 "	....	18,976,616
1890 "	....	16,763,353
1889 "	....	14,013,113
1888 "	....	12,518,894
1887 "	....	11,321,331
1886 "	....	10,221,255

(a.) Quantity or value of product marketed. The ton used is that of 2,000 lbs.

(b.) Copper contents of ore, matte, &c., at 12·823 cents per lb.

(c.) Lead contents of ores, &c., at 4·309 cents per lb.

(d.) Nickel contents of ore, matte, &c., at 40 cents per lb.

(e.) Silver contents of ore at 57·221 cents per oz.

(f.) Oven coke, all the production of Nova Scotia, British Columbia and the North-west Territories.

(g.) Gross return from sale of gas.

(h.) Includes crude oil sold to refiners, and oil sold for fuel and other purposes.

(i.) Zinc contents of ores at 5·1 cents per lb.

*For more complete figures see page 12.

REMARKS.

In the accompanying general table it is shown that the value of the mineral products of Canada during 1904, aggregated over $60,000,000. In comparing this record with that of previous years it must be borne in mind that complete figures are never available at this time of the year, so that in a number of items the data are necessarily partly estimated.

Allowing for this, there nevertheless remains a falling-off of about $2,250,000 in the grand total. This does not necessarily indicate a general slackening in the permanent mineral industries of the country, but rather a gradual return to natural conditions after a few years of abnormal inflation due to the rapid exploitation of the richer and easily accessible portions of the Yukon placers. To this cause can be attributed nearly $2,000,000 of the decrease shown.

Taking the following figures of the actual variation in the values of the metallic products, this feature will be quite apparent. The items given aggregate nearly 85 per cent of the whole production, and it will be seen that, if the Yukon gold yield be eliminated the decreases in some industries are practically offset by increases in others, bringing about practical equality.

Product.	Increase.	Decrease.
	$	$
Copper	....	139,368
Gold, Yukon	....	1,913,000
" B.C., N.S. and Ont	....	530,590
Pig iron (from Canadian ore)	194,042	....
Iron ore, exports	16,811	....
Lead	868,858	....
Nickel	....	783,051
Silver	418,217	....
Zinc	....	24 244
Asbestus	250,487	....
Coal	....	496,333
Coke	149,815	....
Petroleum	....	64,664
Cement	47,400	....
Total	1,945,630	3,951,250
Net decrease	....	2,005,620

The special features of the leading mineral industries which, taken together, contribute close on 85 per cent of the grand aggregate for 1904, are to be found in the table given below.

Product.	Quantity.		Value.	
	Increase.	Decrease.	Increase.	Decrease.
	p. c.	p. c.	p. c.	p. c.
Metallic ;—				
Copper	·67			2·47
Gold				12·97
Pig iron (from Canadian ore only)	62·41		27·41	
Pig iron (from both home and imported ores)	1·87			4·29
Lead	109·49		113·05	
Nickel		15·65		15·65
Silver	16·26		24·46	
Non-metallic :—				
Asbestus and asbestic	16·72		26·94	
Coal		1·75		3·29
Coke		3·16	8·64	
Petroleum	13·55			6·16
Portland cement	35·46		4·12	

Taking the different classes, comparison with the totals for 1903 shows that the 'structural material' and 'clay products' class remained pratically stationary as far as their aggregate value is concerned, whilst the total for the metallic class show a decrease of $2,000,000, a feature which has already been explained.

1903.		1904.	
Product.	Per cent of total mineral production of Canada.	Product.	Per cent of total mineral production of Canada.
1 Gold	30·10	1 Coal and coke	27·32
2 Coal and coke	26·88	2 Gold	27·18
3 Building material	9·05	3 Building material	9·39
4 Copper	9·02	4 Copper	9·13
5 Nickel	7·99	5 Nickel	6·99
6 Silver	2·73	6 Silver	3·53
7 Cement	1·96	7 Lead	2·71
8 Petroleum	1·68	8 Cement	2·07
9 Asbestus	1·46	9 Asbestus	1·96
10 Lead	1·23	10 Petroleum	1·63
11 Pig iron (from Canadian ore)	1·13	11 Pig iron (from Canadian ore)	1·49

The foregoing table is intended to illustrate the relative values of the contributions to the grand total of the mineral output of Canada. The figures given account for all but 6·6 per cent of the whole. They omit all those contributing less than 1 per cent, although some of these, such as the mica and corundum industries, are otherwise interesting and important.

As formerly, the coal and coke output, when added to the value of the gold, constitute considerably more than half the mineral values produced, whilst, if the whole of the metal producing industries together with coal and coke be considered, a little less that ten per cent of the whole remains to be accounted for.

The *per capita* of the total mineral products for 1904 was about \$10.40 as compared with \$11.89, in 1903, and \$2.23, in 1886, the first year for which figures are available.

Gold.—Practically every province in Canada shows a falling off in gold production, in 1904, as compared with 1903. Nova Scotia, which ordinarily has an output of about half a million dollars, shows a decrease of nearly half its production. Several reasons are given for this, among which may be mentioned (1) the extreme drought during the past season, (2) the closing down, owing to financial difficulties, of a number of the best producing mines, and (3) the cessation of production at the Richardson mine owing to the destruction of the shaft and workings by an extensive crush.

In Ontario, although a considerable amount of prospecting and development work has been done, most of the mines that were formerly important producers were not operated during the year.

In British Columbia an increased output from placer mines is indicated, while a smaller production was obtained from the lode mines. The ore shipments from Rossland and vicinity, the chief gold producing district, were less than in 1903 by about 20,000 tons.

The Yukon output for the year (\$10,337,000) is based on the receipts of Canadian Yukon gold at the United States mint at San Francisco and other receiving offices.

Silver.—The bounty granted by the Dominion Government on the production of lead ores seems to have stimulated the operations of the silver-lead mines. The St. Eugene mine, in East Kootenay, was reopened, and its production probably accounts for the greater part of the increase.

Silver ·999 fine is now turned out at the refinery of the Canadian smelting works at Trail, B.C., as is also gold, ·994 fine. Refined silver has been shipped to New York, San Francisco and to China.

The average price per ounce of fine silver in New York during the year was 57·221 cents, as compared with 53·45 cents in 1903.

Lead.—Although over twice as much lead was produced in 1904 as in 1903, the output is still far from its former maximum, viz., 31,584 tons in 1900. The production in 1904 was about 19,000 tons, as compared with 9,070 tons in 1903. The exports of lead from Canada in 1904 were 12,913 tons of lead in ore, &c., and about 21 tons of pig lead. An electrolytic lead refinery is now in operation at the Canadian smelting works, Trail, B.C., producing pig lead, lead pipe, sheet lead, &c. It is said that lead corroding works are to be established in Montreal, by a Chicago firm, for the manufacture of white-lead and other pigments which will require a large amount of pig lead per annum.

Copper.—The copper contained in ore, matte, &c., shipped from Canadian mines in 1904 was about 21,485 tons, as compared with 21,342 tons in 1903.

In Ontario there was a falling off of over a thousand tons, which was more than made up by the increased production from the Boundary district and the Coast district of British Columbia. From Sudbury district, Ontario, 10,154 tons of matte were shipped, containing 2,455 tons of copper (see further under nickel). In British Columbia, shipments from the Boundary district were approximately 818,000 tons in 1904 and from Rossland 342,000 tons as compared with 697,284 tons from the Boundary district and 360,786 tons from Rossland in 1903.

The average price per pound of electrolytic copper in New York in 1904 was 12.823 cents as compared with 13.235 cents in 1903.

Cobalt, etc.—The discovery of certain cobalt, nickel, arsenic and silver ores, which was made public in November 1903, promises to add, in the near future, largely to the production of these metals. The deposits were found during the building of the Timiskaming and Northern Ontario Railway, the roadbed running almost over the top of the first of the outcrops discovered. The ores are contained in a series of almost vertical veins varying in width from eight inches up to six feet, although the wider portions always contain rocky matter. The veins intersect the conglomerate and slate, usually classified as Huronian. All of the deposits thus far discovered possess certain features in common. The minerals represented are chiefly smaltite, niccolite and native silver, with smaller quantities of erythrite dyscrasite, chloanthite and tetrahedrite. In some, the native silver is very abundant and a sample which was fairly representative of one of the smaller veins showed an assay value of $5,237.60 per ton. Analysis of the ore from one of the veins composed mainly of smaltite showed from 16 to 19 per cent of cobalt, 4 to 7 per cent of nickel, 60 to 66 per cent of arsenic, and 3 to 7 per cent of sulphur. The ores are thus so rich, that comparatively small veins could be worked at a hand some profit.

Although no returns have yet been received at this office it is stated that several car loads of ore, which realized very high values, have been shipped from this district.

Nickel.—The following were the results of operations on the nicke copper deposits of Ontario in 1904.

	Tons
Ore mined	203,388
Ore smelted	118,470
Matte produced	8,924
Matte shipped	10,154
Copper contents of matte shipped	2,455
Nickel contents in matte	5,274
Value of matte shipped	$2,193,198

According to customs returns exports of nickel in matte, etc. were as follows :

	Lbs.
To Great Britain	2,028,908
United States	9,204,961
Total	11,233,869

The price of refined nickel in New York remained steady throughout the year at from 40 to 47 cents per pound.

Zinc.—About 533 tons of zinc ore, worth $3,700, were shipped during the year from the Long Lake zinc mine in the County of Frontenac, Ont. No returns have been received of zinc production in British Columbia.

Iron.—Exports of iron ore were 168,828 tons, valued at $401,738. In addition to the ore exported, about 180,932 tons of ore, worth about $489,687, were mined in Canada and charged to Canadian blast furnaces.

Besides the above Canadian ore, 454,671 tons of imported ore, valued at $922,594, were used in Canadian furnaces. The total amount of pig iron manufactured from both Canadian and imported ores was 303,454 tons, of which 21,583 tons were made with charcoal as fuel, and 281,871 tons with coke. The quantity of charcoal used was 3,477,470 bushels and of coke 387,392 tons.

The pig iron was made by three firms in Nova Scotia, two in Quebec and four in Ontario.

Coal and Coke.—With the exception of a small decrease in shipments, coal production in Nova Scotia in 1904 shows but little change. A smaller amount of coke was made, owing to the smaller production of pig iron by the Dominion Iron and Steel Company. Efforts are being made to find new markets farther west in Ontario as well as to increase the exportation. In the North-west Territories many small mines have been opened, and the output shows a substantial growth. Coke is now being made in Alberta. On December 31, 1904, 56 beehive-ovens were in operation at Coleman, Alta., and 34 Belgian ovens, Bernard type, were in operation at Lille, Alta. In British Columbia the output of the Western Fuel Company, in Vancouver island, was considerably diminished, owing to the destruction by fire of the head-works at No. 1 mine. The Crow's Nest Pass Company, however, continued to increase its output, over 1,000,000 tons of coal being produced, of which more than half was used in making coke. The company has now 1,128 coke ovens completed.

Asbestus.—The production of asbestus, divided into crude and mill stock, was as follows:—

	Tons.	Value.
Crude	4,239	$ 509,001
Mill stock	31,396	658,277
Total	35,635	$1,167,278

Exports of asbestus according to Customs returns were:

37,272 tons valued at $1,160,887.

Natural Gas.—There was a somewhat increased production of natural gas in Ontario, due entirely to operations in the Welland field, production in the Essex field having dropped to very small amounts. The development of the gas field at Medicine Hat, Saskatchewan, seems to have been continued with such success. The gas commission of the town of Medicine Hat has now six producing wells, one of which has been put down to a depth of nearly a thousand feet, yielding $1\frac{1}{8}$ million feet per twenty-four hours. The Canadian Pacific Railway Company has just completed drilling a well to a depth of 989 feet with $4\frac{5}{8}$ inch casing to 941 feet. The pressure per square inch developed in eighteen hours was 525 pounds.

Cement.—The production of natural rock cement, which has for a number of years been small in comparison with the output of Portland cement, shows another large decrease in 1904, the sales being only 56,814 barrels, valued at $49,397, as compared with 92,252 barrels valued at $74,655 in 1903. Although a much larger quantity of Portland cement was sold in 1904 the total value, owing to the fall in price is only slightly in excess of that in 1903. In the absence of complete returns, Portland cement statistics have been partially estimated. The following is, however, a close approximation:—

Portland cement sold........	900,358 brls.	valued at $1,272,992
" manufactured...	908,990 "	
Stock on hand January 1, 1904...	124,919 "	
" December 31, 1904.	133,551 "	

The imports of Portland cement in 1904 were:

Six months ending June.....	cwt.	829,872	$ 320,137
" " December..........	"	1,916,336	740,919
Total........................	"	2,746,208	$1,061,056

This is equivalent to about 784,630 barrels of 350 pounds each, at an average price per pound of $1.35. The duty is twelve and a half cents per hundred pounds.

Exports of Products of the Mine, Calendar Year 1904.

Product.		Quantity.	Value.
			$
Aluminium in bars, ingots, etc.	Lbs.	296,801	59,260
Arsenic	"	146,000	6,900
Asbestus	Tons.	37,272	1,160,887
Barytes...........................	Cwt.	13,080	5,178
Chromite	Tons.	3,338	60,336
Coal...........................	"	1,557,412	4,036,373
Feldspar...........................	"	13,960	29,263
Gold bearing quartz, dust, nuggets, etc........	$	....	15,737,477
Gypsum, crude...........................	Tons.	298,211	316,436
Copper, fine in ore, &c........................	Lbs.	38,548,473	4,215,596
" black or coarse, cement-copper and copper in pigs...........................	"	4,809	618
Nickel in ore, matte, &c........................	"	11,233,869	1,091,349
Lead in ore, &c........................	"	25,826,413	558,464
" pig, &c........................	"	42,410	997

Exports of Products of the Mine, Calendar Year 1904.—*Con.*

Product.		Quantity.	Value.
			$
Platinum in ore, concentrates, &c	Oz.	....	140
Silver in ore, &c	"	3,371,013	1,904,394
Mica	Lbs.	795,843	198,482
Mineral pigments	"	832,570	7,260
" waters	Gals.	6,615	2,917
Oil—			
crude	"	4,207	213
refined	"	2,126	470
Ores—			
Antimony	Tons.	160	7,237
Iron	"	168,828	401,738
Manganese	"	123	2,706
Other	"	8,579	222,117
Phosphate	"	191	5,348
Plumbago, crude	Cwt.	3,542	9,609
Pyrites	Tons.	18,279	49,911
Salt	Lbs.	1,006,036	4,186
Sand and gravel	Tons.	399,809	129,803
Stone, ornamental	"	162	1,082
" building	"	70,639	16,720
" for manufacture of grindstones	"	887	8,717
Other products of the mine		....	18,523
Manufactures—			
Bricks	M.	696	5,357
Cement	$	....	5,494
Coke	Tons.	102,463	345,031
Clay	$	....	2,722
Grindstones, mfd	"	....	26,895
Gypsum, ground	"	....	2,333
Iron and steel—			
Stoves	No.	1,366	17,642
Castings	$	....	61,624
Pig iron	Tons.	21,016	200,363
Machinery, N.E.S	$	....	356,868
Scrap iron or steel	Cwt.	157,182	76,125
Hardware, N.E.S	$	....	120,070
Steel and mfgs. of	"	....	332,932
Sewing machines	No.	1,073	22,663
Typewriters	"	4,240	130,115
Lime	$	....	73,838
Metals, N.O.P	"	....	478,435
Plumbago, mfg. of	"	....	6,958
Stone, ornamental	"	....	4,722
" building	"	....	38

VISITORS TO THE MUSEUM.

The number of visitors who signed the museum register during the year 1904 was 32,844 being 5,007 more than in 1903.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The staff at present employed numbers 63.

During the year the following changes took place in the permanent staff:—

Mr. James A. McGee died.

Mr. Charles Camsell was appointed to the technical staff.

Messrs. O. E. Prud'homme, J. A. Robert and J. S. H. Lefebvre were appointed as draughtsmen in the topographical branch.

Mr. John J. McGee was appointed as a Junior Second Class clerk, vice Mr. James A. McGee, deceased.

The funds available for the work and expenditure of the Department during the fiscal year ending 30th June, 1904, were :—

Details.	Grant.	Expenditure.
	$ cts.	$ cts.
Civil-list appropriation	58,116 66	
General appropriation	75,005 00	
Civil-list salaries		52,952 14
Explorations and Surveys		16,719 21
Wages of temporary employees		23,553 00
Printing, engraving and lithographing		18,696 32
Books and instruments		1,585 88
Chemicals and apparatus		496 55
Specimens for Museum		65 20
Stationery, mapping material, &c.		1,669 17
Incidental and other expenses		2,899 09
Advances to explorers		19,202 50
		137,839 06
Deduct.—Advanced in 1902-03 on occount of 1903-04 $10,545 00 Less—unexpended and credited Casual Revenue 90 55		10,454 45
		127,384 61
Unexpended balance Civil-list appropriation		5,164 52
" " General "		572 53
	133,121 66	133,121 66

The correspondence of the Department shows a total of 12,864 letters sent, and 13,762 received.

I have the honour to be, Sir,

Your obedient servant,

ROBERT BELL,

Acting Deputy Head and Director.

Ottawa, May 1905.

APPENDIX I.

ASSAYS, BY M. F. CONNOR, OF ORES REFERRED TO IN MR. INGALL'S REPORT.

—		Copper.	Silver. (Oz. to ton)	Gold. (Oz. to ton)	Platinum.	Remarks.
		%				
C. P. Smith property..	(1)	0·25	0·05	Traces.	Nil.	(1) Pit in west end of property.
Lot 2, Con. III.......	(2)	Nil.	Nil.	Nil.	Nil.	(2) Stripping at east end of property.
Johnson Tp., Algoma.	(3)	2·18	0·14	Traces.	Nil.	(3) Stripping at east end of property.
Rock lake mine, Algoma..		8·15	0·26	....	Nil.	Ore dump.
Bruce mines, Algoma......		5·89	Trace.	....	Nil.	
Cameron mines, Algoma...		3·15	0·05	Average gold value, 15 cts. per ton.	Nil.	Quartz ores containing copper pyrites.
Hinks mining location, Johnson Tp., Algoma....		5·88	0·08	....	Nil.	
South Echo Bay mine, Algoma		4·52	0·16	....	Nil.	
King Edward mine, N. of Bruce mines............		4·62	0·16	....	Nil.	

MAY 25th, 1905.

In view of the rumoured results of assays of ores in the district showing considerable quantities of platinum and of the precious metals, the above set of specimens, collected by Messrs. Ingall and Denis, were examined in the laboratory of the Survey. Unfortunately, no ore concentrations, from which more characteristic results might have been obtained, were available, but the extent of the mineralization of the hand specimens utilized can be judged from the copper contents, if it be surmised, as is most probable, that the precious metals would be associated with the chalcopyrite. In this set of guide assays, it will be noted that platinum is altogether absent, whilst the quantity of gold is insignificant, and silver is present in only unimportant quantities.

APPENDIX II.

Notes on a collection of organic remains from the ferruginous and friable shales of Messenger Brook, Torbrook, near county-line, between Kings and Annapolis, south of Kingston, in King's county, Nova Scotia, collected Nov. 24th, 1902, by Hugh Fletcher, by H. M. Ami, Assistant Palæontologist.

In November, 1902, Mr. Hugh Fletcher, of the Geological Survey staff, forwarded to Dr. J. F. Whiteaves a small collection of fossil organic remains from the more or less altered, rusty shales of Messenger

Brook, Annapolis county, Nova Scotia, with a view of ascertaining the precise geological horizon to which the strata from which the specimens were derived, belonged. "*Dictyonema sociale (var. Websteri)*" was reported to have been found in the same beds with the fossils sent for determination.

This collection was placed in my hands by Dr. Whiteaves and a request was made by Mr. Fletcher for a list of the species which it contained, together with the determination of the horizon indicated by the entombed fauna. I desire to submit the following notes made in a preliminary examination of the obscure forms in the collection.

LIST OF SPECIES.

Echinodermata.

1—Obscure and imperfectly preserved fragments of crinoid stems, too imperfect for identification.

Bryozoa.

2 3—Several species of monticuliporoids, mostly branching forms, which require microscopical sections before they can be identified. Better material required.

4—*Fenestella*, sp. A few fragments of a species of *Fenestella* are clearly discernable in the collection. Between four and five fenestrules or openings between the rows of cells occur in the space of five millimetres. Probably a new species.

Brachiopoda.

5—*Orthis*-like shell, too crushed to be recognized; possibly a *Rhipidomella*.

6—*Strophomena*, sp., indt.

7—*Spirifer* sp., several imperfect casts of a species of this genus, too imperfectly preserved to be identified.

Pelecypoda.

8—*Pterinea*, sp. indt. two specimens occur in the collection which can be referred to this genus. They are incomplete and imperfectly preserved, but they exhibit strong radiating and concentric lines which give to the shell a decided cancellate appearance and structure. Appears to belong to the same section as *Pterinea textilis*, var. *arenaria*, or a closely related species.

Gasteropoda.

9—An obscure fragment of a gasteropod whose affinities appear to place it near to *Platyostoma*, too imperfect for identficatio n.

Crustacea. (Trilobita and Merostomata.)

10—An imperfectly preserved portion of the pygidium which appears to indicate the presence of a Phacops or a *Homalonotus.*

11. *Pterygotus ?* Two crushed and flattened sac-like bodies, which appear on one side of a slab of rock from the Messenger Brook, when examined under a lens exhibit crustacean-like structure whose affinities appear to place them near to the above genus. Close to these sac-like bodies are a large number of more or less regularly disposed, rounded, or at times hexagonal structures, spread out on the face of the slab. These resemble the ova of *Pterygotus* such as have been figured by Dr. Henry Woodward in the Palæontographical Society's Memoir on the "British Fossil Merostomata," plate XVI, fig. 10.

The finely pitted, and crustacean, or horny-like character of the test of the sac-like bodies leads me to conclude, in the absence of further collections and study, that they are probably examples of the sacs in which were enclosed the ova of a species allied to Pterygotus.

The horizon indicated by the species and genera represented in this small collection appears to me to be somewhere in the neighbourhood of the base of the Devonian or the summit of the Silurian system. The forms are practically all marine in character, and I have not been able to detect any form in common between Messenger Brook fossils and those from the Torbrook sandstones obtained by Dr. L. W. Bailey in the same county some years ago. It would, however, be interesting to know the relation of the two series to each other in the succession of the geological formations of south-western Nova Scotia. The sedimentation, as developed in the south-western part of Nova Scotia appears to be very similar to that of south-western England. From a comparative study recently made by the writer, he was able to correlate a number of geological formations in common on both sides of the Atlantic, both in the Silurian and Devonian systems, affording additional evidence of the striking parallelism which exists between the different members of the series, both as to their origin and condition of deposition.

Iron ores occur associated with these fossiliferous strata, and the precise geological horizon of both the sandstones and the shales will be determined when the collections made in 1904, and those which it is hoped will follow in 1905, have been examined and reported upon. The Torbrook sandstones are definitely of Eo-Devonian age ; and it is not at all unlikely that the Messenger Brook shales are higher in the series.

N.B.—Additional material is required from this locality—H. M. A.

APPENDIX III.

Description of a species of Bythotrephis from the dark-gray calcareous and indurated slates collected by Mr. J. B. Tyrrell from a locality along the Unihani river, seven miles north of Dalton's Post, Yukon Territory, Canada. By H. M. Ami, of the Geological Survey of Canada.

BYTHOTREPHIS, Hall, 1847.

BYTHOTREPHIS YUKONESIS, N. Sp.

Description—This species is represented by a number of smooth, slender shining, flattened and somewhat flexuous stems or branches of an alga which divide into a number of branchlets given off at various angles, ranging from an acute angle of from 15° to 20°, to an angle of 75° in the direction of the apex or extremity of the branch or stem.

The largest specimen in the collection—itself a fragment—measures *three* centimetres in length, and one millimetre in breadth, giving off three branches in the space of eight millimetres.

A smaller specimen, giving off a branch about five millimetres from its distal extremity, measures one centimetre in length and is one millimetre across also, as in the largest specimen; the angle formed by the branch and the stem proper being between seventy-five and eighty degrees (75° to 80°). The extreme tips of the branches in this specimen are abruptly pointed.

The twelve specimens in the collection are preserved in a matrix of dark-gray indurated calcareous rock as black shining stems on the divisional planes of stratification. The rock is traversed by numerous veinlets of calcite running at various angles to one another and to the stratification, but usually at right angles to the latter or nearly so.

Locality and Horizon.—Seven miles north of Dalton's Post, Unihani river, Yukon district, Canada. Collected by Mr. J. B. Tyrrell, June 27th, 1898 Lower Palæozoic, not unlike forms from the Lower Ordovician and Cambrian of Canada, and from similar horizon in other parts of the world.

APPENDIX IV.

Determinations of fossil plants from various localities in British Columbia and the North-west Territories, by Professor D. P. Penhallow, of McGill University, Montreal, with notes on the geological horizons indicated, by H. M. Ami, Assistant Palæontologist, Geological Survey of Canada.

Since the demise of Sir William Dawson, of McGill University, to whom most of the fossil plant remains discovered by various geologists in the different provinces and territories of the Dominion were wont to be sent for determination and study by the officers of this Department, this work has fallen upon the shoulders of Professor Penhallow of McGill University, who succeeded Sir William Dawson in the Chair of Botany in that Institution.

Five collections of fossil plants were recently forwarded from the collections of the Geological Survey Museum to Prof. Penhallow, who, at Dr. Bell's request, kindly undertook to determine the species represented. They include the following :—

A.—Leaves, stems of plants, seeds, fragments of cones &c., from the brown shales of the Diamond Vale Coal Company's property at Quilchena, British Columbia, collected by Dr. R. W. Ells and R. A A. Johnston, 1904.

B.—Leaves, fragments of branches, from the gray shales of Coal Gully, near Coutlee, British Columbia. These gray shales are some 400 feet below the horizon of the brown shales holding the abundant flora at Quilchena, B.C. R. W. Ells and R. A. A. Johnston, 1904.

C.—From the valley of the Red Deer river, at the mouth of the Blind Man river, on Berry creek, and five miles below Matjiwin creek, North-west Territories. Collected by Mr. L. M. Lambe, 1897.

D.—Remains of cycads, from the coal-bearing strâta of the Crows Nest coal-fields, Michel station, C.P.R., British Columbia. Collected by J. McEVoy, 1900.

E.—Specimens collected by Mr. J. B. Tyrrell, Mining Engineer in Dawson City, Yukon territory, from the Nordenskiold river, 1898.

A.

Plants from the Diamond Vale Company's property, Quilchena, B.C. :—

Taxodium distichum miocenum, Heer.

Taxodium occidentale, Newb.
Thuya interrupta, Newb.
Ginkgo digitata, (Brongn.) Heer.
Sequoia Nordenskioldii, Heer.
Fragments of exogenous stems associated with leaves of *Taxodium distichum.*
Taxodium distichum, in part.
Fruit of *Betula heterodonta ?* Newb. in part.
Pinus trunculus ? Dawson.
Alnites curta, Dawson. Cones.
Populus obtrita, Dawson.
Carpinus grandis, Unger.
Sassafras cretaceum, n. sp.
Ulmus speciosa, Newb-
Quercus castanopsis, Newb,
Cornus Newberryi, Hollick.
Carya antiquorum, Newb.
Betula angustifolia, Newb.
Populus polymorpha, Newb.

Populus polymorpha, Newb. Thuya interrupta, Newb. Pinus trunculus ? Dawson. Alnites curta, Dawson. Fragment of cone.	Four species on one slab.

Rhamnus ? sp.
Salix orbicularis, n. sp.
Grass seeds.
Picea Quilchensis, n. sp.
Rhamnus serrata, n. sp.
Magnolia sp.

HORIZON INDICATED.

The age of these brown shales, overlying the coal-bearing strata of the Quilchena basin in the Nicola district of British Columbia, from the flora determined by Professor Penhallow, would lead me to infer that it is referable to the Miocene Tertiary. *Populus obtrita, Alnites curta, Carpinus grandis* as well as *Pinus trunculus* were recorded by Sir William Dawson from the brown and very similar shales of the Similkameen valley in his paper on the fossil plants of the latter locality in the Transactions of the Royal Society of Canada for 1890.

I have elsewhere (Trans. Roy. Soc. Can., 2nd Series, Vol. IV, Sect. 4, 1901–1902, p. 220) designated the strata holding the fossil plants described by Sir William Dawson, and the fossil insects by Dr. S. H.

Scudder, as the "Similkameen formation," and to this formation I would also refer the brown plant-bearing shales of the Quilchena coal basin, in the Nicola district of British Columbia. (See p. 42.)

B.

The following specimens are from Coal Gully, near Coutlee, British Columbia, and were collected by Dr. R. W. Ells, and R. A. A. Johnston, 1904.

Taxodium distichum miocenum, Heer.
Ficus sp.
Ulmus sp.
Taxodium distichum.

HORIZON INDICATED.

Notwithstanding the fact, as stated by Dr. Ells, that these gray shales are some 400 feet below the horizon of the brown shales of the Similkameen formation in the Quilchena coal basin, they are nevertheless referable to the Miocene Tertiary. These gray strata, associated as they are with the coal of the area in question, have as yet furnished only a few specimens of fossil plants. On further examination, others may be obtained from these strata, that may throw new light upon the precise geological horizon to which they are to be referred. Until such collections are available, it appears to be quite safe to refer these gray shales to the lower portion or division of the Similkameen formation.

C.

Red Deer river valley, mouth of the Blind Man river, North-west Territories, collected by Mr. L. M. Lambe, during his explorations in vertebrate palæontology, 1897.

Populus obtrita, Dawson.
Taxodium occidentale, Newb.
Sequoia Couttsiae, Heer.
Carya antiquorum, Newb.
Taxodium distichum miocenum, Heer.
Sphenopteris Blomstrandi, Heer.
Viburnum ovatum, Penhallow.
Sphenozamites oblanceolatus, n. p.
Osmundites macrophyllus, n. sp.
Populus cuneata, Newb.
Sequoia Couttsiæ ?

Corylus Macquarrii?
Clintonia cblongifolia, Penhallow.

HORIZONS INDICATED.

The sandstones and associated strata from which these plant-remains were derived on the Red Deer river, at the mouth of the Blind Man river, are referable to the Laramie, and particularly to the upper portion, which is of Tertiary age. This upper series in the Laramie, Mr. Tyrrell has designated as the Paskapoo formation. To this formation the above species of plants obtained by Mr. Lambe and determined by Prof. Penhallow, are referred except *Populus cuneata* and *Sequoia Couttsiæ*, which belong to the Belly River series or formation in the Upper Cretaceous. These two plant-remains came from (a) five miles below the mouth of Matjiwin creek, and (b) Berry creek respectively.

D.

Fossil plants from the coal-bearing stata of the Crows Nest coal basin, Michel station, C.P.R., British Columbia, collected by J. McEvoy, of the Geological Survey of Canada, 1900.

Podozamites lanceolatus, Lindl.
Thyrsopteris sp.—approaching very closely to *T. mackiana*, Heer
Cladophlebis constricta? Newb.

HORIZON INDICATED.

The age of the Crows Nest coal-bearing strata has been ascribed by Sir William Dawson to the Kootanie series, which is generally held to be of Jurasso-Cretaceous age.

E.

Nordenskiold river, Yukon territory, collected by Mr. J. B.Tyrrell, 1898.

Cladophledis sphenopteroides, Font.
Cladophlebis rotundata, Font.
Cladophlebis? sp.
Fragments from stipe of fern fronds, and *Carpolithes.*
Various fragments from stipes and rachises of ferns.

HORIZON INDICATED.

The specimens from this horizon appear to indicate a Lower Cretaceous flora not far removed from that of the Kootanie series of Sir William Dawson.

The Geological Survey of Canada is under special obligations to Professor Penhallow for his willingness to undertake the determination of these various collections.